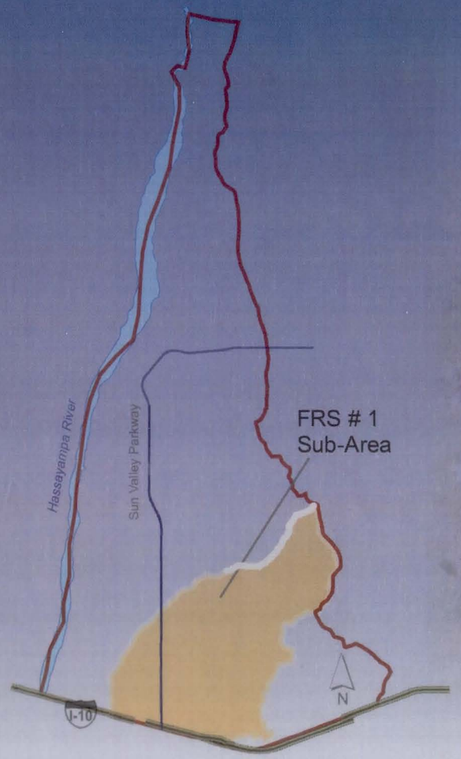
BOOK 20 OF 30

Sun Valley Area Drainage Master Plan



Step 2
Proposed Alternatives
Analysis Report

Volume 6
1 2 OF 3
FRS #1 SUB-AREA

September 2006

Flood Control District of Maricopa County
A211.221

SUN VALLEY AREA DRAINAGE MASTER PLAN

STEP 2 PROPOSED ALTERNATIVES REPORT
FRS #1 SUB-AREA
VOLUME 6

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ENCLOSED DATA CD INCLUDES:

- Digital Copy of Report in PDF Format
- GIS Shapefile Coverages of Project Elements
- Excel Files of Design Analyses
- HEC-1 Model Files

1 ABSTRACT / EXECUTIVE SUMMARY

Structural and non-structural alternatives were developed and evaluated as part of Step 2 of the Sun Valley Area Drainage Master Plan (SVADMP). This is the second of a three step process to develop a drainage master plan for the Sun Valley area. Four flood control alternative strategies were identified in Step 1 of the ADMP process. Those four strategies were further refined in Step 2. The refined alternatives included both non-structural and environmentally friendly, aesthetically compatible structural flood control measures.

In order to achieve this refinement, the area was divided into seven geographic sub-areas based on the type and nature of flooding and the distribution of alluvial fan landforms in the study area. This volume presents the results for one of those sub-areas, the FRS #1 sub-area. Seven different flood control alternatives were developed and evaluated including apex strategy variations including avoidance, on-line and off-line detention basins, and conveyance. Earthen and concrete excavated channels were also compared with a leveed natural corridor for the downfan conveyance structures. Multiple alignment alternatives were also investigated for four of the six piedmont sub-areas. Non-structural approaches were incorporated wherever possible.

Figure 1 Sun Valley Piedmont

Figure 2 Skyline Fan

Engineering and landscape compatibility enhancement costs were estimated for all of the proposed alternatives piedmont sub-areas. The proposed alternatives were evaluated for their flood control function, economic costs, environmental impacts, permitting issues, visual and aesthetic characteristics, and recreation and multiple-use opportunities. Preference for natural leveed corridors downstream of on-line detention basins along multiple alignments was expressed by the project team, stakeholders, and the public for the piedmont sub-areas including the FRS #1 sub-area (this volume).

The recommended alternatives will be carried forward for further refinement of the engineering elements and the cost estimates in Step 3. Special attention will be given to maximizing non-structural, floodplain management approaches along the preferred leveed corridor alignments. Stakeholders and the public will continue to be consulted as to their feedback in attempt to incorporate existing and imminent developer plans into the drainage master plan for the Sun Valley area.

2 INTRODUCTION

2.1 Report Organization

The Step 2 Proposed Alternative Analysis Report is presented in seven (7) volumes. Volume 1 provides an overview of the ADMP, explains the ADMP process and the alternatives analysis, summarizes the Step 2 evaluation and results, and provides recommendations for the Step 3 refinements to the recommended alternative. Volume 1 also provides a discussion of general area-wide flood control issues and potential solutions as well as specific issues and potential solutions for the area north of the Central Arizona Project Canal. The so-called North of CAP sub-area is included in Volume 1 for two reasons: first, the sub-area is not dominated by large alluvial fans like the piedmont sub-areas in the remainder of the study area; second, the recommendations for the North of CAP sub-area are predominantly non-structural in nature.

Volumes 2 through 7 present the proposed alternatives for the piedmont sub-areas as follows:

2) CAP (Volume 2),

3) Wagner Wash (Volume 3),

4) Hassayampa River (Volume 4),

5) White Tanks Wash (Volume 5),

6) FRS #1 (this volume), and

7) FRS #2 & #3 (Volume 7).

The alternatives presented in Volumes 2 though 7 are primarily structural in nature. Therefore, the discussion of design methods, calculations, and results are more involved, and require additional information in their presentation. Volumes 2 through 7 also include site specific data, hydraulic analyses, and cost estimates for each of the proposed alternatives.

It is intended that each Volume of the Step 2 report be able to stand alone so that a reader, such as an interested stakeholder, unfamiliar with the ADMP, or uninterested in other sub-areas, can understand the overall study as well as the details of an individual sub-area of particular interest to them. Excessive detail associated with the design calculations are left out of Volume 1 in order to provide a more digestible document for the reader interested in the Proposed Alternatives Analysis as a whole.

The advantages of this type of report organization are:

- The reduction of reproducible materials required for interested users or stakeholders.
- It provides a condensed overview of the ADMP process and Proposed Alternatives Analyses.
- It narrows the focus to a specific sub-area while still providing an overall comprehensive summary of the Step 2 process and Alternatives descriptions.

2.2 Project Background

The Sun Valley area, located in western Maricopa County, Arizona, is presently experiencing the first stages of accelerated urbanization (Figure 3). Future development is anticipated to occur on the largely undisturbed alluvial fans and piedmont surfaces comprising the western slope of the White Tank Mountains (Figure 4). The upland areas and adjacent watershed drain to the Hassayampa River to the west and the Buckeye Flood Retarding Structure (FRS) Numbers 1, 2, & 3 along Interstate 10 to the south.

The purpose of the SVADMP is to develop a conceptual drainage plan to serve as a roadmap that jurisdictional authorities and developers can use in planning flood control measures to mitigate flood hazards up to the 100-year event. The SVADMP incorporates development plans for the area and jurisdictional drainage policies to develop a preferred regional flood control solution.

The major objectives of the project include the following:

- Plan regional flood hazard mitigation;
- Preparation of approximate alluvial fan floodplain delineations, meeting Federal Emergency Management Agency (FEMA) and Flood Control District of Maricopa County (District) standards, for those alluvial fans in the study area not previously delineated;
- Coordination between the ADMP regional flood control measures and the design of drainage features within the master planned community developments within the study area;
- Preparation of preliminary design of flood control facilities in areas not within master planned communities; and
- Design of landscape aesthetics and visual character in accordance with the District's *Landscape Aesthetics and Multi-Use Consultant Handbook (April 2003)*.

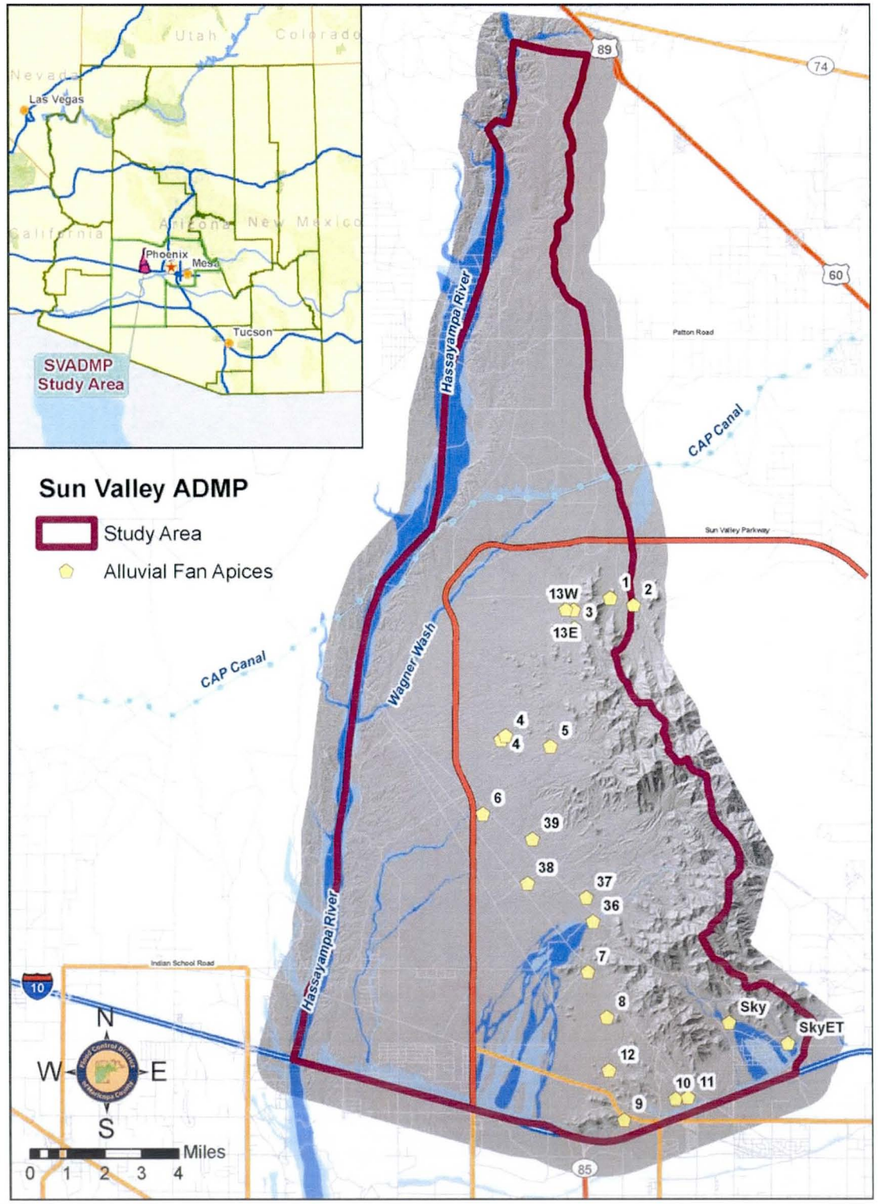

Figure 3 Location of Study Area

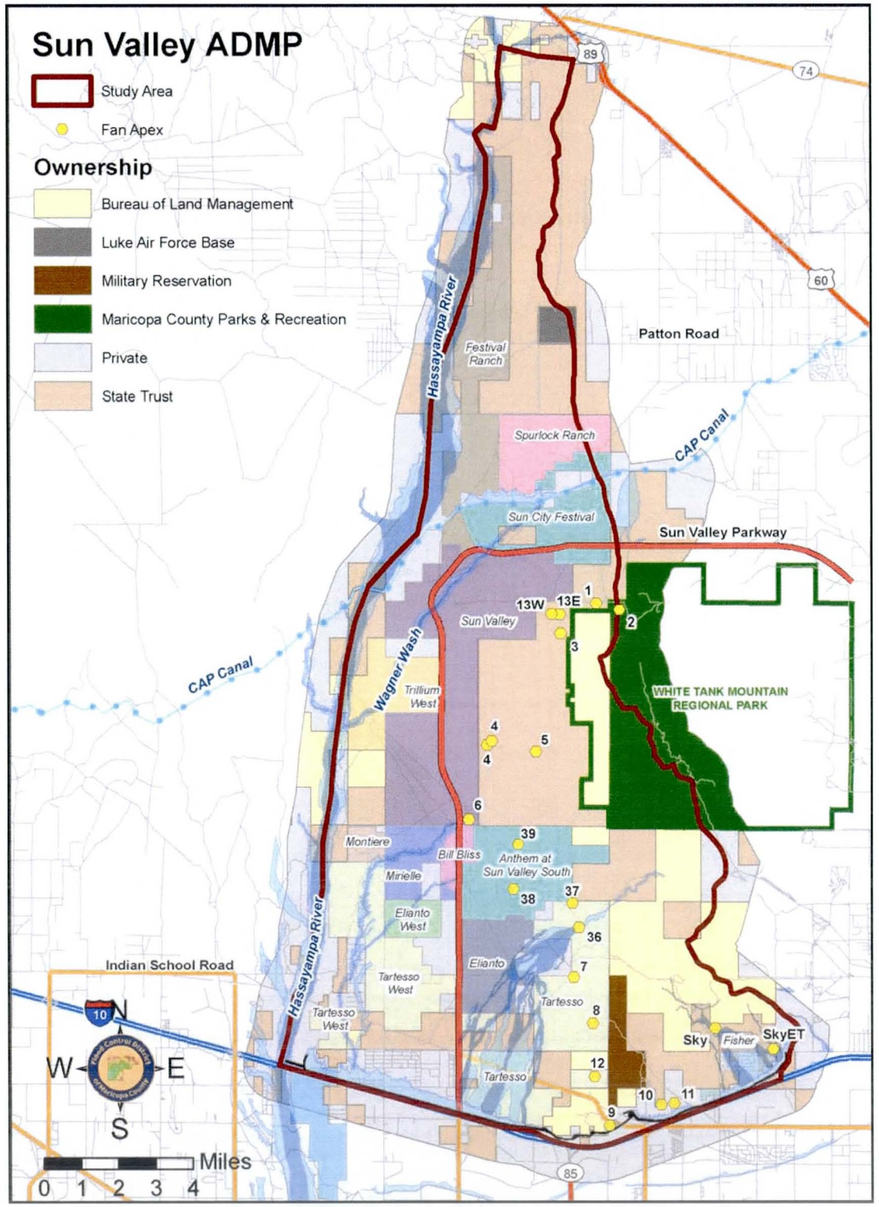

Figure 4 Future developments in the ADMP study area

Previously, the Phase I Buckeye/Sun Valley Area Drainage Master Study (ADMS), conducted by PBS&J, documented and analyzed existing conditions and identified drainage and flooding problems in the study area for the purpose of initial formulation of flood protection alternatives. The Phase II Sun Valley Area Drainage Master Plan builds on the Phase I findings by employing a 3-step process with the goal of developing a Recommended Alternative, consisting of both structural and non-structural measures, to address flood hazards in the study area. Figure 5 shows a flowchart illustrating the SVADMP alternatives development process.

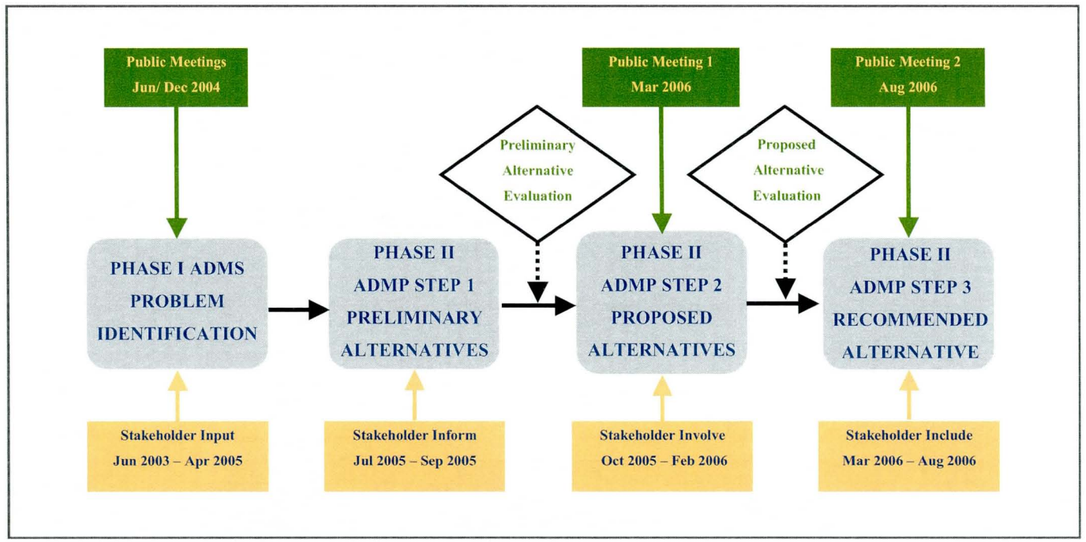

Figure 5 Alternatives development process

This report is part of the Phase II ADMP Step 2 Proposed Alternatives formulation process which focuses on further development of the recommendations of the Step 1 Preliminary Alternatives. The purpose of this study is to evaluate the Step 2 Proposed Alternatives in support of the SVADMP. The Step 2 Proposed Alternatives Report outlines the alternatives development, evaluation, and selection of the Recommended Alternative. The Recommended Alternative will be further evaluated and refined in Step 3 of the ADMP formulation process.

Based upon the recommendations resulting from Step 1, further evaluation of the Preliminary Alternatives was performed at Step 2 to determine engineering feasibility and approximate costs. The Step 1 Preliminary Alternative measures are combined to formulate the conceptual design of regional, whole-fan Step 2 Proposed Alternatives. The concept designs of the Step 2 Proposed Alternatives are presented as part of this study along with cost estimates. The cost estimates include engineering design, major construction items, right-of-way acquisition, major utility relocations, landscape compatibility aesthetic improvements, and maintenance cost for a 50-year design life.

2.3 Authority for Study

The current study was authorized by the Flood Control District of Maricopa County (District) under contract FCD 2004C049 as part of the scope of services for the SVADMP. The Town of Buckeye, Arizona was a project participant. The ADMP was performed by JE Fuller/ Hydrology & Geomorphology, Inc., with subconsultants C.L. Williams Consulting, Inc., Logan Simpson Design, Inc., AMEC Earth & Environmental, EDAW Inc., and Richard H. French, Ph.D., P.E.

2.4 Location of Study Area

The study area is located in western Maricopa County, Arizona and includes a total watershed area of 183 square miles. Figure 3 shows the location of the study area. Most of the study area is located within the Town of Buckeye. The study area is bounded by the White Tank Mountains and Trilby Wash on the east, the Hassayampa River on the west, the Buckeye Flood Retarding Structures on the south and Gates Road to the north. The watercourses within the study area are all tributaries to the Hassayampa River or the Buckeye Flood Retarding Structures, except Fan 2 which is a tributary to Trilby Wash.

3 ADMP Process

3.1 Process Overview

The highly dynamic nature of alluvial fan flooding presents significant challenges for the design of engineered flood control measures. The designed drainage infrastructure must effectively and efficiently convey 100-year discharges without creating unwanted sediment aggradation or degradation. Further complexity is added as flood hazards change in type and severity with geographic position on the fan whether the area of interest is located at the apex, mid-fan, or near the outfall; and if the flood event is less than the 100-year event.

Known problems associated with alluvial fan flooding include spatial uncertainty of the flow distribution, lack of containment within the relatively flat topographic relief laterally across the fan, avulsive movement of defined flow paths, flooding along undefined flow paths, sheet flooding, distributary flow, scour, and landform aggradation (Figure 6). In addition, steep channel slopes between fan apices and fan toes result in high flow velocities with enough energy to move significant volumes of sediment and debris during large floods (Figure 6).

Figure 6 Aerial view of active portion Fan 36 in the FRS 1 Sub-area dated 1954

The Step 1 Preliminary Alternatives Evaluation presented the outline for the alternatives to be analyzed as part of the Step 2 Proposed Alternatives Evaluation. The Step 1 Preliminary Alternatives Evaluation process identified five areas within each fan starting from upstream to downstream: 1) Apex, 2) Up Fan 3) Parkway 4) Down Fan and 5) Outfall (Figure 7). Flooding and drainage characteristics vary for each of these component areas of the alluvial fan landform. This classification permits the design process to identify potential flood control measures specific to each of these areas which, in combination, comprise a whole-fan solution. The whole-fan solution provides a regional flood control system which acts as a major trunk drainage system for the adjacent watersheds.

The trunk system is designed to convey runoff and sediment inflows from the apex plus that generated from the fan surface itself. Note that most, but not all, of the alluvial fans considered in this study have all the five component areas (Figure 8). However, the overall design considerations are similar for all the fans.

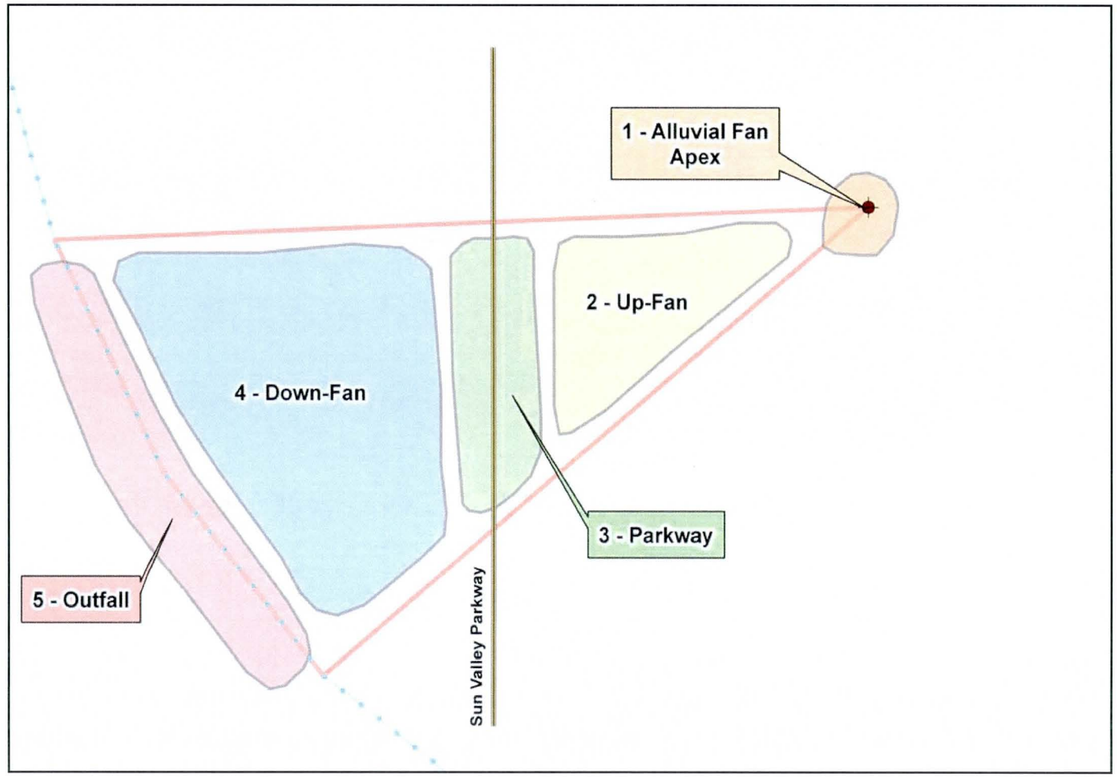

Figure 7 Fan Area Classification

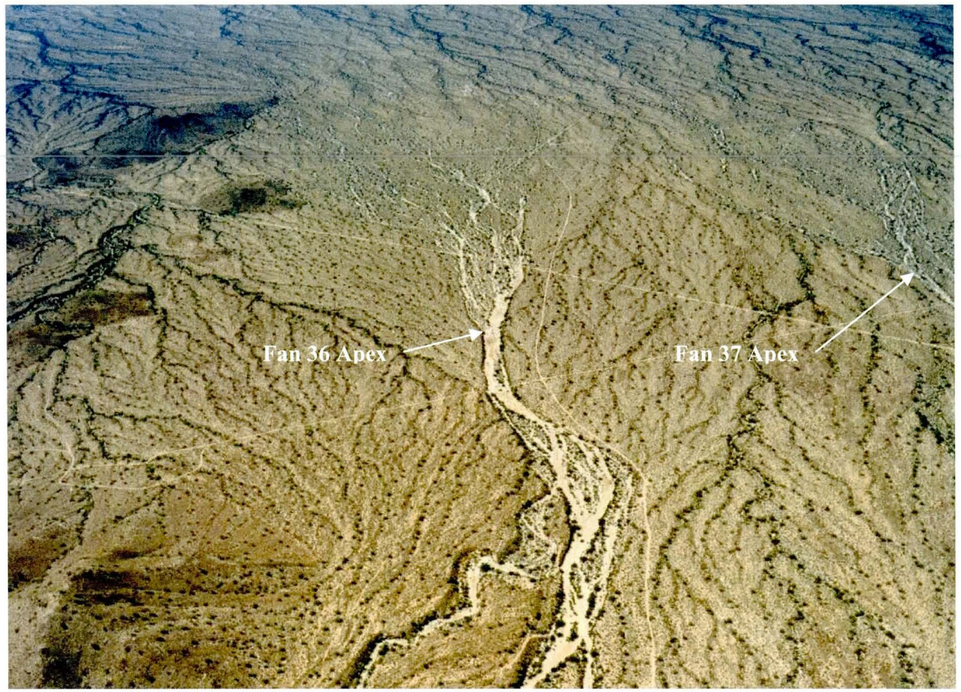

Figure 8 View downstream of Fan 36 (center) and 37 (on right)

The Step 1 process also identified the following design strategies: 1) Conveyance, 2) Storage, 3) Management, and 4) No Measure. These strategies apply to each of the five areas starting from apex to the outfall and form the basis of the Preliminary Alternatives. Four major alternatives were identified based on these strategies: Alternative A, Alternative B, Alternative C, and Alternative D. These four alternatives consist of different combinations of strategies for each of the different areas from apex to outfall. Each alternative can be described as a particular set of strategies applicable to different areas of the fan. In this study, these four alternatives are considered as part of the Step 2 Proposed Alternatives Evaluation process through refinement of the Step 1 concepts.

In order to address alluvial fan flooding hazards in the Sun Valley study area, regional whole-fan alternatives consisting of a suite of structural and non-structural measures will be required. The major structures considered in the Step 2 design approach are detention basins and open channel conveyance corridors. Detention basins reflect the Step 1 Storage strategy, while the channel corridors reflect the Step 1 Conveyance strategy.

Non-structural measures are also considered for the SVADMP alternatives. The Step 1 Management strategy includes development guidelines, floodplain delineation studies, flood detection network recommendations, and/or voluntary flood-prone property acquisition to mitigate impacts to current downstream private landowners and to prevent/mitigate impacts of future development. Management strategies are addressed in the Step 2 Proposed Alternatives Report.

The Step 1 process also defined the No Measure strategy including enforcement of existing regulations and the permitting process, allowing developers to address flood control issues within their parcel footprints in a manner compliant with existing regulations and approved by the District through permitting process. Thus, the No Measure strategy represents a non-structural solution in that no regional flood control solution is a part of this strategy.

The Alternatives A, B, C, and D formulated in the Step 2 process consist of particular combinations of detention basins, conveyance corridors, developer-planned drainage improvements, and 'no measure' options applied to different areas of the alluvial fan starting upstream at the apex to the downstream outfall. The formulation of the alternatives in terms of the specific combinations of structural and non-structural measures selected for the various portions of the alluvial fans are driven by the selection of the measures at the fan apices. For example, Alternative B includes a detention basin located at the fan apex to control flow and sediment discharges to downfan areas. Open channel corridors along multiple alignments contain and convey design discharges through the up-fan area. Off-line detention basins are considered as part of cross and/or lateral drainage improvements at Sun Valley Parkway, outletting through culverts to the down-fan area conveyance corridors to outfall structures.

During the Step 2 process, Alternative B was further subdivided into five similar, but unique alternatives named B1, B2, B3, B4, and B5. This was done primarily to evaluate the following: 1) influence of size of the apex detention basin on the design of the downfan system; 2) different channel cross-section types; and 3) various channel alignments. Further details on each alternative are presented in Section 4.3.

3.2 Additional Process Background for Step 2 Alternatives Formulation

During the initial Step 2 analyses, multiple stakeholder and team meetings were held to discuss the alternatives development. Stakeholders included in the process are listed in Table 1. The stakeholder process included Stakeholder Workgroup meetings as well as numerous individual meetings with stakeholders and the project team. Specific input was received about the potential challenges to direct impacts to existing riparian areas as a result of implementation of the alternatives. In addition, concerns were raised about the scale of proposed facilities. As a result, the so-called 'companion channel' and 'leveed corridor' alternatives were generated for evaluation in Step 2. These alternatives are described further in Section 4.3. Another result of these meetings was to limit detention basin depths to no greater than 11 feet to reduce concerns about relative scale of the basins to neighboring developed features like houses.

Table 1 SVADMP Stakeholders

Meeting No.	Date	Agency	Purpose
1	3/7/2005	MCDOT	Sun Valley Parkway Corridor Study
2	7/14/2005	Fisher/ Williams	Skyline Wash coordination
3	8/10/2005	MCDOT	Sun Valley Parkway Corridor Study and culvert analysis
4	8/16/2005	Agency and Private Sector Stakeholders	Stakeholder Working Group Meeting 1
5	8/25/2005	MCDOT	Sun Valley Parkway Corridor Study
6	8/31/2005	Town of Buckeye	Project coordination, implementation, maintenance
7	9/7/2005	AZ Game & Fish	Project coordination, implementation
8	9/28/2005	CAP	Project coordination, implementation
9	9/30/2005	FRS #1 Sub-area Developers/ Engineers	Project coordination, data collection, implementation
10	10/3/2005	Area 4 N of CAP Sub-area Developers/ Engineers	Project coordination, data collection, implementation
11	10/18/2005	Hassayampa Sub-area Developers/ Engineers	Project coordination, data collection, implementation
12	10/19/2005	Town of Buckeye	Project coordination, implementation, maintenance
13	10/24/2005	ASLD/ Consultant	Project coordination, data collection, implementation
14	11/9/2005	ASLD/ Consultant	Project coordination, data collection, implementation
15	11/9/2005	Town of Buckeye	Project coordination, implementation, maintenance
16	11/22/2005	Fisher/ Williams	Skyline Wash coordination
17	11/29/2005	Public and Private Sector Stakeholders	Stakeholder Working Group Meeting 2
18	12/16/2005	Pulte/CMX	Fan 38 coordination
19	1/26/2006	Developers/ Engineers	Feedback regarding Step 2 alternatives
20	1/26/2006	Town of Buckeye	Project coordination, implementation, maintenance
21	2/8/2006	Town of Buckeye	Project coordination, implementation, maintenance
22	2/9/2006	ASLD/ Consultant	Project coordination, data collection, implementation
23	2/28/2006	Vistoso/ Carter Burgess	Project coordination, data collection, implementation
24	3/8/2005	General Public	Public Meeting 1
25	3/23/2006	Vistoso/ Carter Burgess	Project coordination, data collection, implementation
26	3/23/2006	Lennar/ CVL	Rec Alt coordination, data collection, implementation
27	3/23/2006	Capitol Pacific Homes/ CVL	Rec Alt coordination, data collection, implementation
28	3/28/2006	Stardust/ DEA	Rec Alt coordination, data collection, implementation
29	3/30/2006	Pulte/CMX	Rec Alt coordination, data collection, implementation
30	4/5/2006	Communities Southwest/ WRG	Rec Alt coordination, data collection, implementation
31	4/12/2006	Town of Buckeye	Rec Alt coordination, data collection, implementation
32	4/20/2006	ASLD/ Consultant	Rec Alt coordination, data collection, implementation
33	4/20/2006	MCDOT/ Consultant	Rec Alt coordination, data collection, implementation
34	5/1/2006	Stardust/ DEA	Project coordination

3.3 Landscape Character Assessment

The scope of work for the ADMP specifically states that the alternatives to be developed for the ADMP in Step 2 "are environmentally friendly and blend with the natural landscape of the area following the District's *Policy for the Treatment and Landscape of Flood Control Projects*". The alternatives presented in Section 4.3 all include enhancement elements to ensure that the proposed alternatives meet these objectives. In addition, the cost estimates also include the costs associated with these landscape enhancements.

3.4 Stakeholder and Public Involvement

The District and ADMP project team conducted an extensive stakeholder and public involvement process as part of the ADMP in general, and Step 2 in particular. Numerous group and individual meetings were held with the impacted parties in the area (Table 1). Input was received and two-way communication conducted to ensure clear understanding by the project team and the stakeholders as to the nature of the proposed alternatives and project progress. Ultimately, the close interaction of the project team and stakeholders had a significant impact on the nature and the evaluation of the proposed alternatives for the SVADMP.

4 DESCRIPTION OF ALTERNATIVES

Flood control alternatives for the SVADMP area included both structural and non-structural solutions. Given the landscape compatibility assessment, non-structural solutions are generally preferred whenever possible. However, for the areas impacted by active alluvial fans, the degree, extent, and uncertainties associated with the flood hazards are considered too extreme to make fully non-structural alternatives feasible. Therefore, for the areas impacted by large active alluvial fan flooding, structural measures are central to the proposed flood control alternatives evaluated in Step 2 of the ADMP.

The study area was divided geographically into sub-areas to focus the attention of appropriate structural or non-structural flood control alternatives for each sub-area. The area north of the Central Arizona Project (CAP) Canal is not impacted by large, widespread alluvial fan flooding and was therefore addressed separately. Most of the remainder of the study area south of the CAP is impacted by large active alluvial fans along the White Tank Mountains piedmont. This area south of the CAP was the focus of most of the ADMP alternatives development and evaluation tasks. In addition to the sub-area specific flood control alternatives, be they structural or non-structural, other general flood hazard related issues exist across the study area. These issues are addressed through a category called "areawide" issues.

The following sections describe the structural and non-structural flood control alternatives evaluated in Step 2 of the SVADMP for the FRS #1 sub-area. The North of CAP sub-area is addressed in Volume 1. Additional details on the other piedmont sub-areas are provided in Volumes 2-5 and 7 of the Step 2 Proposed Alternatives Report.

4.1 Areawide

A number of general, or areawide, flood hazard related issues were identified and addressed in the Step 2 portion of the ADMP. Many apply to the FRS #1 sub-area. Again, non-structural flood control alternatives are preferred. Therefore, many of the areawide issues are addressed with a non-structural approach. In other cases, areawide issues related to existing or potential future structural flood control measures. The following areawide items were noted:

Piecemeal solutions – Engineers do not recommend piecemeal construction of flood control projects (except for construction phasing) due to potential for conflicts in design and construction practice, inability to tie in to previously constructed sections, and the potential for permanent gaps. Other concerns with piecemeal flood control solutions include reflective scour, flanking of partial systems, first-come, first-serve inequities, landscape aesthetics, timing issues or other unplanned phasing complications, and potential changes in the regulatory environment whether it be FEMA, Section 404 Clean Water Act, or local ordinance changes. Piecemeal flood control solutions apply to any system including floodway fringe encroachments and channelization. Therefore, whenever structural solutions are proposed to address localized flood or erosion problems in the area, special attention should be paid to address the incompatibility concerns arising from piecemeal solutions.

Stock tanks - Stock tanks present several potential challenges and issues for future development in the area. Though stock tanks are structural flood control facilities of a sort, they are rarely engineered and pose a potential hazard in the event of an embankment failure. The failure of a stock tank can create a larger magnitude flood wave than had the tank not been present. Seventeen stock tanks were identified in the area. Thirteen of those are located north of the CAP Canal. As part of the SVADMP, it is therefore recommended that stock tanks be removed whenever possible as an area develops.

Other floodprone areas (i.e. non-fan floodplains) – It should be remembered that while much of the area is dominated by alluvial fans and their associated flood and sedimentation hazards, other locations within the study area are subject to riverine or sheetflooding conditions. It is recommended that floodplain management be the preferred approach to address future development in areas not specifically impacted by the large active alluvial fans in the area.

ADMS Development Guidelines – The Development Guidelines from the Buckeye / Sun Valley ADMS were reviewed as part of the ADMP proposed alternatives development. The review revealed that the suggested guidelines were focused on single lot development and were not especially applicable to master planned community development as they generally promote application of non-structural flood control measures. The SVADMP study area will be almost exclusively developed as a series of large master planned communities many directly impacted by large active alluvial fans. Therefore, the majority of the development guidelines from the ADMS are not recommended for application to the ADMP. However, the Development Guidelines from the Buckeye / Sun Valley ADMS do specifically identify a goal for flood control features for the area that provides a regional solution, controlling the apex of the active alluvial fans and conveyance of flow through the entire fan. The structural solutions in the Step 2 proposed alternatives for the piedmont sub-areas all achieve this objective.

Flood warning – Another areawide flood hazard mitigation measure could be the development of a flood warning system for the area. Instead of, or in addition to, other structural or non-structural flood control measures, flood detection technologies could be deployed in the study area to warn existing and future residents of the forecast or occurrence of severe weather. Recommendations for the placement of flood detection equipment and/or the development of a flood response plan are part of the Step 3 Recommended Alternative for the ADMP. However, a detailed flood response plan is not part of this project.

4.2 Sub-Areas

To aid the Step 2 alternatives development and evaluation beyond the areawide issues, seven sub-areas within the SVADMP study area were identified:

1) North of CAP (Volume 1)
2) CAP (Volume 2),
3) Wagner Wash (Volume 3),
4) Hassayampa River (Volume 4),
5) White Tank Wash (Volume 5),
6) FRS #1 (this volume), and
7) FRS #2 & #3 (Volume 7).

The sub-areas are based on the outfall locations and the fans discharging to a particular outfall location. For example, fans that drain to Wagner Wash are included in the Wagner Wash sub-area. The sub-areas also represent the hydrologic watershed for the particular outfall location. The sub-area boundaries and fan apices are shown in Figure 9.

This report presents the details of the Step 2 Proposed Alternatives for the FRS #1 sub-area. Volume 1 provides an overview of the Step 2 Proposed Alternatives for the entire study area. Additional details for the other

five alluvial fan sub-areas south of the CAP Canal are presented in separate companion reports (Step 2, Volumes 2-5 and 7).

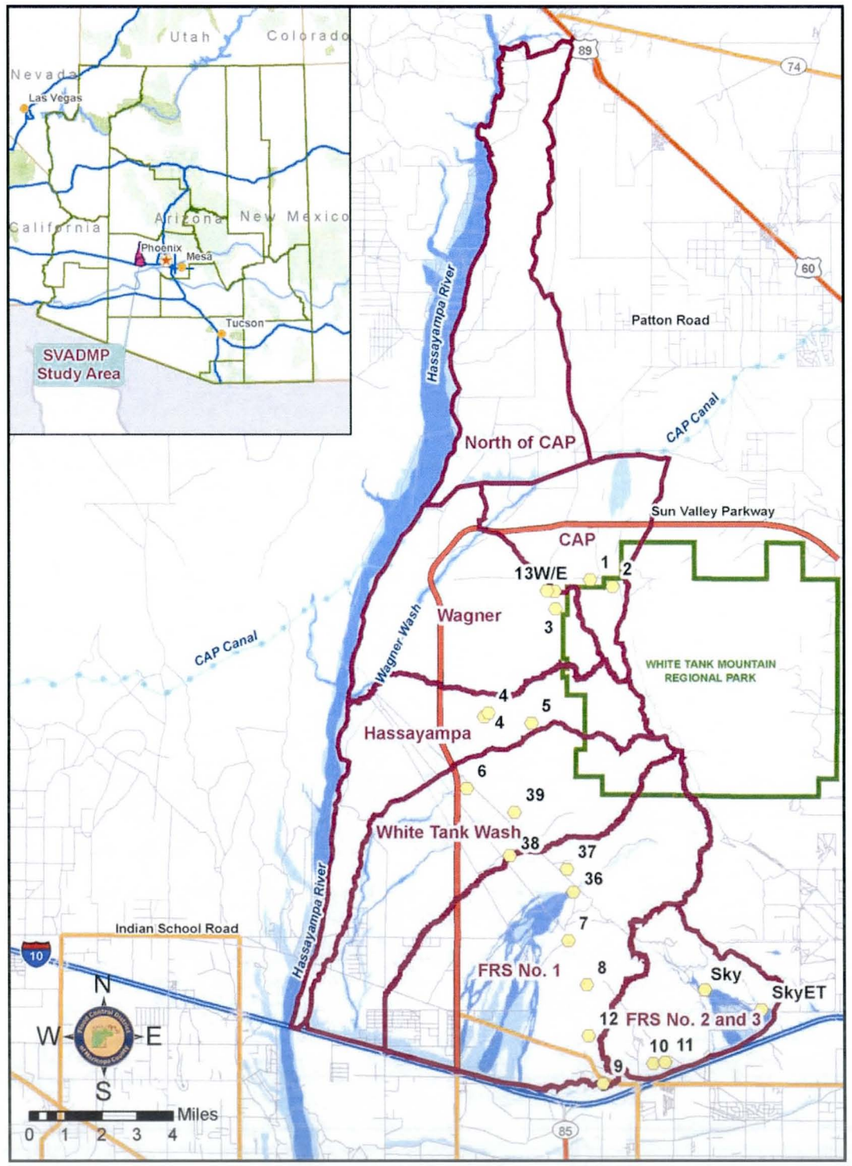

Figure 9 ADMP Sub-Areas

4.3 Piedmont Sub-Areas Alternatives Classification

The Step 1 Preliminary Alternatives Evaluation classified the Alternatives into 4 categories, namely Alternative A, Alternative B, Alternative C, and Alternative D. In this study, the concepts developed during Step 1 process were expanded and refined. Alternative B was further subcategorized into B1, B2, B3, B4, and B5 as listed below. Table 2 provides brief descriptions of the four alternatives.

Table 2 Descriptions of Alternatives

Alternative	Description
A	No measure at apex / Leveed channel section
B1	Big on-line detention basin / Small leveed channel section
B2	Small on-line detention basin / Big leveed channel section
B3	On-line detention basin / Earthen 'companion' channel
B4	On-line detention basin / Leveed channel section along different alignments
B5	Off-line detention basin / Leveed channel section
C	No measure at apex / Concrete 'companion' channel
D	No measure (Whole Fan)

Again, while the flood control alternatives for the active fans in the piedmont sub-areas focused on structural mitigation of the alluvial fan flood and sedimentation hazards, non-structural elements which included wherever possible. In addition, some of the alternatives have greater or lesser degrees of non-structural elements and varies by sub-area. The following sections provide an overview of each of the types of alternatives A-D for the piedmont sub-areas south of the CAP Canal. Additional details for all of the individual piedmont sub-areas are provided in Volumes 2-5 and 7 of the Step 2 Proposed Alternatives Evaluation Report.

4.3.1 Alternative A

The area downstream of the apex represents a region of significant alluvial fan instability. The alluvial fan instability, in turn, results in the uncertainty of flow paths. The region of significant alluvial fan instability can be identified to a reasonable extent. The Step 1 process defines the Alternative A to represent "No Measure" at the apex. The main design objective of this alternative is to allow the natural geomorphic processes to occur within a designated active area downstream of the apex. This provides a largely non-structural approach to the treatment of the alluvial fan hazards near the apex. Downstream of the region of active fan processes, flows will be controlled by structural means; that is, captured via diversion levees/dikes, and collector channels. Once collected, the flows are routed downstream using leveed channel sections, culverts, and detention basins (if needed) until the flows reach the outfalls. In some cases, like Wagner and White Tank Wash sub-areas, the outfall is a large existing riverine riparian wash

system. In these cases a non-structural, floodplain management approach is inherent to the alternative for these reaches.

The advantage of Alternative A is that it minimizes environmental impacts near the apex by preserving existing natural conditions. The main disadvantage is the cost of land set aside to allow for the natural alluvial fan processes.

4.3.2 Alternative B

Alternative B is based on a structural flood control strategy at the apex. The objective of Alternative B is to capture all of the upstream flow at the apex using on-line detention basins. The presence of a detention basin at the apex eliminates the downstream alluvial fan uncertainties. Once collected into the detention basins, flows are routed downstream using open channels, culverts, and additional detention basins (if needed) until the flows reach the outfalls. Again, for Wagner and White Tank Wash within the study area, a non-structural, floodplain management approach is included in the B alternatives for those sub-areas.

This approach increases channel stability by eliminating flow path uncertainty beginning at the apex. This alternative also offers better management of sedimentation issues by capturing incoming sediment directly into the basin. In addition, the alternative provides a continuous, comprehensive flood control trunk system which minimizes the impacts of phasing of developments in the Sun Valley Area.

Alternative B is classified into further sub-categories based on 1) sizing of structures, 2) different channel cross-section types, and 3) different alignment of channels. Alternatives B1, B2, B3, B4, B5 and C represent different combinations of these sub-categories (See Table 3 for details).

Sizing of Basins

The effect of basin size at the apex is evaluated by comparing the effects of a big excavated basin to that of a smaller basin at the apex. The variation in the sizing of the basin at the apex influences the size of the downstream structures. For example, the smaller upstream basin results in a wider channel immediately downstream. The evaluation of basin size is applied to the fans in the CAP and White Tank Wash sub-areas because of their straightforward channel alignment options. Alternatives B1 and B2 represent the big and small basin options and a comparison between these two alternatives was performed to evaluate the effects of basin size on the overall design.

Variations in Channel Cross-sections

Leveed Channel Corridor Section – The existing natural corridor is laterally contained on two sides using a levee. The levee ensures flow containment within the natural corridor while allowing the channel to naturally adjust to the higher discharges resulting from flow concentrations. Figure 10 shows a schematic of the cross-section for the earthen levee natural channel corridor. Walls could be also considered instead of earthen levees to provide flow containment for the natural channel sections. Figure 13 shows the natural channel section with walls as the alternative bank structure. The channels for the A, B1, B2, B4 and B5 alternatives are designed with an earthen leveed natural channel section.

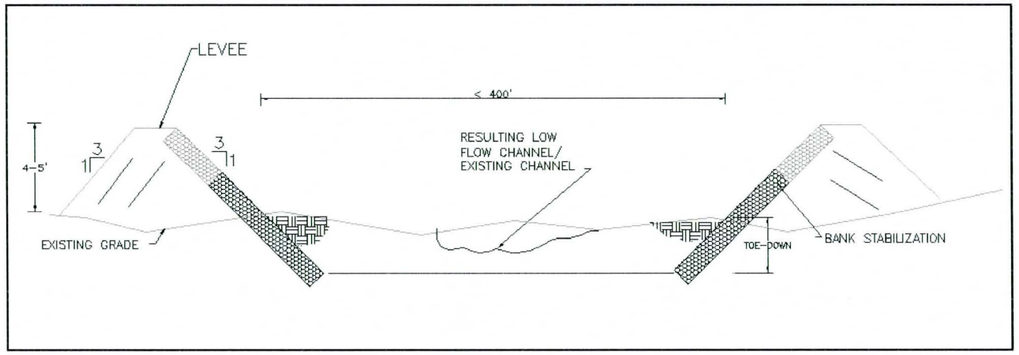

Figure 10 Concept Cross Section for Earthen Leveed Corridor (Alternatives A, B1, B2, B4, B5) (Not to scale)

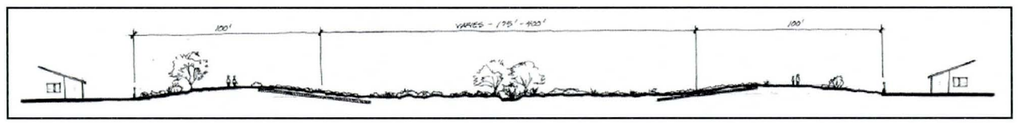

Figure 11 Concept Cross Section for Earthen Leveed Corridor with Landscape Compatibility Enhancements (Alternatives A, B1, B2, B4, B5) (Not to scale)

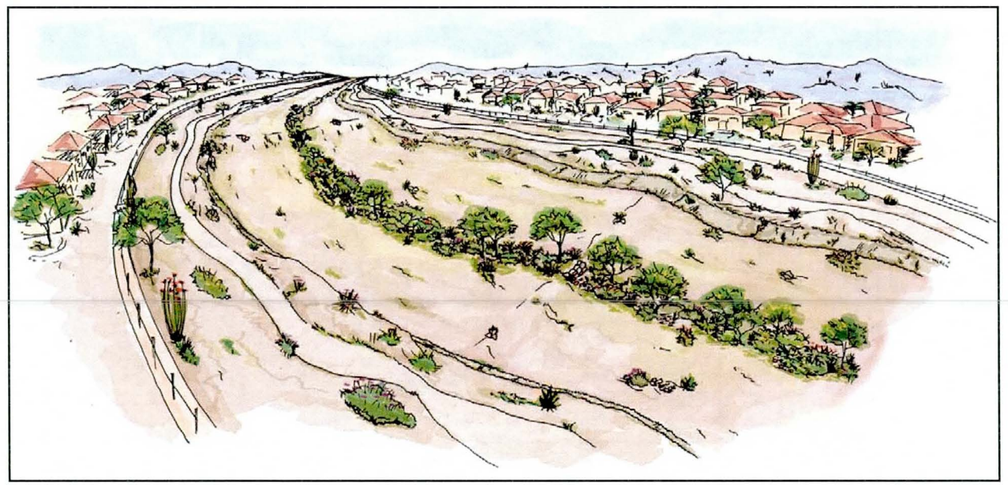

Figure 12 Oblique View of Earthen Leveed Corridor with Landscape Compatibility Enhancements (Not to scale)

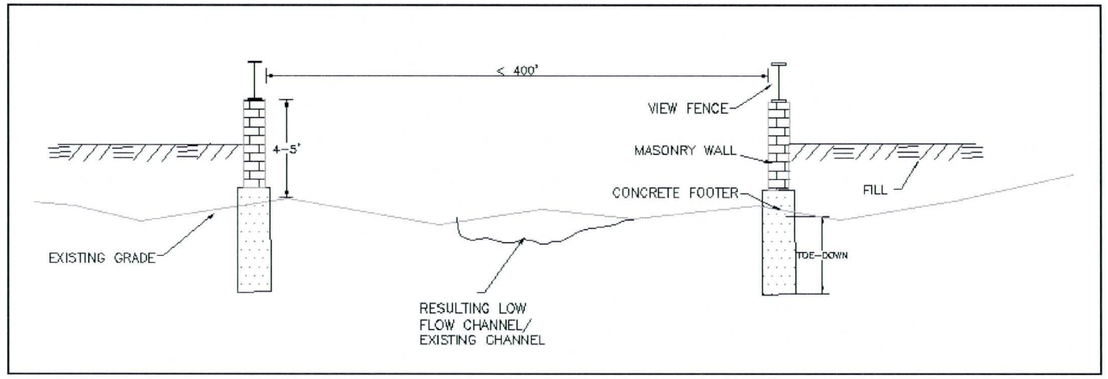

Figure 13 Concept Cross Section for Leveed Corridor with Walls (Alternatives A, B1, B2, B4, B5) (Not to scale)

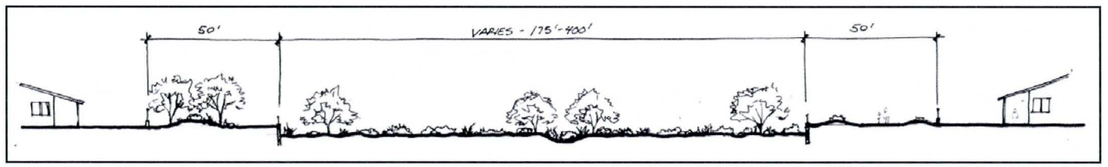

Figure 14 Concept Cross Section for Leveed Corridor with Walls & Landscape Compatibility Enhancements (Alternatives A, B1, B2, B4, B5) (Not to scale)

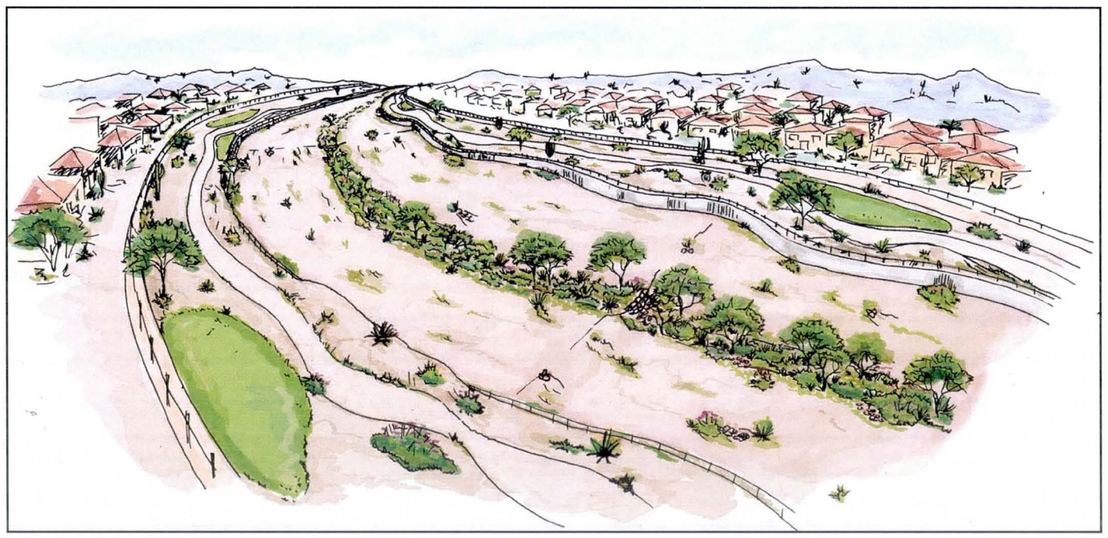

Figure 15 Oblique View of Walled Corridor with Landscape Compatibility Enhancements (Not to scale)

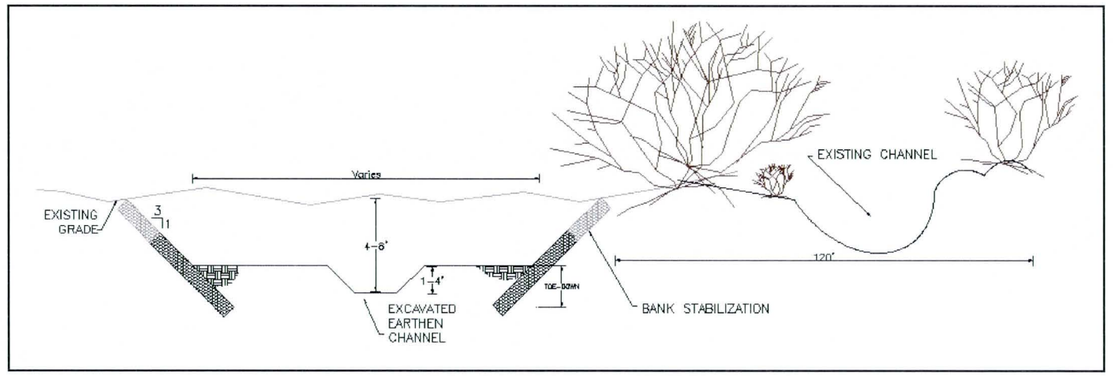

Figure 16 Concept Cross Section for Earthen Companion Channel (Alternative B3) (Not to scale)

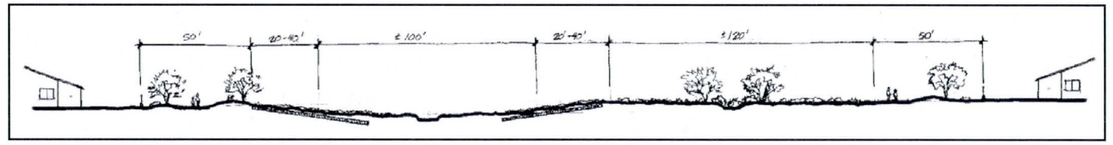

Figure 17 Concept Cross Section for Earthen Companion Channel with Landscape Compatibility Enhancements (Alt B3) (Not to scale)

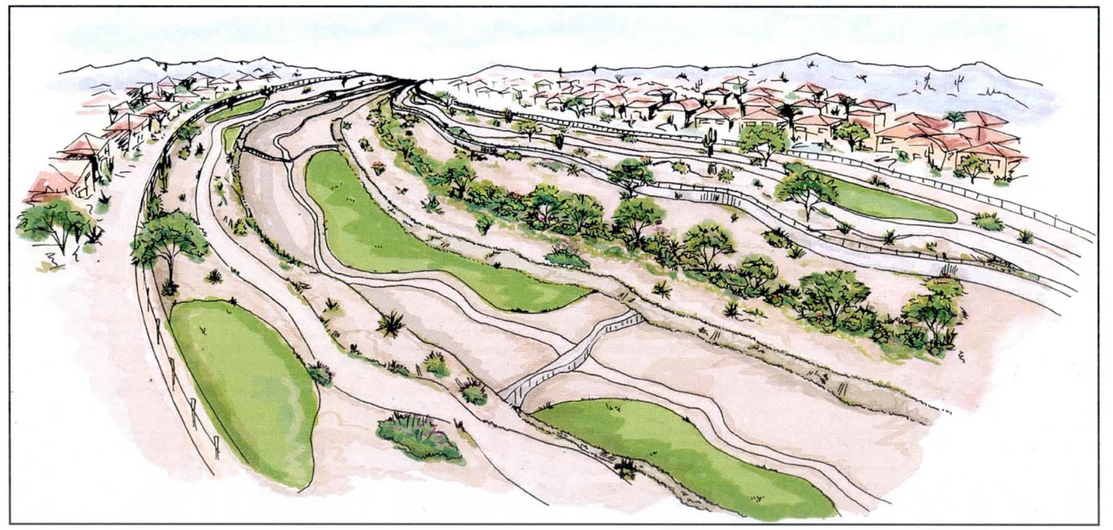

Figure 18 Oblique View of Earthen Excavated Companion Channel with Landscape Compatibility Enhancements (Not to scale)

Earthen Companion Channel – An excavated channel with earthen lining is located adjacent to the existing corridor to convey the flow. The channel is placed adjacent to the existing corridor so that the natural watercourse habitat is not disturbed. Figure 16 shows the concept cross-section for the earthen companion channel. The earthen companion channels are incorporated in Alternative B3.

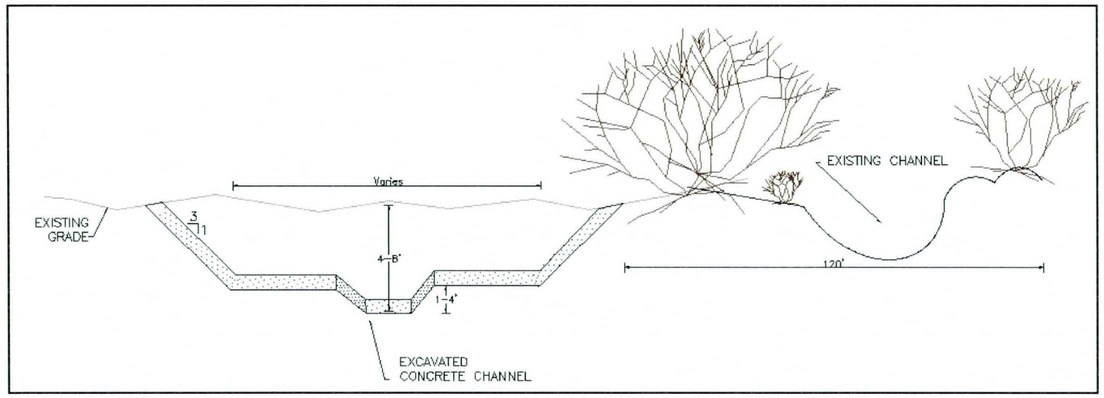

Figure 19 Concept Cross Section for Concrete Companion Channel (Alternative C) (Not to scale)

Concrete Companion Channel – An excavated channel with concrete lining is considered for the C Alternative (See Section 4.3.3. for additional information). Figure 19 shows the concept cross-section for the concrete companion channel.

Variations in Channel Alignments

The choice of the channel alignment can significantly influence the cost of the project. Longer alignments are typically more expensive. The evaluation of the different channel alignments was considered for the following areas:

1) Wagner Wash,

2) Hassayampa River,

3) FRS #1, and

4) FRS #2 & #3.

These sub-areas provide clear possibilities for channel alignment variations. To the contrary, multiple channel alignment were not considered for the CAP and White Tank Wash sub-areas because of their straightforward channel alignment options. The evaluation of the variations in channel alignment was considered as Alternative B4 which was subdivided into B4-1, B4-2 and B4-3 to represent three different channel alignment variations. The other design considerations for Alternative B4 are similar to Alternative B1. Table 3 shows the various design options chosen for each piedmont sub-area.

Table 3 Design Options for Alternatives

Subarea	A	B1	B2	B3	B4	B5	C
CAP	SA, LVC	BB, LVC	SB, LVC	BB, EXCEC	N/A	OB, LVC	BB, EXCCC
Wagner Wash	SA, LVC	N/A	SB, LVC	BB, EXCEC	BB, LVC, 3 Alignments	N/A	BB, EXCCC
White Tank Wash	SA, LVC	BB, LVC	SB, LVC	BB, EXCEC	N/A	N/A	BB, EXCCC
Hassayampa River	SA, LVC	N/A	SB, LVC	BB, EXCEC	BB, LVC, 3 Alignments	N/A	BB, EXCCC
FRS #1	SA, LVC	N/A	SB, LVC	BB, EXCEC	BB, LVC, 3 Alignments	N/A	BB, EXCCC
FRS #2 and #3	SA, LVC	N/A	SB, LVC	BB, EXCEC	BB, LVC, 3 Alignments	N/A	BB, EXCCC

LVC - Leveed Channel, EXCEC - Excavated Earthen Channel, EXCCC - Excavated Concrete Channel
SA - Sedimentation Area, BB - Big On-line Basin, SB - Small On-line Basin, OB - Small Off-line Basin
Note: CAP and White Tank Wash have only one alignment.

Alternative B5 considers an off-line basin at the apex instead of an on-line basin. The off-line basin is designed to be a small basin with the main purpose of reducing the peak flow approximately by 10%. This alternative is similar to Alternative B2 with the only difference being the off-line basin at the apex instead of an on-line basin. Alternative B5 was considered for CAP sub-area and provides a means for evaluating the effectiveness of an off-line basin at the apex.

4.3.3 Alternative C

Alternative C is a structural flood control alternative based on the concept of an excavated concrete-lined channel from the apex to the outfall (Figure 19). No detention basin is provided at the apex. Sedimentation basins are provided throughout the system. The advantages of Alternative C include reduced land cost due to lack of a detention basin near the apex and smaller channel land areas. The concrete channels are easier to maintain as well. The disadvantages are that the concrete channels are not as aesthetically appealing and are less amenable for multi-use. Another disadvantage is the high cost of construction due to excavation and concrete lining.

4.3.4 *Alternative D*

Alternative D follows the "No Measure" strategy as defined by the Step 1 Preliminary Alternatives Evaluation. This alternative relies on existing drainage facilities or new master-planned communities developing their own drainage infrastructure. Current drainage ordinances and floodplain regulations are enforced to ensure adequate flood hazard mitigation measures. Enforcement options can be enhanced by developing new alluvial fan floodplain delineations.

The major advantage of this alternative is that no immediate and expensive action is needed from the District. The main disadvantage compared to the other alternatives is that there will be no regional whole-fan flood control system leading to unnecessary redundancies, unintentional system discontinuities, and/or potential planning problems. This measure is also likely to leave portions of unstable, active alluvial fan areas open and undeveloped.

5 STEP 2 APPROACH

5.1 Data Collection

5.1.1 *Field Survey Information*

Refer to the Flood Control District of Maricopa County (District) for field survey information associated with the 10-foot topographic mapping used in the current study.

5.1.2 *Mapping*

The District provided 10-foot contour mapping and DTM data for use in the hydrologic and hydraulic calculations. That work was done under separate contract for the District in 2000/2001. The flight dates of that mapping were 12-16-00, 12-17-00, and 12-27-00. A triangulated irregular network (TIN) was developed in ArcGIS software using the 10-ft topographic contours. The TIN and the contours were used to obtain all the elevation data used in this study.

5.1.3 *Aerial Photographs*

The Flood Control District provided aerial photographs for use in the GIS applications.

5.1.4 *Existing Culvert Data at Sun Valley Parkway Crossings*

The as-builts for the existing culverts at the Sun Valley Parkway were obtained from MCDOT.

5.1.5 *Sediment Gradations*

Sediment gradations used in this study are based on data collected by Coe and Van Loo, Consultants Inc (CVL). These are the only set of sediment gradation data available at the time of preparation of this report. Additional sediment samples are being collected as part of this study and will be included in the Step 3 refinements of the alternatives.

Upon analyzing the CVL data, the following values were selected for the sediment gradation parameters:

D50 = 1mm D16 = 0.5 mm D65 = 0.15 mm

D90 = 5 mm D84 = 3.5 mm

5.2 Process Overview and Summary of Design Criteria

The following sections provide a brief overview of the design procedures for each structure type and each alternative. The alternatives themselves are described in Section 6 and Section 10. The design procedures vary by structure type and alternative. However, there is significant commonality between alternatives. Table 4 shows a summary of the design criteria used for each of the Step 2 alternatives. All structures are designed for the maximum peak flow or volume from the 100-year 6-hour or 24-hour event.

Using the criteria shown in Table 4, the structural elements for each sub-area were designed using the following general approach:

- Identify the fan apex/upstream area location and the preferred channel alignment from the apex to the outfall. For Wagner, Hassayampa, FRS 1 and FRS 2 & 3 sub-areas, the preferred channel alignment is one of the alignments in B4-1, B4-2, or B4-3. The alignments for the CAP and White Tank Wash sub-areas are the same for all alternatives.
- Identify the set-aside area (A) or design the detention basin (B) near apex location
- Route flow from the apex to Sun Valley Parkway by designing a leveed corridor (A, B1, B2, B4, B5) or excavated channel (B3, C) along the preferred alignment.
- Design an off-line basin upstream of the culvert location at Sun Valley Parkway if the culvert capacity is not adequate. Off-line basin capacity is the volume of flow above the culvert capacity.

- Route the flows from Sun Valley Parkway to the outfall by designing a leveed corridor or excavated channel along the preferred alignment.
- Prepare cost estimates (see section 9.1) for the land cost, construction cost, landscaping cost, and maintenance cost for the base condition and for the landscape compatibility enhancements.

Sediment is controlled at the apex for all alternatives. For the areas downstream of the alluvial fan apex, sedimentation is controlled in two ways. First, sedimentation basins are provided longitudinally along the channels based on the sediment yield from the contributing area to the design reach. Second, grade control structures are included for the leveed corridors (A, B1, B2, B4, B5) and the excavated earthen channels (B3). All earth bottom corridors also include bank and toe protection from scour.

Table 4 Summary of Design Criteria for Step 2 Alternatives

Alternative	Apex Treatment	Basin Geometry Criteria	Downstream Channel	Hydraulic Criteria
A	Active Area Set-aside	N/A	levee/wall	≈ 4 ft levee height; 4 - 6 ft/s; ≤ 400 foot width
B1	On-line Basin; 10% outflow	Z = 3:1 Function; Z = 6:1 Form; D < 12 ft	levee/wall	≈ 4 ft levee height; 4 - 6 ft/s; ≤ 400 foot width
B2	On-line Basin; 90% outflow	Z = 3:1 Function; Z = 6:1 Form; D < 12 ft	levee/wall	≈ 4 ft levee height; 4 - 6 ft/s; ≤ 400 foot width
B3	On-line Basin; 10% outflow	Z = 3:1 Function; Z = 6:1 Form; D < 12 ft	excavated earthen channel	≈ regime w, d, v
B4	On-line Basin; 10% outflow	Z = 3:1 Function; Z = 6:1 Form; D < 12 ft	levee/wall	≈ 4 ft levee height; 4 - 6 ft/s; ≤ 400 foot width
B5	Off-line Basin; 90% bypass flow	Z = 3:1 Function; Z = 6:1 Form; D < 12 ft	levee/wall	≈ 4 ft levee height; 4 - 6 ft/s; ≤ 400 foot width
C	Sediment Basin Only	N/A	excavated concrete channel	Fr < 0.86; 2-year < 2 ft or 5 ft/s
Note: All channels include longitudinal sediment basins based on sediment yield from contributing area.				

Additional details regarding the design considerations associated with each structural element are discussed briefly in the following sections with additional details also provided in Sections 6, 7, and 8.

5.3 Open Channel Design Considerations

Open channels are used for the "conveyance" strategy as recommended by the Step 1 Preliminary Alternatives process. The channels are aligned along existing natural watercourse corridors in order to preserve the existing natural habitat. Most of the alternatives use the existing channel contained within the earthen levees for conveyance. The exceptions to this are the two alternatives where channel excavation is considered. These are the Alternative B3 (Earthen excavated channel) and Alternative C (Concrete excavated channel) which are located approximately parallel and adjacent to the natural corridor. In these cases, a portion of the flows in the excavated channel may have to be diverted into the existing watercourse corridor to preserve the natural habitat.

The channel types are classified into 1) Leveed channel corridor, 2) Excavated channel, and 3) Existing channel. The leveed channel corridor uses the existing watercourse corridor with levees on both sides to contain the flow. The excavated channel can have an earthen or concrete lining and is designed to be excavated below existing ground. The existing channel is any existing channel that is used as part of the design alternative.

The channels are designed to act as a regional flood control trunk system and are sized to convey local drainage as well as sediment from the adjacent watershed area. As part of the Step 2 design process, four discharge values are analyzed to ensure the applicability of the design to a range of flows. The four flows are simply ratios of the 100-year peak flows: 10%, 25%, 75% and 100%. The 10% flow can be expected to approximately represent the 2-year flow, the 25% represent the 10-year flow, and 75% represent the 50-year flow.

Per the District's Hydraulics Manual, minimum freeboard for the open channel is set as the greater of 1 foot and 0.25 ($y + V^2/2g$). For channels with levees, the FEMA freeboard requirement of 3 feet is applied for the concept designs.

Excavated channels are designed for subcritical flow with Froude numbers less than 0.86. Subcritical design results in flows with lower velocity and are favorable from public safety point of view. The design slopes are flatter than the existing slopes to achieve the subcritical flow.

Velocity in the leveed channel corridors is designed to be 4 to 6 ft/sec. This velocity range is expected to adequately move sediment downstream without being so large as to cause excessive erosion. The width of the leveed natural channel is also restricted to 400 ft. Flow depth in the leveed channel is restricted to 1-2 ft unless the velocity and/or width requirement could not be met simultaneously.

A side slope of 3H:1V is assumed for both the main channel as well as the low flow channel for the base design.

5.4 Inline Sedimentation Basin and Drop Structure Design Considerations

Drop structures and inline sedimentation basins are included to control sedimentation issues. The on-line detention basins collect both sediment and flow volume while the off-line basins collect only the flow volume. As a result, the on-line detention basins also function as sedimentation traps near the fan apices. Inline sedimentation basins are placed within the channels acting as sediment traps to collect any additional sediment influx exceeding the capacity of the designed channel. Excessive sediment influx is possible at all the tributary confluences as well as at confluences of any other inflow that may occur in the future. Sediment yield from the upstream reach as well as adjacent watershed provides estimates of sediments entering the channels and is used to size the inline sedimentation basins. Sedimentation basins/traps are distributed along the reach to avoid serious sedimentation problems at any specific location.

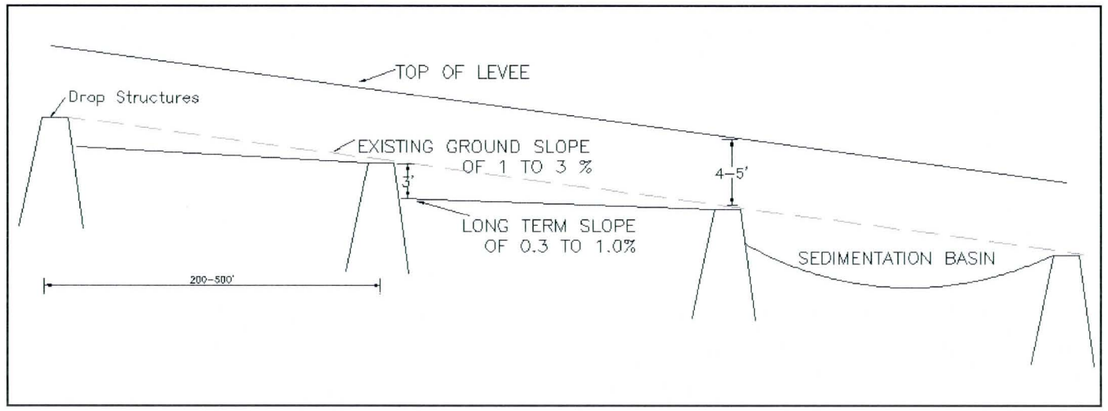

Figure 20 Concept Profile View of Leveed Channel Corridor (Alternatives A, B1, B2, B4, B5) (Not to scale)

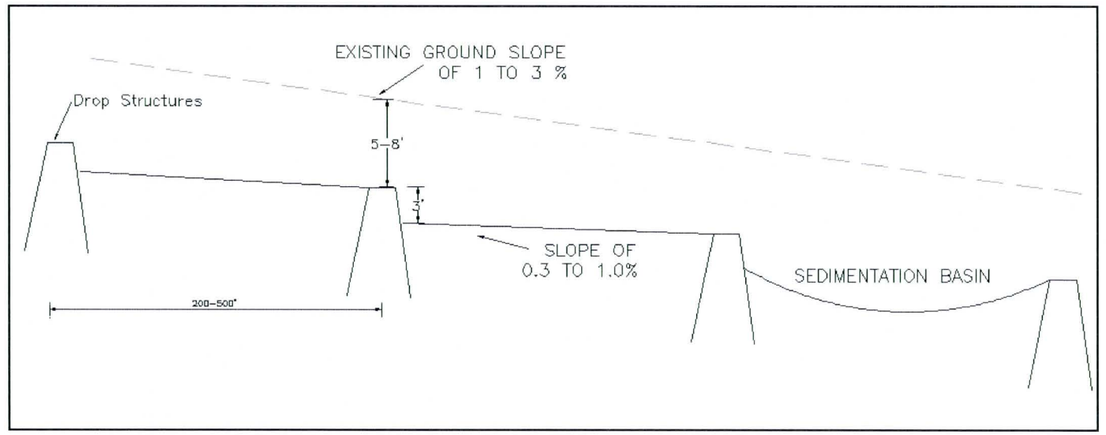

Figure 21 Concept Profile View of Excavated Channel (Alternatives B3 and C) (Not to scale)

The drop structures are designed to be 3 feet high and are spaced accordingly. The 3-foot drop provides a reasonable height from a multiple-use point of view. For the purpose of comparing alternatives considered in the Step 2 process, grade control structures for all alternatives except the concrete excavated channel were assumed to be made of riprap. The riprap is assumed to be buried. The number of drop structures was determined by using the difference between the existing slope and the design slope for excavated channels or anticipated long-term slope for the leveed corridors. The drop structures were spaced to achieve the elevation difference caused by the difference between the existing slope and the design or long-term slope. Figure 20 shows the concept profile view of the leveed channel corridor which is part of A, B1, B2, and B5 alternatives. Figure 21 shows the concept profile view of the excavated channel which is part of the B3 and C alternatives.

5.5 On-line Detention Basin Design Considerations

The on-line detention basins are located mostly at the apices to control the flow and sediment arriving at the fan apices. The basin volume is provided entirely through excavation and is designed to be entirely below existing ground. Raised embankments are not used to provide basin storage volume. Rectangular basins with constant side slopes are considered for the purpose of the base design analyses and sizing. In reality, these would be shaped differently to better fit into the natural setting depending on landscaping and other requirements. The adjustments and cost estimates for these landscape compatibility enhancements are described in Section 9.2. The rectangular basins provide an approximate idea of the required size of basin in terms of storage volume and the minimum land footprint needed to obtain that volume. Figure 22 shows the concept plan view of the on-line basins and Figure 24 shows the concept profile view. Figure 23 and Figure 25 show the on-line basins with landscape compatibility enhancements.

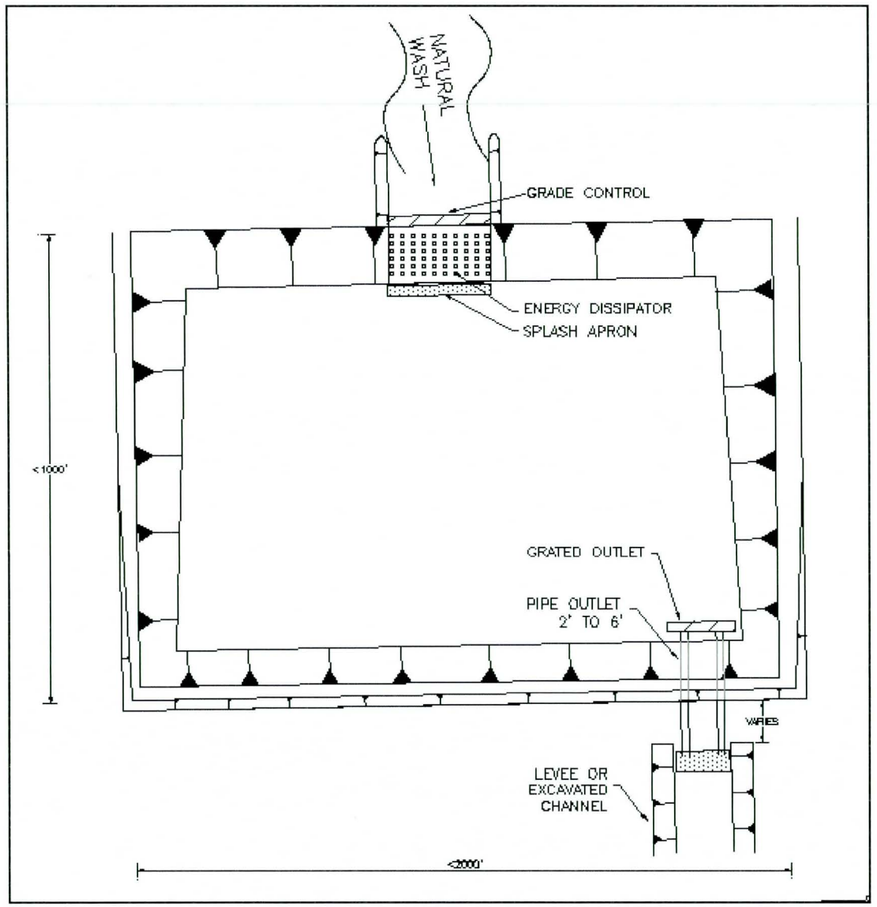

Figure 22 Concept Plan View of On-line Basins for B Alternatives (Not to scale)

Figure 23 Concept Plan View of On-line Basins for B Alternatives with Landscape Compatibility Enhancements (Not to scale)

The big basin option is designed to have a peak outflow of approximately 10% of the peak 100-year design inflow, representing approximately the 2-year flow. The small basin option is designed to have a peak outflow of approximately 90 % of the peak 100-year design inflow.

Pipe outlets are designed to drain the basins. Multiple pipes are needed when the basins are small compared to the total flow volume entering the basins. Appropriate hydraulic equations are used to determine the stage–discharge relationships. Sediment yield from the upstream watershed is used to estimate inflowing sediment volume.

The existing topographic slope was determined from the 10-ft topographic mapping contours. The existing slopes near the apices are approximately 2-3%. These steep slopes result in considerable elevation differences between the upstream and downstream ends of the basins. Basins are designed to have longer dimensions perpendicular to flow direction to minimize the cut-slope exposure on the upstream side of the basins. This gives a minimum basin dimension along the topographic slope and reduces the visual impact of the basins.

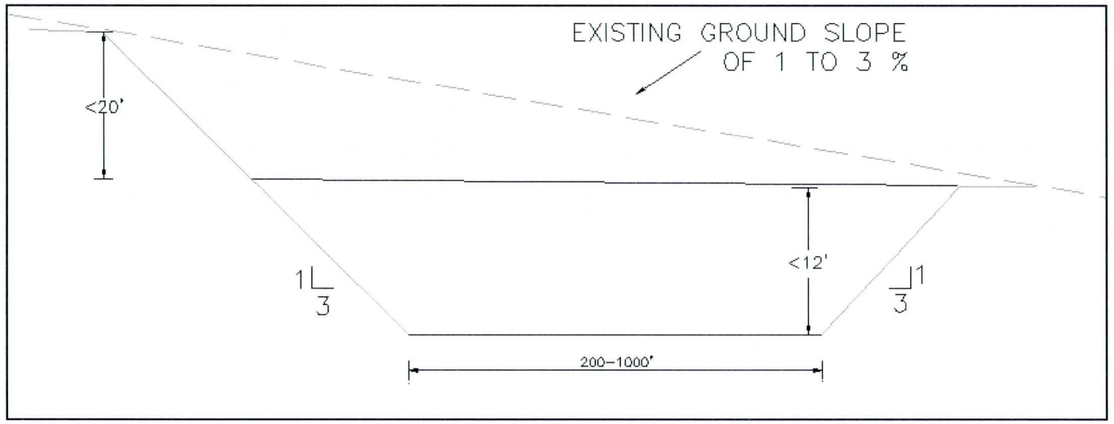

Figure 24 Concept Profile View of On-line Basins (Not to scale)

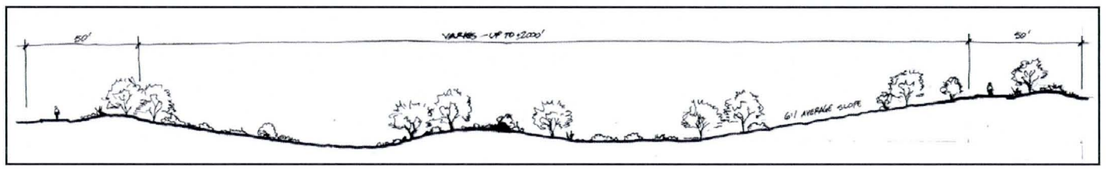

Figure 25 Concept Profile View of On-line Basins with Landscape Compatibility Enhancements (Not to scale)

The basins are designed to be up to 12 feet in depth. This depth includes a freeboard of 1 ft. An initial side slope of 3H:1V is assumed for the base design. Shallower side slopes are included in the landscape compatibility enhancements.

5.6 Off-line Detention Basin Design Considerations

Off-line detention basins are provided in locations where there is a need to reduce peak flows. These locations include: a) upstream of culverts to reduce flow to culvert hydraulic capacity, b) tributary confluences, and c) at the downstream end at outfall locations. Most of these basins will be located downstream of the apices except for the Alternative B5 where an off-line basin is located near the apex.

The flow from the open channel will enter the off-line detention basins via a weir. Figure 26 shows the concept plan view of the off-line basins. Figure 27 shows the off-line basin with landscape compatibility enhancements. The Step 2 design process estimated the volume to be diverted using an inflow-outflow diversion relationship. The weirs were not sized in the Step 2 design process.

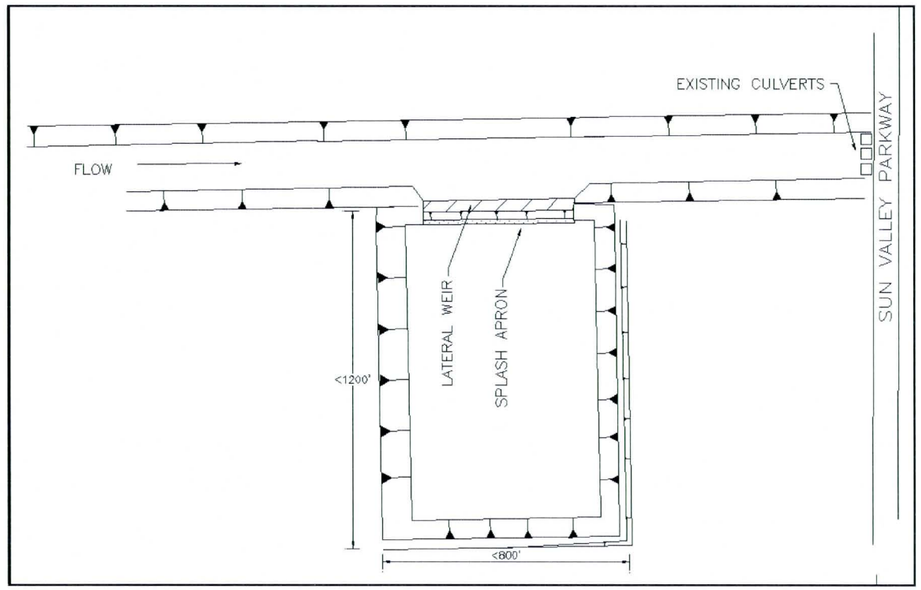

Figure 26 Concept Plan View of Off-line Basins (Not to scale)

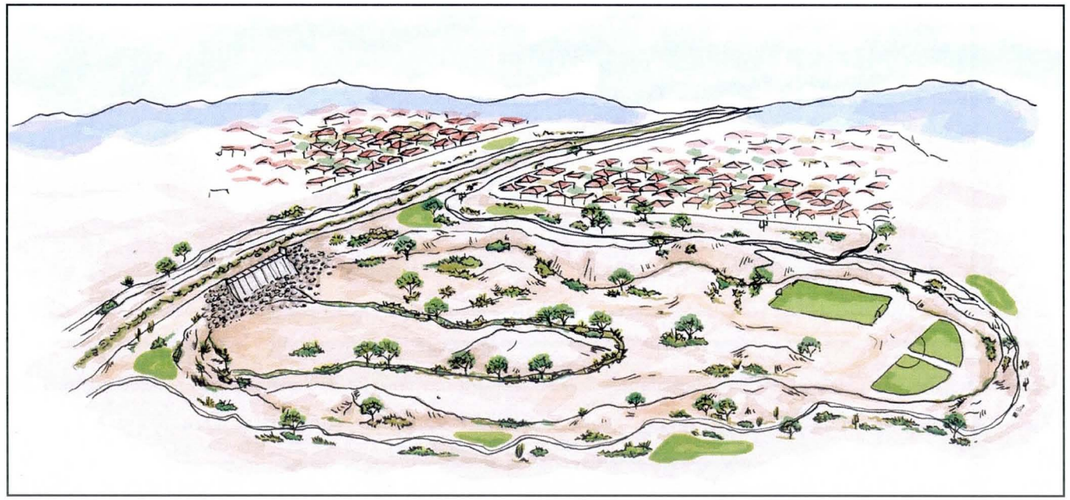

Figure 27 Concept Plan View of Off-line Basins with Landscape Compatibility Enhancements (Not to scale)

5.7 Hydrology

The design of the open channels as well as the detention basins are based on the 100-year peak discharges. HEC-1 modeling is used to determine the peak discharges as well as the flow volume passing through the designed structures. The existing conditions hydrology model is used for the estimation of the peak discharges used in the design. The flows computed from existing conditions model are higher than the future conditions model due to retention requirements. Thus, using the flows computed from the existing conditions model represents a more conservative design approach. In addition, the phasing of the developments is unknown. As a result, it is prudent to be conservative and use the existing conditions hydrology to ensure effective continuous functioning of the flood control system.

A separate HEC-1 model was developed for each sub-area for the 100-year 24-hour and 100-year 6-hour storms for each alternative. For the purpose of the design, the maximum of the values obtained from the 24-hour and 6-hour results were used to ensure adequate functionality under 6-hour and 24-hour storm scenarios. This means that the design analyses sometimes use the 6 hour value and vice-versa depending on whichever is larger.

The procedure to estimate peak flow and flow volume was iterative in nature: The iteration steps can be briefly described as follows:

- Change in structure dimensions affect HEC-1 model
- Change in HEC-1 model affects discharges/volumes
- Change in discharges affect structure dimensions

The HEC-1 models used here are based on the Area 3 HEC-1 model by PBS&J (2005) and Area 4 HEC-1 model by JE Fuller/Hydrology & Geomorphology, Inc (2005). The HEC-1 models were not refined at Step 2 to provide design peak flows at every location for all the design elements. Long open channel sections were treated as a single routing in HEC-1. In addition, some of the subbasins are large providing only a single downstream concentration point. In such situations, the design discharges and volumes were estimated using an area-ratio between the actual area affecting the design element and the entire subbasin modeled in HEC-1. This simplified procedure facilitates a more refined design of multiple channel segments within a large subbasin without the need for refining the HEC-1 model. Future HEC-1 model modifications at Step 3will address the need for additional concentration points to generate peak flow data for concept design refinements.

5.8 Sediment Yield

Sediment contributions from the watershed adjacent to the design element were estimated using sediment yield. The sediment yield was estimated assuming a 3-year maintenance period plus a single 100-year event. An annual sediment yield of 0.3 ac-ft/sq. mi./year and a 100-year event sediment yield of 1 ac-ft/sq. mi. was assumed for this purpose. These values were derived based on examination of numerous previous studies conducted throughout Maricopa County. The total sediment volume was estimated as the sum of 3 average years' sediment volume and one 100-year event volume. The estimation of the contributing watershed area is performed using GIS. The sediment volume entering a particular design element was then estimated using the sediment contributing area and the sediment yield estimates.

5.9 On-line Detention Basin Analyses

The design considerations for the on-line detention basins are described in detail in Section 5.5. The analyses use rectangular basins with constant side slopes (3H:1V). The sediment yield estimates were used to estimate incoming sediment volume. One foot of freeboard was applied to accommodate the flow volume as well as the sediment volume. A stage-storage-discharge relationship was calculated and this relationship entered into the HEC-1 model using SE-SV-SQ records. The stage-storage relationship was determined from the designed basin dimensions. The stage-discharge relationship was determined from pipe outlet equations. The HEC-1 model was then run to estimate the peak volume stored in the basin. The basin dimensions are then resized to hold this maximum volume at peak flow as predicted by HEC-1. In addition, the designed basin depth should be larger than the peak stage as predicted by HEC-1. The estimated sediment yield was added to the depth required to evaluate the adequacy of the basin design. The process was repeated in an iterative fashion until a satisfactory design was achieved.

5.10 Open Channel Analyses

5.10.1 Hydraulics

The hydraulic analyses for open channel design were performed using Manning's equation (normal-depth assumption). An 8-point cross-section was used to represent the channel cross-section dimensions. A Manning's n-value of 0.045 was used for all the alternatives except Alternative C where the designed channel has concrete lining. In places where the existing channel is used, analyses were performed to ensure adequate conveyance and freeboard for the estimated flows entering the channels.

It is anticipated that the leveed conveyance corridors, a low-flow channel will form between the levees in the long term. The low-flow channel dimensions were estimated using regime theory described in Section 5.10.2.

Calculations were also performed to evaluate the hydraulic conditions expected to occur after the leveed corridor develops a low-flow channel. The earthen excavated channels (Alternative B3) were also sized to approximate the estimated regime dimensions.

5.10.2 Regime Theory

Regime theory was used to arrive at approximate estimates of gross dimensions as a function of discharge, d50 etc. The regime theory was specifically used to estimate the dimensions of the low-flow channel. The low-flow channel is expected to form in the long-term for the leveed corridors over time.

In addition, regime theory was used to design the main channel as well as the low-flow channels for the excavated earthen channels (Alternative B3). The main parameters evaluated by the regime theory are: width, depth, and velocity. The design approach aims to match the regime value estimates approximately and does not match all three parameters exactly. The values estimated by regime theory were used as guidance/starting point for the design dimensions and are interpreted as the dimension the channel wants to be or will evolve into in the long-term. The main goal is to not deviate too much from regime theory wherever possible.

Following procedures are considered to estimate the Regime Theory:

- Bray - Equation #1
- Bray - Equation #2
- Hey
- Ackers & Charlton/Lacey
- Parker
- Chang
- Kellerhals
- AMAFCA/Schumm
- Moody & Odem
- BUREC

Bray Equation #1. Bray (1979) developed equations for the geometry of alluvial gravel-bed rivers based the 2-year discharge.

$$W = 2.38\ Q_2^{0.527}$$

$$d = 0.266\ Q_2^{0.33}$$

$$V_m = 8.0\ d^{0.6}\ S_o^{0.29}$$

Where:

W = surface flow width (ft.)

Q_2 = 2-year discharge (cfs.)

d = flow depth (ft.)

V_m = mean channel velocity (ft./sec.)

S_o = channel slope (ft./ft.)

Bray Equation #2. Bray later modified his channel geometry relationships (Hey et. al., 1982) for gravel-bed rivers to include bankfull discharge and the bed material size.

$$W = 2.08\ Q_{bf}^{0.528}\ D_{50}^{-0.07}$$

$$d = 0.256\ Q_{bf}^{0.331}\ D_{50}^{-0.025}$$

$$V_m = 1.87\ Q_{bf}^{0.14}\ D_{50}^{0.095}$$

$$S_o = 0.0965\ Q_{bf}^{-0.334}\ D_{50}^{0.586}$$

Where:

W = surface flow width (ft.)

Q_{bf} = Bankfull discharge (cfs.)

D_{50} = medium bed sediment diameter (ft.)

d = flow depth (ft.)

V_m = mean channel velocity (ft./sec.)

S_o = channel slope (ft./ft.)

Hey Equation. Hey (1982) developed regime equations for gravel bed rivers in England that relate stable channel geometry to bankfull discharge and bedload transport rate.

$$WP = 2.2\ Q_{bf}^{-0.54}\ D_{50}^{-0.05}$$

$$R = 0.161\ Q_{bf}^{0.41}\ D_{50}^{-0.15}$$

$$d_{max} = 0.252\ Q_{bf}^{0.38}\ D_{50}^{-0.16}$$

$$S_o = 0.679\ Q_{bf}^{-0.53}\ Q_s^{-0.13}\ D_{50}^{0.97}$$

Where:

WP = Wetted perimeter (m)

Q_{bf} = Bankfull discharge (m)

D50 = Median sediment diameter (m.)

R = Hydraulic radius (m)

d_{max} = Maximum channel depth (m)

S_o = Channel slope (m/m)

Q_s = Bedload sediment discharge (%)

Parker Equation. Parker (1979) examined gravel bed rivers to obtain his channel geometry equations. He found that, unlike the bed material in sand bed streams, the gravel and cobble bed material in coarse bedded streams is moved only during larger flows. He also noted that the banks of gravel bed streams tended to be more stable and straighter than streams with finer bed materials (MacBroom, 1981). Parker's equations use a dimensionless discharge parameter (Q_*), as described below.

$$W_{bf} = 0.173\ Q_*^{0.5}\ D_{50}$$

$$d = 0.010\ Q_*^{0.415}\ D_{50}$$

$$S_e = 0.223\ Q_*^{-0.410}$$

Where:

W_{bf} = bankfull width, width at top of bank (ft)

$Q_* = 0.039\ V_m\ d^{-1}\ D_{50} / ((\rho_s\text{-}1)/\rho)\ g\ d)^{½})$ (dimensionless)

V_m = mean velocity (ft./sec.)

ρ_s = density of sediment (lbs/ft^2)

ρ = density of water (lbs/ft^2)

g = gravitation coefficient (32.2 $ft./sec.^2$)

D_{50} = mean sediment diameter (ft.)

d = average channel depth (ft)

S_e = energy slope (ft./ft.)

Ackers & Charlton Equation. The Ackers and Charlton (1971) equations were based on data from flume studies which used sand bed materials.

$$W = K_{ac}\ Q^{0.42}$$

Where:

W = surface channel width (ft.)

Q = discharge (cfs)

K_{ac} = a coefficient varying from 3.6 for straight channels to 7.2 for meandering channels

Lacey Equation. The Lacey equation (1929) was developed to describe the geometry of silt-laden canals in India. However, Bray reported (1979) that in gravel rivers in Canada, the Lacey equation was as accurate for predicting velocity as the Manning's equation.

$$V = 0.8Q^{0.167}$$

Where V = mean channel velocity (ft./sec.)

Q = discharge (cfs)

Chang Equation. Chang's (1988) gravel bed equations for channel geometry support his FLUVIAL-12 sediment transport model, which attempts to simulate channel change from sediment continuity data using minimum stream power concepts. Chang provides equations for channel width, depth, and slope.

$$S_o = 0.000442\ D_{50}^{1.15} / Q_{bf}^{0.42}$$

$$W = [1.905 + 0.249(\ln(0.001065\ D_{50}^{1.15} / (S_o\ Q_{bf}^{0.42}))^2]\ Q_{bf}^{0.47}$$

$$d = [0.2077 + 0.0418(\ln(0.000442\ D_{50} / (S_o\ Q_{bf}^{0.42})))^{1.15}]\ Q_{bf}^{0.42}$$

Where:

S_o = channel slope (ft./ft.)

D50 = median sediment diameter (mm.)

Q_{bf} = bankfull discharge (cfs)

W = channel width (ft)

d = average channel depth (ft)

Kellerhals Equations. Kellerhals (1967) developed equations for the equilibrium channel width and depth in gravel bed rivers. The Kellerhals equations use the dominant discharge, which is also referred to as the channel-forming or effective discharge.

$$W = 1.8\ Q_{dd}^{0.5}$$
$$d = 0.166\ Q_{dd}^{0.4}\ K_n^{-0.12}$$

Where:

W = channel width (ft)
Q_{dd} = dominant discharge (cfs)
d = average channel depth (ft)
K_n = Nikuradse's sand grain roughness coefficient

Schumm Equation. Schumm (1961) preferred to examine the width/depth ratio of semi-arid streams, rather than either parameter separately. Schumm's equation is based on the percentage of fine-grained material in the channel banks.

$$F = 255\ M^{-1.08}$$

Where:

F = width/depth ratio
M = percentage of silt/clay in the bed.

AMAFCA Equations. The AMAFCA (1994) equations for width and equilibrium slope were developed from empirical and theoretical data for application to the arroyo systems of northern New Mexico.

$$W = 0.5\ F^{0.6}\ Fr^{-0.4}\ Q^{0.4}$$
$$S_o = 18.28\ n^2\ F^{0.133}\ Fr^{2.133}\ Q^{-0.133}$$

Where:

W = width of channel (ft.)
F = width/depth ratio
Fr = main channel Froude number
Q = discharge (cfs.)
S_o = channel slope (ft./ft.)
n = Manning's n value for channel

Moody & Odem Equations. Moody and Odem (1999) completed an investigation of bankfull channel geometry relationships on a variety of stream types in Arizona using Rosgen channel classification methods. Channel geometry relationships were defined for a number of regions in Arizona.

$$Q_{bf} = 52.334\ DA^{0.5766}$$
$$A = 11.428\ DA^{0.5291}$$
$$TW = 12.301\ DA^{0.3756}$$
$$d = 0.9455\ DA^{0.1506}$$

Where:

Q_{bf} = Bankfull discharge (cfs)
DA = Watershed drainage area (mi^2)
A = Section flow area at bankfull discharge (ft.)
TW = Flow width at bankfull discharge (ft.)
d = Average flow depth at bankfull discharge (ft.)

BUREC Equation. The Bureau of Reclamation (Lane and Carlson, 1953) developed relationships that describe stable channel dimensions for canals cut into coarse grained alluvium.

$$d_{max} = (Q_{bf}/2 \tan \phi)^{0.5}$$
$$A = 2\ d_{max}^2 / \tan \phi$$
$$V_m = 1/n\ (d_{max} \cos \phi / (0.5\ \pi\ (1 - \cos \phi))^{0.667}\ S_e^{0.5}$$
$$TW = d_{max}\ \pi / \tan \phi$$

Where:

d_{max} = Maximum depth of flow (ft.)

Q_{bf} = Bankfull discharge (cfs)

ϕ = Angle of repose of bank material

V_m = mean flow velocity (ft./sec.)

n = Mannings n value

S_e = Energy slope (ft./ft.)

TW = Top width of flow (ft.)

5.10.3 Allowable Velocity

Allowable velocity calculations are performed to evaluate the effectiveness of the channel lining. The allowable velocity is interpreted as the velocity below which no erosion will occur. The leveed corridors are designed to have velocities less than 6 ft/sec so that erosion does not pose a significant threat. The allowable velocity is not a factor in the alternatives with the concrete channels.

Following procedures used to estimate:

- Fortier & Scobey (as modified in Chow)
- BUREC
- Neill (gravel/cobble)
- USACE Table
- FHWA Table

Fortier & Scobey Table Fortier and Scobey (1926) published one of the first tables of permissible velocity in 1926. Their data, based on records of seasoned stable canals, was later republished by a number of federal agencies and other organizations including the FHWA, ASCE, and Chow (MacBroom, 1981). The Fortier and Scobey data (Table 5) distinguish erosion hazards for clear water, silt-laden water, and water transporting sand and gravel (bedload). Their data presumably do not account for the stabilizing effect of bank vegetation.

Table 5 Fortier & Scobey Table of Permissible Canal Velocities (ft/s)

Bank Material	Clear Water	Silt-Laden	Sand/Gravel Bedload
Sandy Loam	1.75	2.50	2.00
Firm Loam	2.50	3.50	2.25
Fine Gravel	2.50	5.00	3.75
Stiff Clay	3.75	5.00	3.00
Coarse Gravel	4.00	5.50	6.50
Cobbles	5.00	5.50	6.50

BUREC/Mavis & Laushey Equation The BUREC (1974) recommends that permissible velocity be estimated using a modification of the Mavis and Laushey equation (Jurnikis, 1971), which was developed by bridge engineers in Great Britain (MacBroom, 1981). The BUREC equation is a function of grain size, and is most applicable to bed material.

$V_b = 0.64\ D^{(4/9)}$ for D < 6.0 mm

$V_b = 0.5\ D^{1/2}$ for D > 6.0 mm

Where:

V_b = competent velocity (ft/sec)

D = particle diameter (mm)

Neill Equation Neill (1975) developed equations that are a function of flow depth and grain size for permissible velocities on gravel and cobble bed streams, with a separate equation for cohesive soils.

$V_b = 3.15\ d^{(1/3)}\ D^{(2/3)}$ (non-cohesive soils)

$V_b = 7.5\ d^{(1/6)}\ \tau_c^{1/2}$ (for cohesive soils)

Where:

V_b = competent velocity (ft/sec)

d = flow depth (ft)

D = grain size (ft)

τ_c = critical shear stress (lb/ft^2)

USACOE Permissible Velocity The Corps of Engineers (1970; 1995) has established suggested maximum velocities for design of non-scouring flood control channels, as shown in Table 6.

Table 6 Suggested Maximum Permissible Mean Channel Velocities (USACOE, 1995)

Channel Material	Mean Velocity (ft/sec)
Fine Sand	2.0
Fine Gravel	6.0
Grass-Lined Banks (< 5% Slope, Sandy Silt, Bermuda Grass)	8.0
Poor Rock (Sedimentary)	10.0
Good Rock (Igneous or Metamorphic)	20.0

The Corps of Engineers (1990) has also developed criteria relating flow depth and velocity to the beginning of movement of granular bed materials and erosion of cohesive bank materials, as summarized in Table 7.

Table 7 Corps of Engineers Erosive Velocity Data

Grain Size (mm)	Flow Depth (ft)	Velocity (ft/sec)	Cohesiveness	Flow Depth (ft)	Velocity (ft/sec)
1 (sand)	5 10	2.5 4.0	Very Soft	5 10	2.0 2.5
10 (gravel)	5 10	4.5 5.5	Average	5 10	3.5 4.0
100 (cobbles)	5 10	9.5 10.5	Very Stiff	5 10	5.5 6.0

5.10.4 Equilibrium Slope

The equilibrium slope is defined as the slope at which the channel bed is in equilibrium. It is interpreted as the slope the channel would evolve into, provided continuous flows for a long period of time and provides an idea as to what the design slope should be.

Following equations are computed:

- Schoklitsch
- MPM
- Shields
- Lane's Tractive Force
- Average BUREC
- Bray
- Henderson
- BUREC
- Simplified AMAFCA

Equilibrium slope[1] is defined as the slope which causes the channel's sediment transport capacity to equal the incoming sediment supply (ADWR, 1985). If the slope is too steep, channel velocities will be high and net erosion will occur. If the slope is too flat, channel velocities will be low and net deposition will occur. The equilibrium slope is the slope that the undisturbed, natural channel will tend towards over the long term. While there are philosophical and practical problems with applying equilibrium slope concepts to ephemeral streams with variable channel geometry and high flash flood potential, or streams where the natural hydrology has been altered by urbanization, equilibrium slope equations provide a useful order-of-magnitude assessment of the likelihood of vertical channel adjustments.

5.10.5 Methodology

Design reach-averaged data required for application of equilibrium slope equations to the study area were derived from the following sources:

- Hydraulic data – normal-depth computations
- Hydrologic data - HEC-1 modeling and area weighting

[1] Equilibrium slope is also referred to as stable slope or limiting slope.

- Topographic data – 10-foot contour data and DTM

Most equilibrium slope equations are based on the mean annual flood, the "channel-forming," or "bankfull" discharge. On many perennial alluvial streams, particularly in humid climates, the mean annual flood and the channel-forming and bankfull discharges are nearly equivalent. However, on ephemeral streams where flow events are rare, the channel-forming discharge is often difficult to determine. To account for the discrepancies in what flow rate is appropriate for equilibrium slope analyses, and to assess the trend of expected slope adjustments during floods, a range of discharges were used in the equilibrium slope equations to assess the expected slope adjustment over a range of discharges. Four ratios of the 100-year peak discharge estimate were examined: 10%, 25%, 75%, and 100%. The 10% flow was assumed to approximate the 2-5-year flood. The 25% flow was assumed to approximate the 10-year event. The 2-year event approximates the mean annual flood calculated on a probability-weighted basis. The 10-year event better approximates bankfull conditions in many ephemeral stream reaches. The following equilibrium slope equations were applied to the study reach:

- Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) Equations
- BUREC Equation
- Bray Equation
- Henderson Equation

The BUREC (Pemberton and Lara, 1984) published a manual for computing scour and channel degradation downstream of dams or other structures that interrupt the natural sediment supply to the downstream channel. The BUREC manual describes the following four approaches for estimating equilibrium slope:

- Schoklitsch Equation
- Meyer-Peter Muller Equation
- Shield's Diagram Method
- Lane's Tractive Force Method

The latter four equations listed above are zero bed sediment discharge (clear water) equations, and represent minimum slopes that would occur if sediment supply were disrupted, such as might occur downstream of a large in-stream sand and gravel mine, a dam, or an on-line detention basin.

5.10.6 AMAFCA Equation

The AMAFCA (1994) equation for the maximum equilibrium slope is based on the sediment transport characteristics of the reach.

$$S_L = \left(\frac{a}{q_s}\right)^{\frac{10}{3(c-b)}} q^{\frac{2(2b+3c)}{3(c-b)}} \left(\frac{n}{1.49}\right)$$

Where:

S_L = channel slope (ft./ft.)

q_s = unit sediment transport (cfs/ft)

q = water discharge (cfs)

n = Manning's roughness

a, b, c = power function coefficients from sediment transport function

A simplified version of the AMAFCA Equation is written for wide, rectangular channels, similar to the design channels for the ADMP study, based on the assumptions that steep, wide, rectangular alluvial streams flow at or close to critical depth and that sediment supply is transport limited.[1]

$$S_s = 18.28\ n^2\ F^{0.133}\ F_r^{2.133}\ Q_{dd}^{-0.133}$$

Where:

S_s = Stable slope (ft/ft)

n = Manning's roughness value for the channel

F = Width/depth ratio of the channel

F_r = Froude number for the channel

Q_{dd} = Dominant discharge (cfs)

5.10.7 BUREC Equation

The BUREC published an equation for stable slope based on theoretical considerations of sediment transport (MacBroom, 1981).

$$S_L = (0.00021\ D_{50}\ W_{bf} / Q)^{0.75}$$

[1] Transport limited means that the sediment inflow equals or exceeds the reach transport capacity.

Where:

S_L = Stable slope (ft/ft)
D_{50} = Bed sediment diameter (ft)
W_{bf} = Channel width (ft)
Q = Discharge (cfs)

5.10.8 Bray Equation

Bray's (1979) equation for equilibrium slope is based on regime analysis of perennial gravel bed streams in Alberta, Canada.

$$S_L = 0.965\ Q_2^{-0.344}\ D_{50}^{0.58}$$

Where:

S_L = Equilibrium slope (ft/ft)
D_{50} = Mean bed sediment diameter (ft)
Q_2= 2-year discharge (cfs)

5.10.9 Henderson Equation

To generate an equation for the slope of stable channels, Henderson (1961) modified the Lane (1952) equations using a threshold theory of shear stress concept.

$$S_L = 0.44\ D_{90}^{1.15}\ Q^{-0.46}$$

Where:

S_L = Stable slope (ft/ft)
D_{90} = Bed sediment diameter for which 90 percent is smaller (ft)
Q = Discharge (cfs)

5.10.10 Schoklitsch Equation

The Schoklitsch (Shulits, 1935) equation is based on the concept of zero bedload transport.

$$S_L = K_s\ (D\ W_{bf}/Q)^{3/4}$$

Where:

S_L = Stable slope (ft/ft)
K_s = 0.00174
W_{bf} = Bankfull width (ft)
D = Mean bed sediment diameter (mm)
Q = Dominant discharge (cfs)

5.10.11 Meyer-Peter, Muller Equation

The Meyer-Peter, Muller (1948) equation is based on the incipient motion theory, or the point of initiation of sediment transport.

$$S_L = K_{mpm}\ (Q/Q_{bf})\ (n_s/D_{90}^{1/6})^{3/2}\ D / d$$

Where:

S_L = Stable slope (ft/ft)
K_{mpm} = 0.19
Q/Q_{bf} = Ratio of total flow to flow over the channel
Q_{bf} = Dominant discharge (cfs)
n_s = Manning's n for the stream bed
D_{90} = Bed sediment diameter for which 90 percent is smaller (mm)
D = Mean sediment diameter (mm)
d = Channel depth (ft)

5.10.12 Shields Diagram Method

The Shields diagram (1936) for determining the boundary condition for no sediment transport can be used to define an equation for stable slope.

$$R_* = U_* D / \upsilon$$

$$U_* = (S_L R g)^{1/2}$$

$$T_* = \tau_c / ((\gamma_s - \gamma_w) D)$$

Where:

S_L = Stable slope (ft/ft)

R_* = Boundary Reynold's number

U_* = Shear velocity = $(S_L\ R\ g)^{\wedge 0.5}$

D = Mean sediment diameter (mm)

υ = Kinematic velocity of water (ft/sec^2)

R = Hydraulic radius for wide channels (ft)

g = Gravitational constant = 32.2 ft/sec^2

T_* = Dimensionless shear stress

τ_c = Critical shear stress (lb/ft^2)

γ_s = Specific weight of sediment (lb/ft^3)

γ_w = Specific weight of water (lb/ft^3)

5.10.13 Lane's Tractive Force Method

Lane's equation for stable slope uses critical tractive force relationships.

$$S_L = (\tau_c/\gamma_w)\ d$$

Where:

S_L = Stable slope (ft/ft)

d = Mean flow depth (ft)

τ_c = Critical shear stress (lb/ft^2)

γ_w = Specific weight of water (lb/ft^3)

Among the equations used, AMAFCA is the only one that is for live-bed while all others are for clear water. The clear water equations predict slopes are smaller than the AMAFCA equation which generally predicts higher values of slope. The slope influences the hydraulics significantly and can directly impact the velocity in channel which affects the sedimentation issues. However, the range of equilibrium slope estimates from the equations investigated varies greatly. In order to arrive at a slope for use in the Step 2 hydraulic and design process, the average of the clear water equations (Schkoklitsch, MPM, Shields, and Lane) was taken and averaged with the results from the Simplified AMAFCA, Bray, and Henderson equations. The resulting average slope was assumed representative of the long-term slope to develop in the leveed corridors. In addition, this result was used to compute the grade control requirements for the leveed corridors. Finally, this slope was also used to for the hydraulic design of the earthen excavated channels (B3).

5.10.14Sediment Transport Capacity

The sediment transport capacity is used to estimate of the rate of sediment transport in tons/day. The sediment transport capacity can be used to ensure the adequate sediment continuity and provides channel sediment trend when compared with the inflowing sediment transport load. It can also be used to estimate sediment volume using maximum sediment concentrations and the flow volume.

The following equations are computed:

- Zeller Fullerton
- Ackers White
- Colby
- Einstein
- Engelund/Hansen
- Kalinske
- Laursen
- MPM
- Rottner
- Schoklitsch
- Toffaleti
- Yang

The calculations are performed based on procedures in Yang, 1995. It may be noted that each these equations have been developed under different circumstances and may not be entirely valid for all the conditions proposed in the design. However, the sediment transport capacity values are used as a gross estimate of sediment flux and to provide qualitative estimates of sedimentation and erosion possibilities.

5.10.15Scour and Toe Protection

The toe-down for the levee and other bank protection are estimated using the general scour estimates. The Pima County General Scour Equations are used for this purpose. It is assumed that the bend scour is negligible as most of the designed channels have somewhat straight alignments. The long-term scour is estimated from equilibrium slope and the local scour is defined low flow channel depth.

Scour calculations in this report are performed using procedures outlined in the City of Tucson's *Standards Manual for Drainage Design and Floodplain Management* - Chapter VI - Erosion and Sedimentation (1989; hereafter, "the COT Manual"). The following equation for depth of scour in a stream is given in the COT Manual:

$$Z_t = 1.3\ (Z_{gs} + \tfrac{1}{2}\ Z_a + Z_{ls} + Z_{bs} + Z_{lft})$$

where:

Z_t = Design scour depth, excluding long-term degradation or aggradation (ft)
Z_{gs} = General scour depth (ft)
Z_a = Anti-dune trough depth (ft)
Z_{ls} = Local scour depth (ft)
Z_{bs} = Bend scour depth (ft)
Z_{lft} = Low-flow thalweg depth (ft)
1.3 = Safety factor to account for non-uniform flow distribution

General scour, Z_{gs}, is the component of scour that represents the mobile portion of the bed-material of the channel bottom. General scour was estimated using the following equation:

$$Z_{gs} = Y_{max}\ [(0.0685\ V_m^{0.8})/(Y_h^{0.4}\ S_e^{0.3})\text{-}1]$$

where:

Z_{gs} = General scour depth (ft)
V_m = Average velocity of flow at design discharge (ft/sec)
Y_{max} = Maximum depth of flow at design discharge (ft)
Y_h = Hydraulic depth of flow at design discharge, (ft)
S_e = Energy slope (ft/ft)

Where Z_{gs} was determined to be negative, the general scour component was assumed to be zero, in keeping with the recommended practice in the COT Manual.

Anti-dune trough depth, Za, is the component of scour caused by movement of dune shaped bed forms along the bottom of the channel. The anti-dune trough depth was estimated using the following equation:

$$Z_a = 0.0137\ V^2_m$$

where:

V_m = Average velocity of flow at design discharge (ft/sec)

Bend scour, Z_{bs}, occurs on the outside of bends in a stream channel, and is caused by spiral transverse currents. Bend scour was estimated using the following equation:

$$Z_{bs} = 0.0685\ Y_{max}\ V_m^{0.8}\ \ Y_h^{-0.4}\ S_e^{-0.3}\ \{2.1\ [\sin^2(\alpha/2)/\cos\alpha]^{0.2} - 1\}$$

where:

Z_{bs} = Bend-scour component of total scour depth (ft), and
= 0 when $r_c/T > 10.0$, or $\alpha < 17.8^o$
= computed value when $0.5 < r_c/T < 10.0$, or $17.8^o < \alpha < 60^o$
= computed value when $\alpha = 60^o$ when $r_c/T < 0.5$, or $\alpha > 60^o$
Y_{max} = Maximum depth of flow immediately upstream of the bend (ft)
V_m = Average velocity of flow immediately upstream of the bend (ft/sec)
Y_h = Hydraulic depth of flow immediately upstream of the bend (ft)
S_e = Energy slope immediately upstream of the bend (ft/ft)
α = Angle formed by the projection of the channel centerline from the point of curvature to a point which meets a line tangent to the outer bank of the channel (degrees)
r_c = radius of curvature along centerline of channel (ft)
T = channel top width (ft)

The bend angle was computed from the arccosine of the reciprocal of the sinuosity. A sinuosity of 1.1 was assumed for all design reaches. The thalweg depth used for the scour depth calculation was set as low-flow channel depth for both the leveed corridors and the excavated earthen channel.

Scour depth below drop structures was estimated using the following equation from Schoklitsch (1935):

$$D_s = 4.75\ h^{0.2}\ q^{0.57}\ /\ d_{90}^{0.32}$$

where:

D_s = Scour depth below downstream water surface (m)
h = Drop height (m)
q = Unit discharge ($m^3/s/m$)
d_{90} = Bed material size for which 90% of the sample is finer (mm)

5.11 Off-line Detention Basins

Off-line detention basins were included in situations where the flow needs to be limited to accommodate downstream capacity of existing channels, culverts or delineated floodplains. These basins are modeled as diversions in HEC-1 using the DI/DQ records. At the culvert locations along Sun Valley Parkway, the purpose of the off-line basin is to reduce the flow capacity to the maximum capacity of the culvert. The maximum capacity of the culvert is determined using HY8 results as the flow rate that occurs when the upstream water surface elevation is 1 foot above the culvert top elevation. At other locations, flows higher than certain desired values are diverted and the inflow/outflow relations are the design parameters.

6 DESIGN PROCEDURES

The details of the design procedure for all the alternatives and structural elements are presented in this section. The alternatives are described in Section 10.

6.1 Alternative A

- Identify the fan apex/upstream area location and the preferred channel alignment from the apex to the outfall. For Wagner, Hassayampa, FRS 1 and FRS 2 & 3 sub-areas, the preferred channel alignment is one of the alignments in B4-1, B4-2, or B4-3. The alignments for the CAP and White Tank Wash sub-areas are the same for all alternatives.
- Set aside adequate area for active alluvial fan processes to occur. This up-fan area is immediately downstream of the apex. The areas used were taken from delineations prepared by Ayres (2005) as part of the Buckeye/Sun Valley ADMS.
- Design collector channels downstream of the sedimentation area to collect all the flows from the upstream watershed (See section 6.11).
- Route flow from collector channels to Sun Valley Parkway by designing leveed natural channel along the preferred channel alignment (See section 6.10).
- Design off-line basin upstream of the culvert location if the culvert capacity is not adequate. Off-line basin capacity is the volume of flow above the culvert capacity (See section 6.9).
- Route the flows to the outfall by designing leveed natural channel (See section 6.10).
- Design off-line basin upstream of the outfall location if the capacity of the outfall is not adequate. Off-line basin capacity is the volume of flow greater than capacity of the outfall (See section 6.9).

6.2 Alternative B1

- This alternative is only considered for CAP and White Tank Wash sub-areas. Alternative B4 is equivalent to B1 alternative for Wagner, Hassayampa, FRS 1 and FRS 2 & 3 sub-areas (see section 6.5).
- Identify the fan apex/upstream area location and the preferred channel alignment from the apex to the outfall.
- Design big on-line basin near apex location using the following criterion: Peak Outflow ≈ 10% Peak Inflow.
- Route flow from big on-line basin to Sun Valley Parkway by designing leveed natural channel along the preferred channel alignment (See section 6.10).
- Design off-line basin upstream of the culvert location if the culvert capacity is not adequate. Off-line basin capacity is the volume of flow above the culvert capacity (See section 6.9).
- Route the flows from Sun Valley Parkway to the outfall by designing leveed natural channel along the preferred channel alignment (See section 6.10).
- Design off-line basin upstream of the outfall location if the capacity of the outfall is not adequate. Off-line basin capacity is the volume of flow greater than capacity of the outfall (See section 6.9).

6.3 Alternative B2

- Identify the fan apex/upstream area location and the preferred channel alignment from the apex to the outfall. For Wagner, Hassayampa, FRS 1 and FRS 2 & 3 sub-areas, the preferred channel alignment is one of the alignments in B4-1, B4-2, or B4-3. The alignments for the CAP and White Tank Wash sub-areas are the same for all alternatives.
- Design small on-line basin near apex location using the following criterion: Peak Outflow ≈ 90% Peak Inflow
- Route flow from small on-line basin to Sun Valley Parkway by designing leveed natural channel along the preferred channel alignment (See section 6.10).

- Design off-line basin upstream of the culvert location if the culvert capacity is not adequate. Off-line basin capacity is the volume of flow above the culvert capacity (See section 6.9).
- Route the flows from Sun Valley Parkway to the outfall by designing leveed natural channel along the preferred channel alignment (See section 6.10).
- Design off-line basin upstream of the outfall location if the capacity of the outfall is not adequate. Off-line basin capacity is the volume of flow greater than capacity of the outfall (See section 6.9).

6.4 Alternative B3

- Identify fan apex/upstream area location and preferred channel alignment from the apex to the outfall. For Wagner, Hassayampa, FRS 1 and FRS 2 & 3 sub-areas, the preferred channel alignment is one of the alignments in B4-1, B4-2, or B4-3. The alignments for the CAP and White Tank Wash sub-areas are the same for all alternatives.
- Design big on-line basin near apex location using the following criterion: Peak Outflow ≈ 10% Peak Inflow.
- Route flow from big on-line basin to Sun Valley Parkway by designing excavated earthen channel along the preferred channel alignment (See section 6.11).
- Design off-line basin upstream of the culvert location if the culvert capacity is not adequate. Off-line basin capacity is the volume of flow above the culvert capacity (See section 6.9).
- Route the flows from Sun Valley Parkway to the outfall by designing excavated earthen channel along the preferred channel alignment (See section 6.11).
- Design off-line basin upstream of the outfall location if the capacity of the outfall is not adequate. Off-line basin capacity is the volume of flow greater than capacity of the outfall (See section 6.9).

6.5 Alternative B4

- This alternative is only considered for Wagner, Hassayampa, FRS 1, and FRS 2 & 3 sub-areas. Alternative B1 is equivalent to B4 alternative for CAP and White Tank Wash sub-areas (see section 6.2).
- Alternatives B4-1, B4-2, and B4-3 represent the three channel alignments considered. Perform all the design procedure steps for B1 (See Section 6.2) using each of the three channel alignments.
- Select preferred alignment based on evaluation criteria such as cost, feasibility, etc.
- Perform design for Alternatives B2, B3, and C for the preferred alignment.

6.6 Alternative B5

- This alternative is only considered for CAP sub-area.
- Identify the fan apex/upstream area location and the preferred channel alignment from the apex to the outfall. For Wagner, Hassayampa, FRS 1 and FRS 2 & 3 sub-areas, the preferred channel alignment is one of the alignments in B4-1, B4-2, or B4-3. The alignments for the CAP and White Tank Wash sub-areas are the same for all alternatives.
- Design small off-line basin near apex location using the following criterion: Peak Outflow ≈ 90% Peak Inflow
- Route flow from small off-line basin to Sun Valley Parkway by designing leveed natural channel along the preferred channel alignment (See section 6.10).
- Design off-line basin upstream of the culvert location if the culvert capacity is not adequate. Off-line basin capacity is the volume of flow above the culvert capacity (See section 6.9).
- Route the flows from Sun Valley Parkway to the outfall by designing leveed natural channel along the preferred channel alignment (See section 6.10).
- Design off-line basin upstream of the outfall location if the capacity of the outfall is not adequate. Off-line basin capacity is the volume of flow greater than capacity of the outfall (See section 6.9).

6.7 Alternative C

- Identify the fan apex/upstream area location and the preferred channel alignment from the apex to the outfall. For Wagner, Hassayampa, FRS 1 and FRS 2 & 3 sub-areas, the preferred channel alignment is one of the alignments in B4-1, B4-2, or B4-3. The alignments for the CAP and White Tank Wash sub-areas are the same for all alternatives.
- Route flow from the apex to Sun Valley Parkway by designing excavated concrete channel along the preferred channel alignment (See section 6.12).
- Design off-line basin upstream of the culvert location if the culvert capacity is not adequate. Off-line basin capacity is the volume of flow above the culvert capacity (See section 6.9).

- Route the flows from Sun Valley Parkway to the outfall by designing excavated concrete channel along the preferred channel alignment (See section 6.12).
- Design off-line basin upstream of the outfall location if the capacity of the outfall is not adequate. Off-line basin capacity is the volume of flow greater than capacity of the outfall (See section 6.9).

6.8 On-line Basin Design Procedure

- Determine upstream sediment contributing area.
- Using this area, estimate sediment yield (see Section 5.8).
- Identity upstream reaches that bring sediment into the on-line basin. Determine sediment volume using flow volume from HEC-1 and sediment concentration at the upstream reach (sediment volume = flow volume x sediment concentration). Repeat this step for all upstream reaches.
- Determine topographic slope at the proposed location of the basin. This slope is used to determine the elevation difference at the upstream and downstream ends of the basin. The elevation difference is restricted to a maximum value of 20 ft.
- Determine basin dimensions: Length, width and depth. Side slopes are fixed at 3H:1V. Freeboard is fixed at 1 foot. These parameters determine the total volume provided as well as total head available for the outflow.
- Determine outlet structure type, size/number and invert elevation. These parameters along with the basin dimensions determine stage-storage-outflow relation.
- Update the stage-storage-outflow relation in HEC-1 6-hour and 24-hour models.
- Run the 6-hour and 24-hour HEC-1 models
- Obtain the maximum peak flow volume and peak stage from HEC-1 results
- Compare with designed basin volume and basin depth (includes freeboard and sediment) to see if they are adequate.
- Modify basin dimensions and outlet structure parameters and repeat the process until the basin volume and depth are adequate.

6.9 Off-line Basin Design Procedure

- Determine topographic slope at the proposed location of the basin. This slope is used to determine the elevation difference at the upstream and downstream ends of the basin. The elevation difference is restricted to a maximum value of 20 ft.
- Determine basin dimensions: Length, width and depth. Side slopes are fixed at 3H:1V. Freeboard is fixed at 1 foot. These parameters determine the total volume provided as well as total head available for the outflow.
- If the off-line basin is at a location upstream of a culvert, import the HY8 results for the culvert into an inflow-outflow table (see section 5.11). If the off-line basin is at a location upstream of an outfall, then setup an inflow-outflow table to divert all flows exceeding the capacity of the channel into the off-line basin.
- Update the inflow-outflow relation in HEC-1 6-hour and 24-hour models.
- Run the 6-hour and 24-hour HEC-1 models
- Obtain the diverted flow rate and volume from HEC-1 results
- Compare with designed basin volume and basin depth (includes freeboard) to see if they are adequate.
- Modify basin dimensions and repeat the process until the basin volume and depth are adequate.

6.10 Leveed Natural Channel Design Procedure

- Identify the channel alignment and determine the length and existing slope along the proposed alignment.
- Select Manning's n values. A value of 0.045 is assumed for the leveed natural channels.
- Determine sediment gradation parameters such as D_{50}, etc.
- Determine upstream drainage area. This is used in the Moody & Odem Regime Equations.
- Determine the adjacent area that can contribute to the sediment volume entering the reach. Using this area, estimate sediment yield (see Section 5.8).

- Identity upstream reaches, basins, and adjacent watershed areas that bring flow into the channel. The HEC-1 model KK IDs for these components are identified and appropriate weighting factors (see section 5.7) are applied to arrive at the 100-year peak flow for the proposed channel.
- Identity upstream reaches that bring sediment into the channel. Determine sediment flux entering channel from these upstream channels.
- Establish an initial width and depth of the leveed channel and set up the conveyance cross-section. Depth of flow in the initial cross section is targeted at about 1 foot and velocity of the 75 percent and 100 percent flow rates are greater than 4 feet per second but less than 6 feet per second. The bottom width may not exceed 400 feet.
- Determine the average equilibrium slope (see section 5.10.4) for the selected cross-section, existing slope and sediment gradation data.
- Set the long-term slope based on the average equilibrium slope.
- Determine the velocity, flow depth, and Froude number.
- The velocity in the initial cross section should be approximately 4-6 ft/sec. The flow depth should be in the range of 1 to 2 feet and the Froude number less than 0.86. The available freeboard must be larger than the required freeboard. Repeat sizing width and depth of the channel until these conditions are satisfied.
- Determine the shape of the long-term low-flow channel using hydraulics results for the long-term slope. The shape of the long-term low-flow channel is determined by the regime theory results for the 10% and 25% peak flow results for width, depth, and velocity.
- Determine sediment transport capacity for the channel as designed (see section 5.10.14). If the sediment influx is larger than the sediment transport capacity, deposition is anticipated. Erosion is anticipated otherwise.
- Perform allowable velocity calculations (see section 5.10.3) to determine that the channel, as designed, would be stable.
- Determine the number of drop structures needed (see section 5) using the length of the channel, existing slope, and the long-term design slope. A 3-foot drop height is assumed for all drop structures.
- Determine number of sedimentation basins needed using the estimates of the sediment volume entering the channel.
- Determine the toe down required for bank protection. The toe down is computed based on the estimated scour depth computed (see section 5.10.15).
- Determine any additional ROW area needed. These are needed in the estimation of the land costs.
- Perform cost estimates (see section 9.1) to arrive at the land cost, construction cost, landscaping cost and maintenance cost. The channel costs are estimated for the following: (a) land cost for the channel area, (b) land cost for the levee area, (c) other additional right of way area, (d) toe protection using riprap, e) levee fill, f) levee lining, g) drop structures using riprap, and h) sedimentation basins.

6.11 Excavated Earthen Channel Design Procedure

- Identify the channel alignment and determine the length and existing slope along the proposed alignment.
- Select Manning's n values. A value of 0.045 is used for the earthen excavated channel.
- Determine sediment gradation parameters such as D_{50}, etc.
- Determine upstream drainage area. This is used in the Moody & Odem Regime Equations.
- Determine the adjacent area that can contribute to the sediment volume entering the reach. Using this area, estimate sediment yield (see Section 5.8).
- Identity upstream reaches, basins, and adjacent watershed areas that bring flow into the channel. The HEC-1 model KK IDs for these components are identified and appropriate weighting factors (see section 5.7) are applied to arrive at the 100-year peak flow for the proposed channel.
- Identity upstream reaches that bring sediment into the channel. Determine sediment flux entering channel from these upstream channels.
- Establish an initial width and depth of the excavated channel and set up the conveyance cross-section.
- Determine the average equilibrium slope (see section 5.10.4) for the selected cross-section, existing slope and sediment gradation data.
- Determine the design slope based on the equilibrium slope. For the B3 Alternative, the hydraulics of only the design (long-term) slope are evaluated as the channel will be constructed to this slope.

- Determine the velocity, flow depth, and Froude number.
- The flow width and depth are approximately set based on regime theory. The flow depth should be less than 8 feet and the Froude number less than 0.86. The available freeboard must be larger than the required freeboard. Repeat sizing width and depth of the channel until these conditions are satisfied.
- Determine sediment transport capacity for the channel as designed (see section 5.10.14). If the sediment influx is larger than the sediment transport capacity, deposition is anticipated. Erosion is anticipated otherwise.
- Perform allowable velocity calculations (see section 5.10.3) to determine that the channel, as designed, would be stable.
- Determine the number of drop structures needed (see section 5) using the length of the channel, the existing slope and the design (long-term) slope. A 3-foot drop height is assumed for all drop structures.
- Determine number of sedimentation basins needed using the estimates of the sediment volume entering the channel.
- Determine any additional ROW area needed. These are needed in the estimation of the land costs. A 120-foot preservation corridor is assumed for all excavated channel alternatives except for collector channels associated with Alternative A.
- Perform cost estimates (see section 9.1) to determine the land cost, construction cost, landscaping cost and maintenance cost. The channel costs are estimated for the following: (a) land cost for the channel area, (b) land cost for the adjacent natural preservation corridor, (c) other additional right of way area (d) channel excavation costs, (e) toe protection using riprap, f) drop structures using riprap, and g) sedimentation basins. Excavation costs are determined based on the channel cross sectional area and the difference between the existing slope and design channel slope.

6.12 Excavated Concrete Channel Design Procedure

- Identify the channel alignment and determine the length and existing slope along the proposed alignment.
- Select Manning's n values. A value of 0.02 is used for the concrete excavated channels.
- Determine sediment gradation parameters such as D_{50}, etc.
- Determine upstream drainage area. This is used in the Moody & Odem Regime Equations.
- Determine the adjacent area that can contribute to the sediment volume entering the reach. Using this area, estimate sediment yield (see Section 5.8).
- Identity upstream reaches, basins, and adjacent watershed areas that bring flow into the channel. The HEC-1 model KK IDs for these components are identified and appropriate weighting factors (see section 5.7) are applied to arrive at the 100-year peak flow for the proposed channel.
- Identity upstream reaches that bring sediment into the channel. Determine sediment flux entering channel from these upstream channels.
- Establish an initial width and depth of the excavated channel and set up the conveyance cross-section.
- Determine the average equilibrium slope (see section 5.10.4) for the selected cross-section, existing slope and sediment gradation data.
- Determine the slope based on the Froude number. The Froude number should be set less than 0.86. The initial slope and the long-term slope are set as the same value.
- Determine the velocity, flow depth, and Froude number.
- The flow depth should be less than 8 feet. The available freeboard must be larger than the required freeboard. Low flow channels are sized such that the 10 percent and 25 percent depth and velocity are not considered too highly dangerous for adults possibly caught within the channel based on criteria in ACER TM-11 (USBR, 1988). Generally, velocity is kept below 5 feet per second and depth less than 2 feet wherever possible. Repeat sizing width and depth of the channel until these conditions are satisfied.
- Determine sediment transport capacity for the channel as designed (see section 5.10.14). If the sediment influx is larger than the sediment transport capacity, deposition is anticipated. Erosion is anticipated otherwise.
- Determine the number of drop structures needed (see section 5) using the length of the channel, existing slope and the design slope. A 3-foot drop height is assumed for all drop structures.
- Determine number of sedimentation basins needed using the estimates of the sediment volume entering the channel.

- Determine any additional ROW area needed. These are needed in the estimation of the land costs. A 120-foot preservation corridor is assumed for all excavated channel alternatives except for collector channels associated with Alternative A.
- Perform cost estimates (see section 9.1) to arrive at the land cost, construction cost, landscaping cost and maintenance cost. The channel costs are estimated for the following: (a) land cost for the channel area, (b) land cost for the adjacent natural corridor, (c) other additional right of way area (d) channel excavation costs, e) drop structures using concrete, and f) sedimentation basins. Excavation costs are determined based on the channel cross sectional area and the difference between the existing slope and design channel slope.

7 LANDSCAPE COMPATIBILITY ENHANCEMENTS

In order to ensure that the proposed structural flood control measures are compatible with the future landscape character of the area, some enhancements to the engineering design concepts are required. In 1993, the District adopted a "Policy for the Aesthetic treatment and Landscaping of Flood Control projects". This policy aims at planning and designing flood control projects that are compatible with the visual character of the adjacent landscape. In addition, the policy also aims at the integration of the recreational activities into the planning and design of the flood control facilities.

The design aspects of landscape compatibility enhancement are the enhancements imposed on a base engineering design to achieve compatibility with this policy. In particular, the enhancements require modifications to engineering structures to blend them into the landscape by integrating non-rectilinear forms, appropriate scale, etc. The landscape enhancements result in additional costs to the project when compared to the costs of the base engineering design. The details pertaining to the design aspects of the enhancements as well as the cost differential for the enhancements are presented in this section. The hydraulics and sediment transport calculations are performed only for the base engineering design and not for the landscape compatibility enhanced design. These calculations for the landscape compatibility enhanced design will be incorporated at the Step 3 design refinement process.

7.1 Landscape Compatibility Enhancements to Leveed Channel

The landscape compatibility enhancement to the levee consists of the flattening of the levee side slope, increase of the top-width of the levee as well the height of the levee. Height adjustments to earth and walled levees were also added to vary to the profile of these structures in the landscape. The levee side slope will vary between 4:1 to 8:1. The height increase in the levee will vary along the length of the levee between 0 to 2 ft. The top-width of earth levees was increased from 14 feet in the base design to 20 feet in the enhanced design. The estimation of project cost increases due to landscape compatibility enhancements were performed by using an average side slope of 6:1 and an average increase in the levee height of 1 ft. These adjustments result in increased fill volume, increased levee lining, as well as increased land area. The increase in the land area, in turn, increases the landscape and maintenance costs. The increase in the levee lining costs is a result of the increased exposed levee surface area.

If a walled corridor channel is adopted instead of a levee, an additional land buffer of 50 ft is applied to each side of the channel. In addition, an average increase of 1 foot is incorporated to the wall height to reflect the vertical variation required to provide landscape compatibility.

7.2 Landscape Compatibility Enhancements to Excavated Channel

The landscape compatibility enhancements for the excavated channel involve a decrease in the side slope of the channel and an additional 50 ft buffer area parallel to all channels. The side slope for the enhanced design will vary between 4:1 to 8:1. For purpose of the cost estimates for the landscape compatibility enhancement components, the average side slope was decreased from 3:1 to 6:1. The decrease in the side slope increases the total land area needed which, in turn, increases the landscape and maintenance costs.

7.3 Landscape Compatibility Enhancements to On-line/Off-line Basins

The landscape compatibility enhancements for the detention basins include a decrease in the side slope, a buffer area around the basins and architectural enhancements to inlet and outlet structures. The side slope for the enhanced design will vary between 4:1 to 8:1. For purpose of the cost estimates, the average side slopes of the basins are decreased from 3:1 to 6:1. The slope change was performed along with an adjustment to the longer dimension of the basin so there is no change in net storage volume between the base design and the enhanced design. However, due to decreased slope, the excavation volume will be higher for the enhanced design. The change in the longer dimension of the basin will also contribute to an increase in the land costs. In addition, a buffer of 50 feet was added around the perimeter of all detention basins. This change also increases the land area resulting in increased land costs. Finally, additional costs were included for architectural enhancements to the inlet and outlet structures which are assumed to be 20% of base cost for the inlet structure and 5% for the outlet structure.

7.4 Landscape Compatibility Enhancements to Drop Structures

The landscape compatibility enhancement for the drop structures results in longer length for the drop structures. A 10% increase in the length of the drop structures was applied to achieve the enhancement. Architectural enhancements to the drop structure materials are also anticipated.

8 FRS #1 SUB-AREA SPECIFIC DESIGN CONSIDERATIONS

The FRS #1 sub-area is located on the southwestern slope of the White Tank Mountains piedmont. Three major alluvial fans, designated Fan 7, Site 36, and Site 37, drain from the White Tank Mountain Regional Park onto the piedmont in this sub-area. The Fan 7 portion of the piedmont receives inflows of water and sediment from two additional small alluvial fans, designated Fan 8 and Fan 9. The piedmont below Site 37 is bisected by the Sun Valley Parkway which runs north to south across the piedmont in this area. The downstream portions of Site 36 and Fan 7 are bisected by the old Tonopah-Salome Highway. Existing drainage facilities along the Sun Valley Parkway consist of culverts of various sizes beneath the roadway at various locations. There are no existing drainage facilities crossing the Tonopah-Salome Highway. All of the design concepts for the FRS #1 sub-area alternatives incorporate the existing culverts without modification where appropriate. Therefore, design flow rates for channels or conveyance corridors downstream of the Parkway are limited to the existing culvert capacities by offline detention facilities at or near the Sun Valley Parkway. Culvert capacities were computed assuming a headwater depth equal to one foot greater than the internal culvert height as indicated on the design plan sheets for the Parkway.

The B4-1 Alternative detains flows from all the alluvial fan apices and directs them into a common outfall corridor along the eastern portion of the piedmont. The corridors from Site 37 to Site 36 and a portion of the corridor from Site 36 to Fan 7 are achieved by means of an excavated channel. Elsewhere, the corridors for the B4-1 Alternative are leveed sections. The B4-1 Alternative was the shortest total length of the alignment alternatives. Therefore, the B4-1 alignment was also used to develop concept designs and costs for the B2, B3, and C Alternatives.

The B4-2 Alternative provided separate leveed conveyance corridors for Site 37, but continues to combine the outfall corridor from Site 36 to Fan 7. The B4-3 Alternative provides separate outfall corridors for Site 37, Site 36, and Fan 7. Fans 8 and 9 are collected by the Fan 7 leveed corridor in the B4-3 Alternative.

Diversion channels for Alternative A were assumed to be partially excavated with a downstream levee for the purposes of the cost estimation. Active alluvial fan areas were derived from the unstable delineations performed for the ADMS by Ayers (2005) and as part of the Site 36 Floodplain Delineation Study (JEF, 2001).

The FRS #1 sub-area contains an approximately 2.5 square mile area of existing development south of McDowell Road and west of Sun Valley Parkway. All of the alternatives include one of two alternative alignment scenarios for flood control corridors in this area. Alternatives B4-1, B2, B3, and C include an excavated channel flowing from east to west along McDowell Road to White Tank Wash. The channel for Alternative C is a concrete lined channel, while the others are earthen. Alternatives A, B4-2, and B4-3 have a leveed corridor which runs from north to south extending the proposed outfall from Site 37 south across the developed area to the FRS No. 1 pool area.

9 STEP 2 COST ESTIMATES

9.1 Base Cost Estimates

Base costs for each alternative were estimated by establishing unit costs for the various design components. The total cost for each component was obtained by multiplying the quantities involved with the unit costs. The cost components considered in the design are: 1) Land Cost, 2) Construction Cost, 3) Landscaping Cost, and 4) Maintenance Cost.

For the channels, the cost estimates are categorized into the following: (a) Levee (Alternatives A, B1, B2, B4, B5), (b) Levee Lining (Alternatives A, B1, B2, B4, B5), (c) Channel Excavation (Alternatives B3, C), (d) Channel Lining (Alternative C) (e) Toe Protection (f) Drop Structures (Alternatives A, B1, B2, B3, B4, B5), (g) Sedimentation Basins and (h) Other. The "Other" category is included for the purpose of including any other miscellaneous cost. Table 8 summarizes the channel materials selected for the purpose of cost estimation of the alternatives.

Table 8 Cost Estimate Categories for Channels

Channel Type	Channel Lining	Toe Protection	Levee Fill	Levee Lining	Drop Structures	Sedimentation Basins
Leveed Natural	None	Riprap	Yes	Riprap	Riprap	Yes
Earthen Excavated	None	Riprap	No	None	Riprap	Yes
Concrete Excavated	Concrete	None	No	None	Concrete	Yes

Similarly for the basins, the costs are categorized into: (a) basin, b) inlet, (c) outlet, and (d) other.

The four cost components are estimated for all the cost categories. A summation of all cost components provides the total cost for the particular channel or basin. The costs for all design elements (channels and basins) are totaled to provide the total cost for the particular alternative in a sub-area.

The procedures adopted in estimating the cost for each component are presented below. The details of the calculations performed as presented in Appendix A. The summary of the unit costs for all the components is presented in Table 9.

9.1.1 Land Cost

The land cost is the major cost component in most of the alternatives. The land cost is estimated using a unit cost of $100,000 per acre except for one design reach through existing homes in sub-area FRS #1. A land cost of $250,000 per acre was applied to that reach. The land areas considered in the estimates are: 1) on-line basin footprint, 2) off-line basin footprint, 3) channel area between the levees (A, B1, B2, B4, B5), 4) excavated channel area (B3, C),

5) adjacent natural preservation corridor (B3, C), 6) area occupied by levee and/or access road (A, B1, B2, B4, B5), and 7) area set-aside for natural active fan processes to occur (A).

9.1.2 Construction Cost

The construction costs are estimated mainly based on unit costs for materials and excavation costs. The unit material cost includes all costs associated with material fully constructed in place. For example, a unit cost of $75 for riprap drop structures includes the cost of material as well the cost constructing the drop structure. A contingency cost of 25% is applied to the estimated base construction cost. Similarly, the cost for the engineering design is set at 5% of the base construction cost. The sum of the base construction cost, contingency cost and the design cost provides the total construction cost.

9.1.3 Landscaping Cost

The landscaping costs are also applied as unit costs for the cost categories where landscaping is needed. The landscaping costs are mostly based on "per area" unit cost with the areas estimated using the design parameters. A landscaping cost of $1 per square foot was assumed based on an assumption of 60% of the area landscaped at $1.50 per square foot and 40% of the area naturally seeded at $0.06 per square foot. Landscaping costs were applied only to the disturbed areas impacted by the structural elements of the alternatives. For example, the surface area of the excavated earthen channels (B3) was assumed to require landscaping. Similarly, the external slopes of the levees were assumed to require landscaping. This landscape cost is for basic reestablishment of vegetation on disturbed areas. It does not include the cost of landscape enhancements required for compatibility of the structural flood control measures with the future landscape character of the area. Landscape compatibility enhancement costs are discussed in Section 9.2.

9.1.4 Maintenance Cost

The maintenance costs are based on a 3-year maintenance cycle. The costs are estimated for a design life of 50 years. The costs include maintenance costs for a period of 50 years assuming that maintenance will be performed every 3 years.

Table 9 Summary of Unit Costs

	Construction Units	Construction Cost	Landscape Units	Landscape Cost	Maintenance Units	3 Year Maintenance Cost
Levee						
Fill	cu. Yd	$ 7.00	sq. Yd	$ 9.00	sq. Yd	$ 0.70
Wall	sq. Yd	$ 215.00	sq. Yd	$ -	sq. Yd	$ 4.50
Toe Protection						
Riprap	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 1.50
Gabions	cu. Yd	$ 85.00	sq. Yd	$ -	sq. Yd	$ 1.70
Soil Cement	cu. Yd	$ 50.00	sq. Yd	$ -	sq. Yd	$ 1.50
Concrete	cu. Yd	$ 155.00	sq. Yd	$ -	sq. Yd	$ 2.35
Levee Lining						
Riprap	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 1.25
Gabions	cu. Yd	$ 85.00	sq. Yd	$ -	sq. Yd	$ 1.50
Soil Cement	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 1.80
Concrete	cu. Yd	$ 155.00	sq. Yd	$ -	sq. Yd	$ 2.00
Channel Lining						
Riprap	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 2.00
Gabions	cu. Yd	$ 85.00	sq. Yd	$ -	sq. Yd	$ 2.25
Soil Cement	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 3.00
Concrete	cu. Yd	$ 155.00	sq. Yd	$ -	sq. Yd	$ 2.50
Drop Structure						
Riprap	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 2.00
Gabions	cu. Yd	$ 85.00	sq. Yd	$ -	sq. Yd	$ 2.25
Soil Cement	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 3.00
Concrete	cu. Yd	$ 155.00	sq. Yd	$ -	sq. Yd	$ 2.50
Basin Inlet						
Riprap	cu. Yd	$ 75.00	sq. Yd	$ -	sq. Yd	$ 2.00
Concrete	cu. Yd	$ 155.00	sq. Yd	$ -	sq. Yd	$ 2.50
Pipes						
24" RGRCP	LF	$ 55.00	sq. Yd	$ -		$ 0.55
30" & 36" RGR	LF	$ 82.00	sq. Yd	$ -		$ 1.20
42" & 48" RGR	LF	$ 160.00	sq. Yd	$ -		$ 2.40
54" & 60" RGR	LF	$ 183.00	sq. Yd	$ -		$ 2.75

	Construction Units	Construction Cost	Landscape Units	Landscape Cost	Maintenance Units	3 Year Maintenance Cost
Channel						
Excavated Channel	$ 10.00	cu. Yd	sq. Yd	$ 9.00	sq. Yd	$ 0.50
Sedimentation Basin						
Sedimentation Basi	$ 10.00	cu. Yd	sq. Yd	$ -	sq. Yd	$ 0.50
Basin						
Excavated Basin	$ 4.00	cu. Yd	sq. Yd	$ 9.00	sq. Yd	$ 0.50
Outlet Cost	Based on 100'x12' Weir					
None	EA	$ -	sq. Yd	$ -	sq. Yd	$ -
Concrete Weir	EA	$ 15,000.00	sq. Yd	$ -	sq. Yd	$ 2.50
Riprap Weir	EA	$ 10,000.00	sq. Yd	$ -	sq. Yd	$ 2.00
Pipe	LF	$ 160.00	sq. Yd	$ -	sq. Yd	$ 1.00

9.2 Landscape Compatibility Enhancement Costs

In order to ensure that the proposed structural flood control measures are compatible with the future landscape character of the area, some enhancements to the base engineering design concepts were required. In particular, the engineering structures require modifications to blend them into the landscape (i.e. irregular form, etc). Additional costs will be incurred to ensure that the proposed structural flood control measures conform with the future landscape character of the Sun Valley area. The additional costs were estimated based on increased land area, construction, and maintenance requirements for the enhanced structures. Details of the computation of the landscape compatibility enhancement costs are provided in Section 7.

10 FRS #1 SUB-AREA DESIGN SUMMARY

The design summary of all the alternatives for the FRS #1 sub-area is presented in the following sections. Table 10 shows a summary of the cost estimates for each alternative for the FRS #1 sub-area. Table 11 shows a summary of the landscape enhanced costs for the FRS #1 sub-area.

Table 10 Base Cost Summary

Alternative	Land Area	Costs (in $1000) Land Cost	Constr. Cost	Lndscp Cost	Maint. Cost	Total Cost	Cost Percentages Land Cost %	Constr. Cost %	Lndscp Cost %	Maint. Cost %
A	1970	$ 196,730	$ 54,379	$ 9,567	$ 22,650	$ 283,325	69%	19%	3%	8%
B2	540	$ 53,980	$ 32,816	$ 7,286	$ 14,606	$ 108,688	50%	30%	7%	13%
B3	400	$ 39,830	$ 101,382	$ 11,163	$ 12,479	$ 164,855	24%	61%	7%	8%
B41	407	$ 40,690	$ 40,305	$ 10,099	$ 15,900	$ 106,994	38%	38%	9%	15%
B42	700	$ 69,939	$ 48,156	$ 10,785	$ 20,960	$ 149,840	47%	32%	7%	14%
B43	1027	$ 102,679	$ 60,828	$ 12,928	$ 26,669	$ 203,104	51%	30%	6%	13%
C	350	$ 34,770	$ 170,198	$ 8,956	$ 19,012	$ 232,936	15%	73%	4%	8%

Table 11 Landscape Enhanced Cost Summary

Alt.	Land Area (acres)	Costs (in $1000) Land Cost	Constr. Cost	Lndscp Cost	Maint. Cost	Total Cost	Percentage Cost Increase Land Cost %	Constr. Cost %	Lndscp Cost %	Maint. Cost %	Total Cost
A	2090	$ 209,000	$ 83,308	$ 17,379	$ 42,278	$ 351,965	6%	53%	82%	87%	24%
B2	647	$ 64,410	$ 50,131	$ 12,929	$ 27,504	$ 154,974	19%	53%	77%	88%	43%
B3	557	$ 55,560	$ 125,833	$ 15,070	$ 16,141	$ 212,604	39%	24%	35%	29%	29%
B41	535	$ 53,360	$ 56,602	$ 16,315	$ 27,953	$ 154,230	31%	40%	62%	76%	44%
B42	836	$ 83,570	$ 75,142	$ 19,753	$ 41,320	$ 219,785	19%	56%	83%	97%	47%
B43	1194	$ 119,290	$ 96,406	$ 24,188	$ 53,082	$ 292,966	16%	58%	87%	99%	44%
C	469	$ 47,000	$ 217,113	$ 11,348	$ 28,666	$ 304,127	35%	28%	27%	51%	31%

The cost estimates reveal the following information from the alternative comparisons.

Alignment alternatives – As discussed in Section 8, three alignment alternatives were considered to control flooding on the major alluvial fans in the FRS #1 sub-area. The B4-1 Alternative combined the corridors from Fan 37 and 36 by means of an excavated channel so that it is combined into one corridor until the outlet.. The B4-2 Alternative provides two separate alignments, one from Fan 37 and one from Fan 36 combined with all of the other fans. The B4-3 Alternative provides corridors for Fan 37, Fan 36 to the outlet. All of the other fans are combined so that there are three corridors total.

The costs of the B4-1, B4-2 and B4-3 Alternatives are increasingly more expensive due to the addition of more corridors. Because of these additional corridors, each alignment alternative is longer than the one before, therefore somewhat more expensive. The B4-1 Alternative was the shortest total length and hence least expensive. The B4-1 Alternative was therefore selected for application of the small basin (B2) and excavated companion channel alternatives (B3 and C).

Sizing alternatives - The large on-line basin (B4-1) alternative is approximately the same cost as the small on-line basin (B2). The off-line basin (B5) was not explicitly analyzed for the FRS #1 sub-area because it was shown to have a similar cost to the small on-line basin in the CAP sub-area analysis (see Volume 2). The reasons for this result are: 1) the downstream reach peak discharges are driven by the on-fan runoff and 2) land cost is the largest portion of the total cost for the leveed corridor alternatives.

Other apex or conveyance strategies – The A alternative and excavated channel alternatives (B3 and C) are the most expensive alternatives; even more expensive than the multiple leveed corridors with apex basins. In the case of the A alternative, the land cost associated with the active alluvial fan area makes this approach much more expensive than the apex basin alternatives. The active fan area is recovered for potential development. For the excavated channel alternatives, the construction costs are much greater than the land area saved. Additionally, these alternatives include a 120-foot preservation corridor as part of the land cost which offsets some of the potential cost savings.

Landscape compatibility enhancements – The landscape compatibility enhancements include costs for additional land requirements, construction requirements (excavation and fill), increased landscaping area, and increased maintenance (due to the larger areas requiring maintenance). The increased costs for landscape compatibility enhancements average about 40 percent for all alternatives, ranging from about 30 to 55 percent. The increased costs are greatest for the B4-2 and B4-3 alternatives and least for the B3 alternative.

Wall vs. Earth Levee – The relative cost differences for the walled corridor versus the earthen levee corridor were also evaluated. A comparison of the per unit channel length was performed for an example reach. Table 12 shows the results of this comparison. The costs for the wall do not include any fill behind the wall. That is, the wall serves as the levee by itself without any backfill "uphill" of the wall. The walled levee ranges from about 45 to 80 percent less expensive than the earthen levee option depending on levee height. The cost differential is greater the taller the levee. The differences in cost are due to additional construction costs, landscape compatibility enhancement costs, and land costs associated with the earthen levee. The primary reason the cost difference increases with levee height is related to the size of the levee footprint. The earth levee footprint grows with increasing height whereas the wall footprint (and 50-foot landscape enhancement buffer) does not. The larger levee footprint results in larger construction, land, landscaping, enhancement, and maintenance costs.

Table 12 Walled vs. Earth Levee Cost Comparison

	Levee			Wall			
Levee/Wall Height (ft)	Base Cost per foot	LC Enh. Cost per foot	Total Cost per foot	Base Cost per foot	LC Enh. Cost per foot	Total Cost per foot	Percentage Difference
3.5	$ 611	$ 672	$ 1,284	$ 381	$ 512	$ 893	44%
4	$ 675	$ 734	$ 1,409	$ 421	$ 512	$ 932	51%
4.5	$ 725	$ 814	$ 1,539	$ 460	$ 512	$ 972	58%
5	$ 795	$ 876	$ 1,671	$ 499	$ 512	$ 1,011	65%
5.5	$ 847	$ 975	$ 1,822	$ 539	$ 512	$ 1,050	73%
6	$ 915	$ 1,045	$ 1,960	$ 578	$ 512	$ 1,090	80%

10.1 Summary

Engineering cost estimates for the Step 2 Proposed Alternatives were computed. The apex basin alternatives with leveed corridors are generally the least expensive alternatives compared the excavated channel alternatives or apex avoidance strategy.

In addition, the additional costs associated with meeting the landscape aesthetic requirements were also estimated. The results indicate that the landscape compatible alternatives are about 40 percent more expensive than the base engineering costs. In addition, the costs of the earthen levee were compared to a walled levee. Those calculations showed that the walled levee approach is significantly less expensive compared to the earthen levee.

The following sections provide a summary of each alternative for the FRS #1 sub-area along with bulleted lists of the key features, advantages, disadvantages, and opportunities associated with each alternative. Additional details of the design calculations, hydrologic models, and cost estimates are provided in Appendix A for each alternative. The summary sheets are followed by the alternatives evaluation in Section 11.

10.2 ALTERNATIVE A - Summary Sheet for FRS #1 Sub-Area

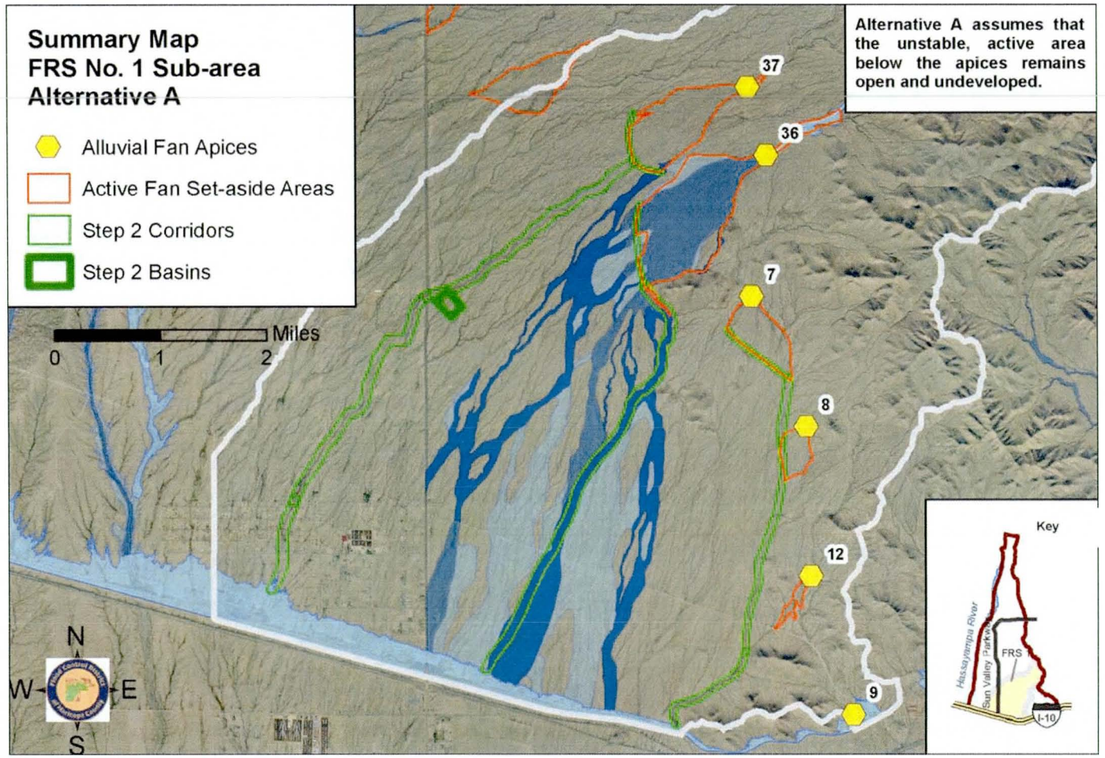

Figure 28 Summary Map of Alternative A for the FRS #1 Sub-Area

10.2.1 Description for Alternative A

The main design objective of the A Alternative is to allow the natural geomorphic processes to occur within a designated active alluvial fan area downstream of the apex. Flood flows and sediment are controlled downstream of the region of uncertainty. The flows will be captured in the up-fan area by partially excavated collector channels. At the Sun Valley Parkway, one off-line detention basins is required to restrict peak flow to the existing culvert capacity. Once collected, the flows are routed downstream using leveed corridor channel sections until the flows reach the outfall along Buckeye FRS No. 1.

Flows from Fans 36 and 37 directed south and west in two separate leveed corridors. An off-line detention basin is needed at the Sun Valley Parkway to restrict peak flow to the existing culvert capacity for Fan 37. Flows downstream of the Parkway continue downstream to FRS No. 1 in a leveed corridor collecting additional tributary inflows along the way. The downstream-most reach passes through existing development which will require acquisition in order to pass the leveed corridor south to the FRS.

Flows from Fans 7, 8, and 12 are collected into a common leveed corridor downstream of their respective active fan areas. The corridor outfalls near the east end of FRS No. 1.

10.2.2 Key Features

- $283.3 million is the estimated total cost
- One off-line basin with a total volume of 109 acre feet
- No on-line basins
- 16 miles of corridors, of which 2.3 miles are excavated collector channels
- 1,950 acres needed for right of way. This includes 1,147 acres for active fan area set-aside areas.

10.2.3 Advantages

- Provides for continued natural fan processes near apices
- Effectively manages active alluvial fan sedimentation issues
- Provides trunk system which minimizes the impacts of development phasing
- Achieves context sensitivity of new facilities

10.2.4 Disadvantages

- Costly structures
- Fill requirements exceed excavation volume
- Large right of way demand
- Requires a large off-line basin at Sun Valley Parkway
- Requires acquisition of existing homes

10.2.5 Opportunities

- Provides multiple connections from FRS No. 1 to up-fan area for recreation
- Provides multiple connections from FRS No. 1 to up-fan environment for wildlife

10.3 ALTERNATIVE B2 - Summary Sheet for FRS #1 Sub-Area

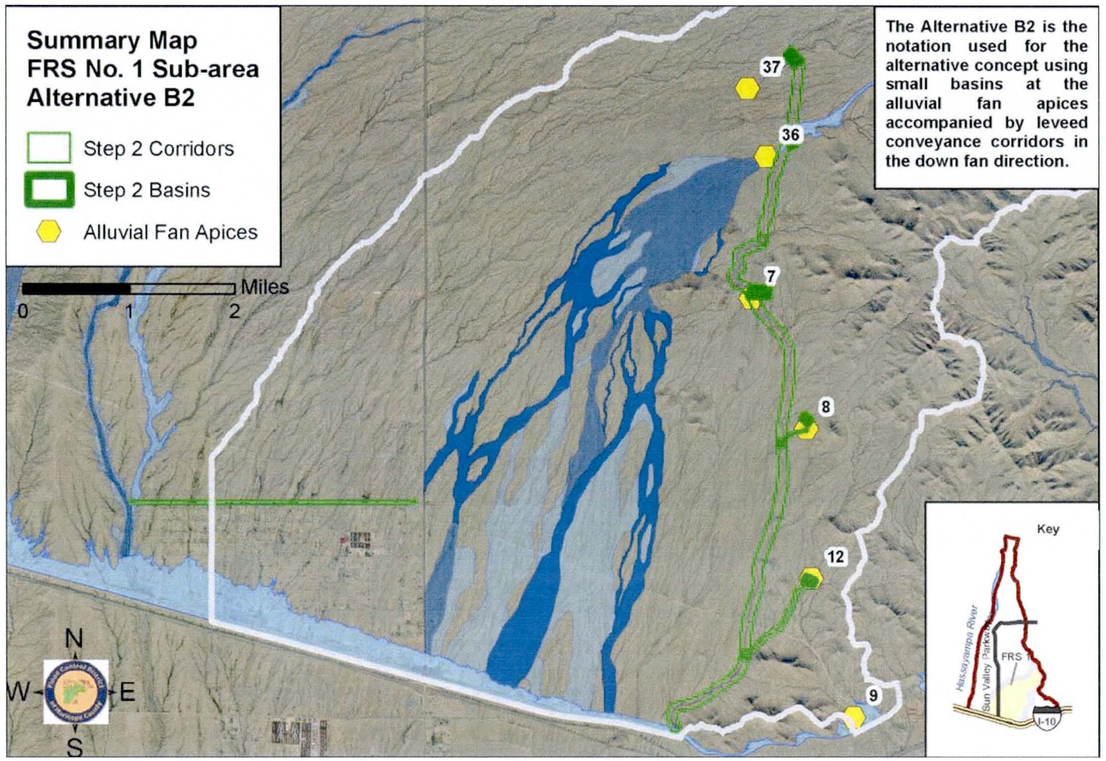

Figure 29 Summary Map of Alternative B2 for the FRS #1 Sub-Area

10.3.1 Description for Alternative B2

The purpose of Alternative B is to capture the upstream flow at the apex using on-line detention basins. The presence of the detention basins eliminates the downstream alluvial fan uncertainties by controlling flood flow and sediment at the alluvial fan apices downstream to Buckeye FRS No. 1. Alternative B2 is based on using a relatively smaller on-line detention basin at the apex accompanied by leveed corridor channel sections in the down fan direction. The B2 Alternative was evaluated for the alignment from the B4-1 Alternative.

Outflows from the detention basin at Fan 37 are directed south in an excavated channel to Fan 36 where they enter another detention basin. The combined outflows at Fan 36 continue south in another excavated channel to a natural wash and then further on to another on-line detention basin at Fan 7. Again, the combined outflows continue south, now in a leveed corridor channel section. This leveed corridor continues south to FRS No. 1. It is joined by outflows from leveed corridors downstream of on-line basins at Fans 8 and 12.

The area of existing development south of McDowell Road, west of Sun Valley Parkway is protected by an earthen excavated channel along McDowell Road. The channel discharges to White Tank Wash. No structural improvements are proposed for White Tank Wash.

10.3.2 Key Features

- $108.7 million is the estimated total cost
- Five on-line basins with a total excavation volume of 299 acre feet
- No off-line basins
- 11.2 miles of corridors
- 517 acres needed for right of way

10.3.3 Advantages

- Eliminates flow path uncertainty at the apices
- Effectively manages active alluvial fan sedimentation issues
- Does not require acquisition of existing homes
- Mitigates existing flooding problems for existing development

10.3.4 Disadvantages

- Large costly structures
- Requires excavation of two channel reaches to cross subwatershed divides
- Requires more excavation than fill
- Does not provide a trunk system for internal drainage of much of the sub-area

10.3.5 Opportunities

- Provides connection from FRS No. 1 to up-fan areas and mountain front for recreation

10.4 ALTERNATIVE B3 - Summary Sheet for FRS #1 Sub-Area

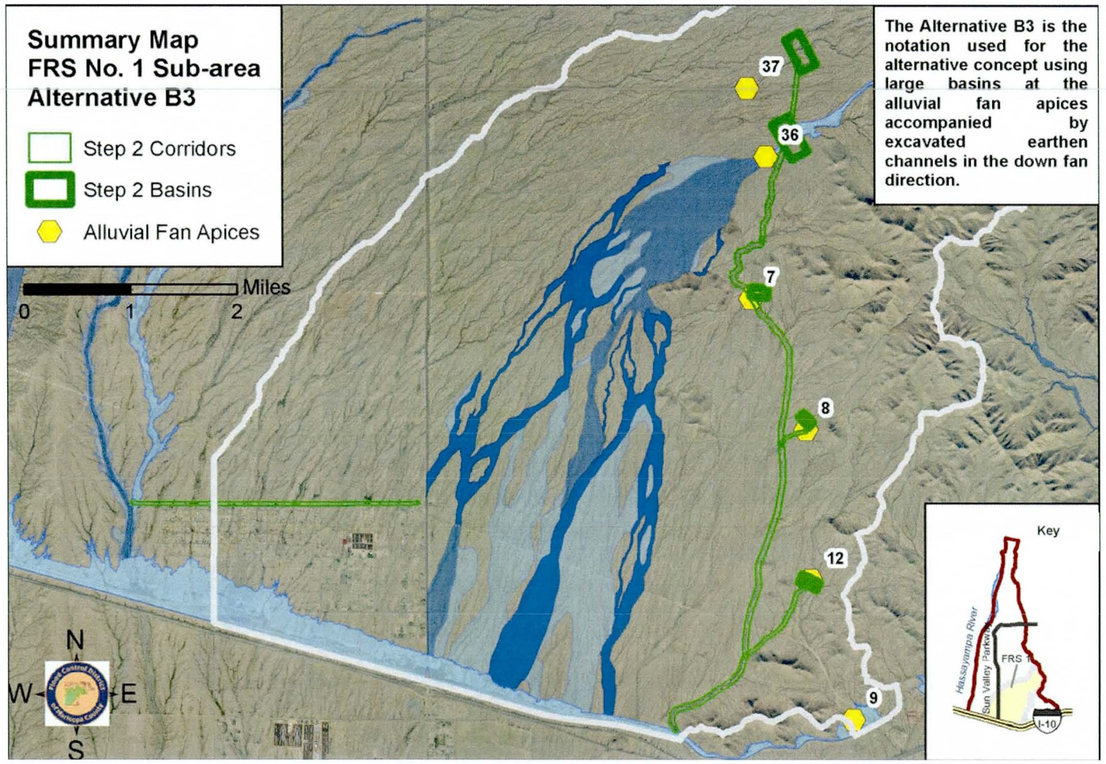

Figure 30 Summary Map of Alternative B3 for the FRS #1 Sub-Area

10.4.1 Description for Alternative B3

The purpose of Alternative B is to capture the upstream flow at the apex using on-line detention basins. The presence of the detention basins eliminates the downstream alluvial fan uncertainties by controlling flood flow and sediment at the alluvial fan apices downstream to Buckeye FRS No. 1. Alternative B3 is based on using a relatively larger on-line detention basin at the apex accompanied by excavated earthen channel sections in the down fan direction. The excavated earthen channels are complemented with a 120-foot wide adjacent riparian preservation corridor where possible. The B3 Alternative was evaluated for the alignment from the B4-1 Alternative.

Outflows from the detention basin at Fan 37 are directed south in an excavated channel to Fan 36 where they enter another detention basin. The combined outflows at Fan 36 continue south in another excavated channel to a natural wash and then further on to another on-line detention basin at Fan 7. Again, the combined outflows continue south, now in an excavated earthen channel section. This channel continues south to FRS No. 1. It is joined by outflows from excavated earthen channels downstream of on-line basins at Fans 8 and 12.

The area of existing development south of McDowell Road, west of Sun Valley Parkway is protected by an earthen excavated channel along McDowell Road. The channel discharges to White Tank Wash. No structural improvements are proposed for White Tank Wash.

10.4.2 Key Features

- $164.9 million is the estimated total cost
- Five on-line basins with a total excavation volume of 1,818 acre feet
- No on-line basins
- 11.2 miles of corridors
- 304 acres needed for right of way, including the riparian preservation corridor

10.4.3 Advantages

- Eliminate flow path uncertainty at the apex
- Effectively manages active alluvial fan sedimentation issues
- Preserves riparian corridor in undisturbed state
- Does not require acquisition of existing homes
- Mitigates existing flooding problems for existing development

10.4.4 Disadvantages

- Large costly structures.
- Significant excavation costs
- Requires excavation of two channel reaches to cross subwatershed divides
- Requires more significantly more excavation than fill
- Does not provide a trunk system for internal drainage of much of the sub-area

10.4.5 Opportunities

- Provides connection from FRS No. 1 to up-fan areas and mountain front for recreation

10.5 ALTERNATIVE B4-1 - Summary Sheet for FRS #1 Sub-Area

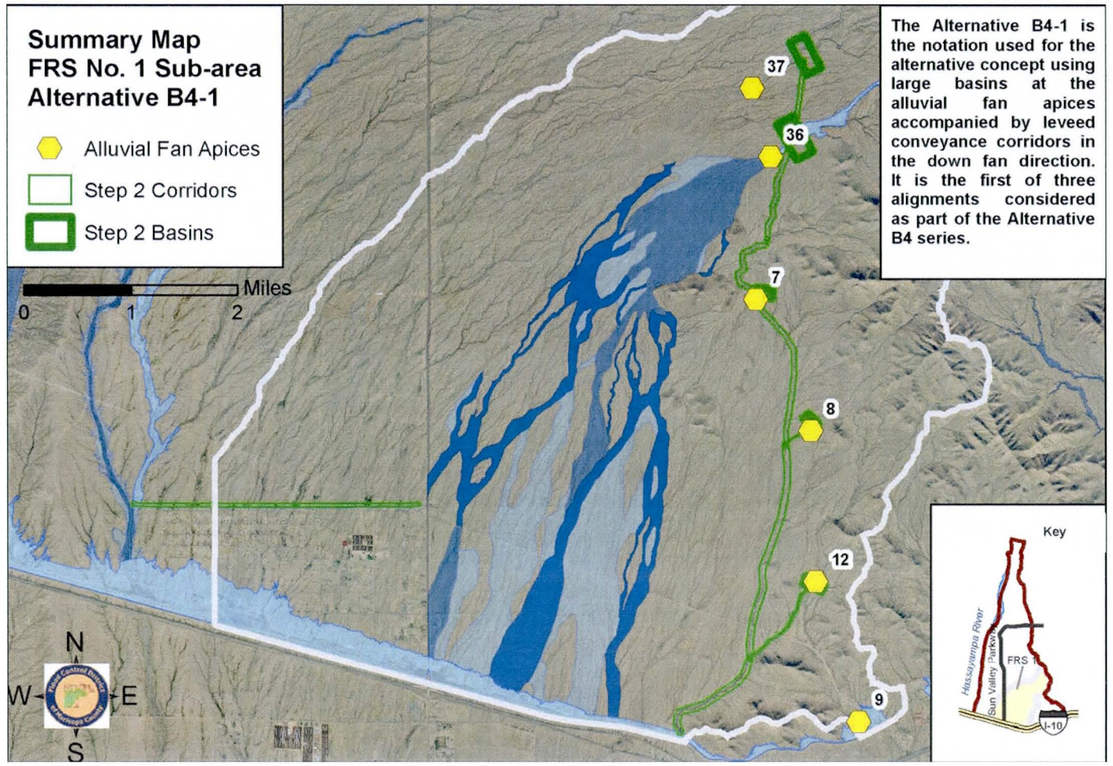

Figure 31 Summary Map of Alternative B4-1 for the FRS #1 Sub-Area

10.5.1 Description for Alternative B4-1

The purpose of Alternative B is to capture the upstream flow at the apex using on-line detention basins. The presence of the detention basins eliminates the downstream alluvial fan uncertainties by controlling flood flow and sediment at the alluvial fan apices downstream to Buckeye FRS No. 1. Alternative B4-1 is based on using a relatively larger on-line detention basin at the apex accompanied by leveed channel sections in the down fan direction where possible. It is the first of three corridor alignments considered as part of the Alternative B4 series.

Outflows from the detention basin at Fan 37 are directed south in an excavated channel to Fan 36 where they enter another detention basin. The combined outflows at Fan 36 continue south in another excavated channel to a natural wash and then further on to another on-line detention basin at Fan 7. Again, the combined outflows continue south, now in a leveed corridor channel section. This leveed corridor continues south to FRS No. 1. It is joined by outflows from leveed corridors downstream of on-line basins at Fans 8 and 12.

The area of existing development south of McDowell Road, west of Sun Valley Parkway is protected by an earthen excavated channel along McDowell Road. The channel discharges to White Tank Wash. No structural improvements are proposed for White Tank Wash.

10.5.2 Key Features

- $107.0 million is the estimated total cost
- Five on-line basins with a total excavation volume of 1,818 acre feet
- No on-line basins
- 11.2 miles of corridors
- 311 acres needed for right of way.

10.5.3 Advantages

- Eliminates flow path uncertainty at the apices
- Effectively manages active alluvial fan sedimentation issues
- Does not require acquisition of existing homes
- Mitigates existing flooding problems for existing development

10.5.4 Disadvantages

- Large costly structures
- Requires excavation of two channel reaches to cross subwatershed divides
- Does not provide a trunk system for internal drainage of much of the sub-area
- Requires significantly more excavation than fill

10.5.5 Opportunities

- Provides connection from FRS No. 1 to up-fan areas and mountain front for recreation

10.6 ALTERNATIVE B4-2 - Summary Sheet for FRS #1 Sub-Area

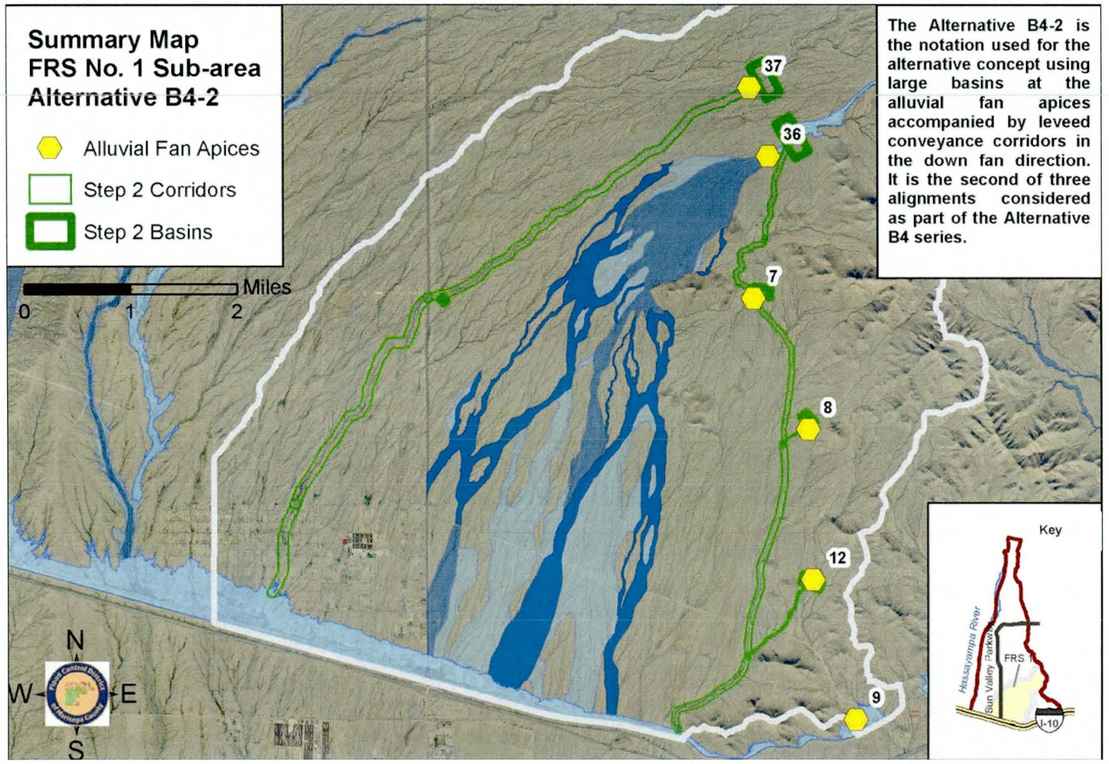

Figure 32 Summary Map of Alternative B4-2 for the FRS #1 Sub-Area

10.6.1 Description for Alternative B4-2

The purpose of Alternative B is to capture the upstream flow at the apex using on-line detention basins. The presence of the detention basins eliminates the downstream alluvial fan uncertainties by controlling flood flow and sediment at the alluvial fan apices downstream to Buckeye FRS No. 1. Alternative B4-2 is based on using a relatively larger on-line detention basin at the apex accompanied by leveed channel sections in the down fan direction where possible. It is the second of three corridor alignments considered as part of the Alternative B4 series.

Outflows from the detention basin at Fan 37 are directed southwest in a leveed corridor channel section to Sun Valley Parkway. A small off-line basin is required to limit the 100-year peak discharge to the existing culvert capacity. Downstream of the Parkway, flows continue within a leveed corridor to McDowell Road. Downstream of McDowell Road, the leveed corridor continues through an area of existing development south of McDowell Road.

Outflows at Fan 36 are directed south in an excavated channel to a natural wash and then further on to another on-line detention basin at Fan 7. The combined outflows are routed south in a leveed corridor channel section. This leveed corridor continues south to FRS No. 1. It is joined by outflows from leveed corridors downstream of on-line basins at Fans 8 and 12.

10.6.2 Key Features

- $149.8 million is the estimated total cost
- Five on-line basins with a total excavation volume of 1,639 acre feet
- One small off-line basin at Sun Valley Parkway with 4 acre feet excavation volume
- 14.7 miles of leveed corridors
- 605 acres needed for right of way

10.6.3 Advantages

- Eliminates flow path uncertainty at the apices
- Effectively manages active alluvial fan sedimentation issues
- Provides a trunk system which minimizes the impacts of development phasing

10.6.4 Disadvantages

- Large costly structures
- Requires excavation of two channel reaches to cross subwatershed divides
- Requires significantly more excavation than fill
- Requires acquisition of existing homes

10.6.5 Opportunities

- Provides multiple connection froms FRS No. 1 to up-fan areas for recreation

10.7 ALTERNATIVE B4-3 - Summary Sheet for FRS #1 Sub-Area

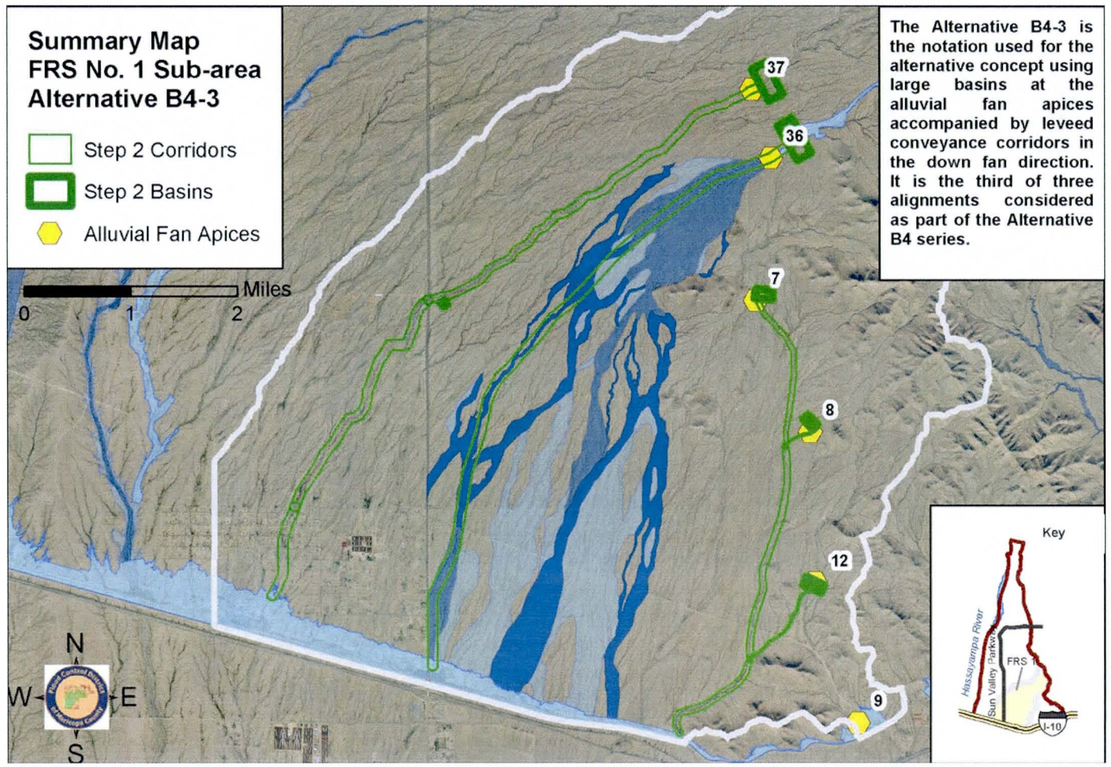

Figure 33 Summary Map of Alternative B4-3 for the FRS #1 Sub-Area

10.7.1 Description for Alternative B4-3

The purpose of Alternative B is to capture the upstream flow at the apex using on-line detention basins. The presence of the detention basins eliminates the downstream alluvial fan uncertainties by controlling flood flow and sediment at the alluvial fan apices downstream to Buckeye FRS No. 1. Alternative B4-3 is based on using a relatively larger on-line detention basin at the apex accompanied by leveed channel sections in the down fan direction where possible. It is the third of three corridor alignments considered as part of the Alternative B4 series.

Outflows from the detention basin at Fan 37 are directed southwest in a leveed corridor channel section to Sun Valley Parkway. A small off-line basin is required to limit the 100-year peak discharge to the existing culvert capacity. Downstream of the Parkway, flows continue within a leveed corridor to McDowell Road. Downstream of McDowell Road, the leveed corridor continues through an area of existing development south of McDowell Road.

Outflows from the on-line basin at Fan 36 are directed south and west in another leveed corridor to FRS No. 1. The on-line detention basin outflows at Fan 7 are routed south in a leveed corridor channel section to FRS No. 1. It is joined along the way by outflows from leveed corridors downstream of on-line basins at Fans 8 and 12.

Key Features

- $203.1 million is the estimated total cost
- Five on-line basins with a total excavation volume of 1,639 acre feet
- One off-line basin with 4 acre feet excavation volume at Sun Valley Parkway
- 19.5 miles of leveed corridors
- 932 acres needed for right of way

10.7.2 Advantages

- Eliminates flow path uncertainty at the apices
- Effectively manages active alluvial fan sedimentation issues
- Provides a trunk system which minimizes the impacts of development phasing
- Distributes inflows to FRS along length of pool area
- Utilizes proposed (approved?) developer corridors

10.7.3 Disadvantages

- Large costly structures
- Requires excavation of two channel reaches to cross subwatershed divides
- Requires significantly more excavation than fill
- Requires acquisition of existing homes

10.7.4 Opportunities

- Provides multiple connection froms FRS No. 1 to up-fan areas for recreation

10.8 ALTERNATIVE C - Summary Sheet for FRS #1 Sub-Area

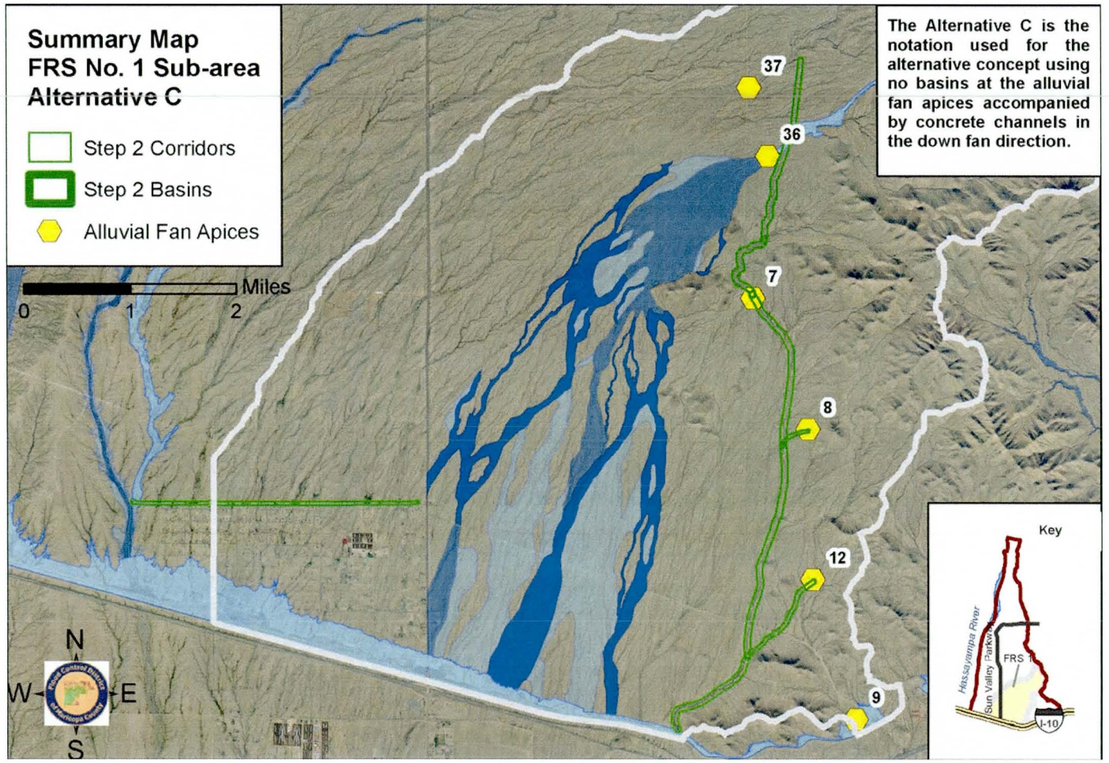

Figure 34 Summary Map of Alternative C for the FRS #1 Sub-Area

10.8.1 Description for Alternative C

Alternative C is based on the concept of an excavated concrete-lined channel from the apex to the outfall, without providing any detention basin is at the apex. To address sedimentation associated with the alluvial fan systems, sedimentation basins are provided throughout the system. The excavated concrete channels are complemented with a 120-foot wide adjacent riparian preservation corridor. The C Alternative is based on the alignment from the B4-1 Alternative.

Flows from Fan 37 are directed south in an excavated channel to Fan 36. The combined flows at Fan 36 continue south in another excavated channel to Fan 7. Again, the combined flows continue south. This channel continues south to FRS No. 1. It is joined by excavated concrete channels from Fans 8 and 12.

The area of existing development south of McDowell Road, west of Sun Valley Parkway is protected by an excavated concrete channel along McDowell Road. The channel discharges to White Tank Wash. No structural improvements are proposed for White Tank Wash.

10.8.2 Key Features

- $232.9 is the estimated total cost
- No detention basins
- 11.2 miles of concrete channel corridors
- 348 acres needed for right of way, including the riparian preservation corridor

10.8.3 Advantages

- Minimizes land costs
- Effectively manages active alluvial fan sedimentation issues
- Preserves riparian corridor in undisturbed state
- Does not require acquisition of existing homes
- Mitigates existing flooding problems for existing development

10.8.4 Disadvantages

- High costs associated to excavation and concrete lining
- Potential aesthetic concerns even with architectural treatments and preservation corridor
- Potential safety concerns to persons caught in channels during flooding

10.9 ALTERNATIVE D - Summary Sheet for FRS #1 Sub-Area

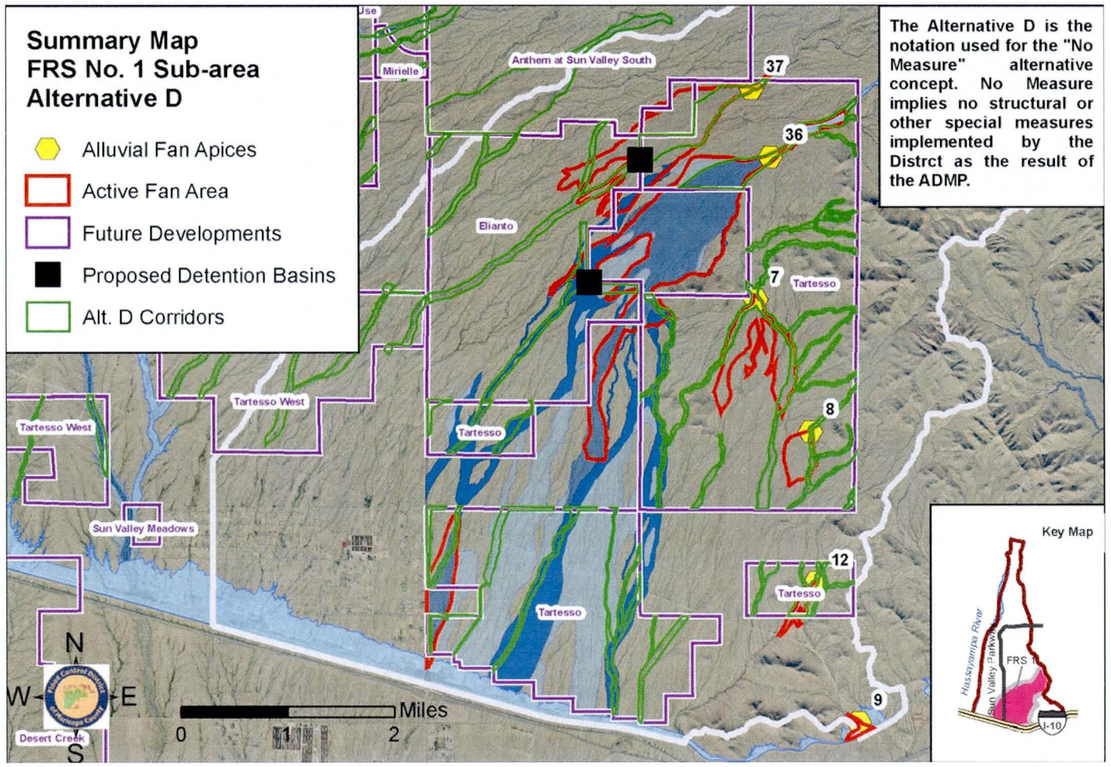

Figure 35 Summary Map of Alternative D for the FRS #1 Sub-Area

10.9.1 Description for Alternative D

Alternative D relies on existing drainage facilities or new master-planned communities developing their own drainage infrastructure. Current drainage ordinances and floodplain regulations are enforced to ensure adequate flood hazard mitigation measures. Enforcement options can be enhanced by developing new alluvial fan floodplain delineations.

The major advantage of this alternative is that no immediate and expensive action is needed from the District. The main disadvantage compared to the other alternatives is that there will be no regional whole-fan flood control system leading to unnecessary redundancies and/or potential planning problems. This measure is also likely to leave portions of unstable, active alluvial fan areas open and undeveloped.

In the FRS No. 1 Sub-area, the nature of phasing and land ownership has led to proposals for two collector systems and detention basins at the upstream boundary of the Elianto master planned community to control Fans 36 and 37. Potential corridors downstream of Elianto include a portion presently under construction on Tartesso West and some speculative reaches elsewhere. A channel along McDowell Road was also inferred as necessary to provide an outfall for the Fan 37 system. As elsewhere, note the unplanned areas between existing master planned communities.

10.9.2 Key Features

- Hazards addressed entirely by future development

10.9.3 Advantages

- Requires no direct public expenditures

10.9.4 Disadvantages

- Discontinuity of solutions across development boundaries
- Unnecessary redundancies in flood control solutions
- Long-term maintenance assurances
- Concerns with timing and phasing of development and flood control mitigation measures
- Large areas of development within FEMA floodplains

11 ALTERNATIVES EVALUATION

11.1 Evaluation Criteria

Criteria to evaluate the Step 2 alternatives were developed though a series of meetings with the project team. Table 13 shows twenty-three criteria in three broad categories that were selected for evaluation of the Step 2 alternatives. The same evaluation criteria were used for all of the ADMP piedmont sub-areas including the FRS #1 sub-area.

Table 13 Step 2 Alternative Evaluation Criteria

Public Safety Criteria (Function)	
1) Public Safety Enhancement • Improve Public Infrastructure • Reduce Flood Level • Number of People Impacted	**2) Level of Damage Reduction** • Dollar Costs Saved/Reduced • Flood Frequency Impacted
3) Transportation Impacts • Collector or Arterial Roadway • Only Access • Number of People Impacted	**4) Upstream/Downstream Impacts** • Stand Alone • Systematic Solution
5) Relative Risk of Failure • Lower than average • Average • Greater than average	**6) Eliminates Flood Problem** • Partial Solution • Whole Solution
7) Design Certainty • Captures apex flow •	**8) Constructability** • Excavation excess •
Economic Criteria (Common)	
9) Comparative Benefit Cost • Dollars • Number of People • Regional Solution • Recoverable Flood Plain	**10) ROW Acquisition Necessary** • Existing ROW Available • Amount Needed • Private or Public Land
11) Condemnation Required • Yes • No	**12) Cost of Implementation (in $1,000)** • < than $50,000 • < than $500,000 • < than $1,000,000
13) Maintenance Cost • Lessened • Increased • Neutral • Comparative to Other Measure	**14) Potential Cost Sharing Partner** • Already Contacted • Already Willing • Possibly
Social/ Environmental/ Aesthetic/ Multi-Use Criteria (Form)	
15) Public Support • Known • Anticipated • Unknown	**16) Public Acceptance** • Known • Anticipated • Applicable • Unknown
17) Addresses Public Complaint/Concern • Response From Public • Unknown	**18) Private Acceptance** • Known • Anticipated • Applicable • Unknown
19) Environmental Impacts • Habitat • Hazmat • Cultural • 404	**20) Complexity of Environmental Permitting** • Minimal • Average • Significant
21) Visual Resource Impacts/ Aesthetic Compatibility • Incompatible • Partially Compatible • Fully Compatible	**22) Multi-Use Opportunities** • Minimal • Average • Significant
23) F.C. Method Consistency with Buckeye Recreation Master Plan • Incompatible • Partially Compatible • Fully Compatible	

11.2 Evaluation Results

Table 14 through Table 17 present the scored results of the evaluation meetings held with the project team. Table 17 presents a summary of the recommended alternative for the FRS #1 sub-area resulting from the process.

The alternatives evaluation was divided into two steps: 1) strategy evaluation and 2) evaluation by sub-area. In each of the two steps, the evaluation criteria listed in Table 13 were used to assign a lumped score for each of the three primary categories (Public Safety, Economic, and Social/Environmental/Aesthetic/Multi-use).

11.2.1 Strategy Evaluation

The relative merits and disadvantages of the alternatives are discussed in this section without considering any FRS #1 sub-area specific issues. The evaluation criteria are presented for the type of treatment at the apices as well as the type of channel cross-section.

Alternative A - Sedimentation Area at Apex

The main design objective of the A Alternative is to allow the natural geomorphic processes to occur within a designated active alluvial fan area downstream of the apex. This designated active alluvial fan area is the highlight of this alternative and distinguishes this alternative with other alternatives where basins are used at the apices to control alluvial fan uncertainties. Therefore, the discussion below focuses mainly on the designated alluvial fan area. Most of the downstream impacts are expected to be similar to that in other alternatives.

Public Safety:

- The lack of basins could result in no significant reduction in the peak discharges. Thus, the risk of failure in the downstream is not reduced due to lack of reduction in the peak discharges.
- Area set aside could be a potential hazard to public if access is not adequately restricted.
- Sediment deposition will occur in the area. Deposition within the collector channels must be handled through maintenance. If proper maintenance is not performed, channel capacity may be reduced leading to overflow.
- Area set aside may be used for other purposes. This might include transportation; though roadways are not recommended within the set aside area.
- The designated active area is not available for development. Therefore the land costs for the A Alternative can be significant, especially for the larger alluvial fans. In addition, the risk of impacts to downstream areas is higher (compared to other alternatives with the basins at the apex) due to uncertainties associated with the designated sedimentation area.

Economics:

- The set aside land area is usually large enough to significantly impact the land costs, especially for the larger alluvial fans.
- The construction cost will be significantly less compared to the basin-based alternatives where large excavation volumes can be expected to result in larger costs.
- The area required is large when compared to other alternatives.
- The peak discharges downstream of the apex region are larger compared to other alternatives where the presence of basins reduces the peak flows. The larger peak flows result in the need for larger structures downstream increasing the cost of the project.
- The lack of basins near the apex means that the fill material available from excavation is minimal. Therefore, the opportunity to re-use the excavated dirt as fill material is not present in this alternative.

Social/ Environmental/ Aesthetic/ Multi-Use Criteria

- The designated alluvial area is set aside to allow natural sedimentation process to occur. As a result, this area is not conducive for all types of recreational multi-use.
- This alternative is favorable from habitat preservation point of view since the existing natural corridor is mostly preserved in the designated sedimentation area. The collector channels require some disturbance to the natural habitat. However, they are not significant compared to the area of disturbance in the basin-based alternatives.
- This alternative may fair better in 404 permitting process.
- Preservation of the existing corridor as well as lack of major engineered structures provides minimal visual resources impacts. Since the existing corridor is preserved, the aesthetic compatibility is better compared to the basin-based alternatives. Cultural and hazmat impacts are also expected to be minimal applying a similar reasoning.

Alternative B - Big Basin/Small Basin/Off-line/On-line

The main objective Alternatives B2, B3, B4-1, B4-2, and B4-3 is to evaluate the effectiveness of basins at the apices as flood control measures. The B2 alternative represents the big-basin option while the B3 represents a smaller basin. Both are on-line basin options. The B4 Alternatives is a small off-line basin for water and an in-line sediment only basin. The basin at the apex is the highlight of these alternatives and distinguishes them from other alternatives where basins are not used at the apices to control alluvial fan uncertainties and/or reduce peak discharges. Therefore, the discussion below focuses mainly on the basins at the apices. Most of the downstream impacts are expected to be similar to that in other alternatives.

Public Safety:

- The basin alternatives provide design certainty from the flood control point of view by capturing the flows at the apices and metering them downstream in a controlled fashion.
- The on-line basins are generally preferred to off-line basins as they provide a higher degree of certainty with respect to the control of the active alluvial fan.

- The presence of the basin results in lowered peak discharges. Lower peak discharges correlate to lower risk of failure and public endangerment downstream. However, flows will last longer resulting in increased duration of flood exposure to the public. Lower peak discharges also reduce the number of people potentially impacted by a flood event.
- The failure of the basin itself could be more dangerous than a conveyance only strategy because of reduced conveyance downstream. Significant development can be anticipated to occur near the washes that carry the outflow from the basins and hence more at risk in the event of a basin failure or discharges in excess of the basin design. However, the possibility of failure of the basin is considered low. As a result, the presence of the basin at the apex can be, in overall, considered as a reduction in potential downstream flood related risks.
- The large basin (B1 Alternative) can be expected to influence the bigger flood events with significant reduction in the peak discharges. The presence of the basin may not influence smaller events and the smaller flows could go through the basins relatively unhindered. The significant reduction in the peak discharges will potentially benefit a larger area.
- For the small basin (B2 Alternative), the reduction of peak discharge at the apex is not as high as in large basins (B1 Alternative). The downstream peak flows can still be quite large compared to upstream peak flows. As a result, the potential downstream risks in terms of area of benefit as well as number of people benefited are also larger. However, a small basin will be more beneficial when compared to Alternatives A and C where there are no basins at the apices.
- Sedimentation is expected to occur within the basins requiring regular maintenance. However, if unusually high sedimentation occurs during a large flood event, the storage capacity of the basins can be reduced causing a flooding problem for the downstream properties. Risk from failure of the sedimentation capacity is greater for the off-line basin.
- There is a potential risk exposure to public if the basins are designed to accommodate recreational uses. Flood water will enter at least a portion of the basin during even smaller floods posing a potential danger to recreationists within the basins.

Economics:

- The big basins (B1) cover a larger area compared to B2 and B5 alternatives. However, the right of way (ROW) area needed will be smaller when compared to that of the A alternative where much larger area is designated as the sedimentation area.
- The basins can be designed as multi-use recreational facilities. The land area set aside for the construction of the basins could also act in lieu of the open space requirements. These multi-purpose uses of the land may reduce the apparent cost of the land.
- The land area at the apices is not presently developed. Therefore, condemnation of existing developed properties may not be needed to facilitate the construction of the basins.
- Excavation is the major part of the construction of the basins. Given the long period of deposition at the apices, the excavation process may be relatively easy. However, construction of the basins could become difficult if significant bed rock is encountered during excavation.
- The excavation excess can be potentially used as fill material for the levees. The big basin (B1) alternative will produce more excess material compared to the B2 alternative. The availability of fill material for the construction of levees can be a significant benefit in terms of construction costs.
- The big basin (B1) alternative has larger maintenance costs compared to the smaller basin (B2 or B5) alternatives. The differences are directly related to the size of the basins and volume of flows captured.

Social/ Environmental/ Aesthetic/ Multi-Use Criteria

- The basins provide considerable opportunity for recreational and other multiple-uses.
- Significant excavation will be needed to construct the basins. The basins will be larger for the B1 alternative and will have larger impact on the visual and aesthetic compatibility. The basins will have to be enhanced to achieve compatibility with the landscape of the area which will require additional expenditures.
- The basin excavations can be expected to impact the natural habitat as well.
- The excavations may also have cultural implications and exact excavation locations may have to be determined if cultural impacts are determined. However, native people's activities in the area were generally limited to hunting and gathering. No known habitations exist in the area.
- If developed recreational facilities are not part of a basin, the larger basins provide potential open space area for future wildlife habitat.
- Hazmat impacts at the basin locations are mostly unknown, but are not expected to be a significant limitation.
- The disturbance to the existing corridor is likely to play a key role in the 404 permitting process. Mitigation of the environmental impacts must the planned and designed to aid in the approval of the 404 permitting process.

Leveed Corridors

The leveed corridor is designed as the flow conveyance from the upstream apex to the downstream outfall. Existing washes are contained between designed earthen levees and/or walls on both sides to provide adequate conveyance.

Public Safety:

- The levees/walls provide engineered means of flow conveyance. The inclusion of adequate freeboard ensures the design certainty for flows up to the 100-year flow event. In other words, the flows (up to the 100-year event) can be expected to be conveyed from the apex to the outfall in a predictable controlled fashion as long as the levee/walls function as designed. This flow containment provides an improvement in public safety compared to existing conditions where the naturally existing banks may or may not provide adequate flow containment or erosion protection.
- The 100-year event design flow could be significantly higher than the flow capacity of the existing channel. While the levees will contain flow within the designed channel corridor, changes can be anticipated in the

channel cross-section due to the change in the flow rates. The smaller events could lead to a meandering channel as well as a flatter low flow channel slope. While the channel configuration can be expected to transform due to changes in flow conditions, flow containment will still be achieved through levees and the freeboard. The designed levees/walls satisfy the FEMA freeboard requirement of at least 3 feet above the 100-year water surface elevation.

- Drastic events such as levee failures could result in catastrophic impact to the properties adjacent to the selected conveyance paths. The conveyance relies on the successful functioning of the levees unless adequate conveyance capacity already exists.
- The presence of levees at road crossings requires an elevated bridge over the corridor to facilitate transportation requirements while in the case of excavated channels bridges need not be elevated above existing ground. A bridge could be avoided if the local topography allows for easy crossing of the levees. In such cases, a dip crossing could be used. Dip crossings can provide considerable cost savings compared to bridges. However, from public safety point of view, dip crossings are not preferred because of the risk they pose to motorists during flooding. Bridges provide higher certainty in transportation access during flood events.

Economics:

- The excavation excess material can be used to construct the levees. This presents an opportunity to avoid hauling away the excavated material as well as hauling in of fill material. This can potentially lead to significant cost savings.
- The selected conveyance paths are located along existing wash corridors with existing flood hazards. Therefore, at least part of the area may have been located in a floodway with limited development options potentially reducing land acquisition costs.
- It is possible that adequate conveyance is available based on existing topography at several locations along the selected conveyance paths. This could eliminate the need for a levee while providing the necessary flow containment. In such situations, there would be a considerable cost savings as well as reduction in risk. Channel banks may still require erosion protection but flow containment will likely be not compromised.
- The structures such as levees, walls, grade control structures, as well as, sedimentation basins will require regular maintenance to ensure continuous and proper functioning. Sedimentation basins shall be located where significant deposition is expected. Any deposited material should be removed on a periodic basis or after a significant flood event. Erosion can be expected to be contained by the grade control structures and bank protection. However, localized erosion problems may still arise requiring monitoring and repair as needed.
- It is possible that the land set aside for the leveed corridor can also be used to satisfy the open space requirements. This could result in significant cost savings.

Social/ Environmental/ Aesthetic/ Multi-Use Criteria

- The leveed corridor leaves most of the existing corridor undisturbed. The construction of the levee and the grade control structures can be expected to disturb only parts of the corridor. Typically, the levees are less than 5 ft tall and 200 to 400 ft apart. This makes this option visually compatible with the existing surrounding and also quite favorable from the environmental permitting and cultural point of view.
- The top of levees presents the possibility of use as a trail. Other multi-use opportunities will be very limited in nature since the existing corridor is relatively not influenced by the design.
- The walled corridor option includes parallel buffer areas that could also provide multiple use opportunities adjacent to the conveyance area.

<u>Excavated Channel – Earthen (B3) and Concrete (C)</u>

The excavated channel is designed as a companion channel to the existing wash corridor which is preserved. Two types of excavated channels were evaluated: an earthen excavated channel (B3), and a concrete excavated channel (C).

Public Safety:

- The entire flood conveyance channel is below ground and is designed to have a freeboard of at least 1 ft for the 100 year event. The channel, thus, has adequate conveyance for all flows up to the 100-year flow. The conveyance as designed could be reduced by significant deposition or increase in vegetation. However, these changes must be quite dramatic to pose a significant risk of overflow.
- The excavated channels will deliver flow faster than the channel with natural cross-section. Faster flows pose a more serious public safety problem if people or animals get caught in the flow.
- The banks of the earthen excavated channel (B3) are protected from failure through bank and toe protection. In the event of bank protection failure, the channel may shift location and cause damage to adjacent property. While this scenario represents a structural failure, flow is likely to be still contained. Therefore, such a potential failure does not pose a widespread, significant public safety problem.
- The concrete channel (C) could also experience a lining failure, but is considered less likely than for an earthen channel.
- The channel is designed to a slope that is flatter than the existing slope. The designed slope is maintained by grade control. Grade control failure could lead to similar channel location changes as in B3. Another consequence of failure could be damage to underground utilities. Again, the concrete channel would be expected to have a lower chance of experiencing drop structure failure.

Economics:

- The excavation volume is exorbitantly high and represents a significant portion of the total cost of the excavated channel alternatives. Hauling away of the excavated excess could be major obstacle. Concrete channels, in addition, require concrete lining of the entire channel cross-section. The establishment of concrete lining is also very expensive and could form a significant portion of the total project cost.
- The land needed for the excavated channel and the adjacent existing corridor is generally similar to the levee/wall corridor needs. Therefore, the excavated channels do not significantly lower land costs.
- The excavated channels provide the opportunity to avoid the construction of the bridges at road crossings. The conveyance is below ground and could be handled by structures such as box culverts. The adjacent preserved wash would also need to be crossed in some fashion.

- Sedimentation basins will be located in places where significant deposition is anticipated. Periodic maintenance is needed to clear the collected sediment deposits.
- The earthen excavated channel may encounter localized erosion while this is not a problem in concrete channels. Monitoring and erosion maintenance of the excavated channels will be needed to ensure long-term functionality of the channels.

Social/ Environmental/ Aesthetic/ Multi-Use Criteria

- The excavated channel is located adjacent to an existing wash corridor. This will leave the existing corridor completely undisturbed. This is favorable for habitat preservation. The visual impacts can be significant since the excavated channel, particularly with concrete lining, is considered less aesthetically pleasing than the levee/wall corridor.
- The environmental impacts could be minimal since the channel is located separately from the corridor. However, the existing corridor must be provided with an irrigation mechanism to ensure sustainability of the natural habitat. Flow could come from the flood channel or adjacent tributary areas.
- The excavated channel provides possibilities for multiple-use such as trails.

Alternative D

The "No Measure" alternative relies on existing drainage and floodplain regulations to manage the alluvial fan flood and sedimentation hazards. Individual developments would provide flood hazard mitigation measures for their own properties.

Public Safety:

- Hazards will be addressed entirely by future development. Local communities will have to review and approve all proposed drainage facilities.
- The potential for a discontinuity of solutions across development boundaries exists.
- Long-term maintenance of any constructed facilities is potentially less certain.

Economics:

- Developers would pay for their own improvements. Costs are likely to be passed on to the individual residential and commercial property buyers.
- Because of the distribution of land ownership and the timing/phasing of individual development, there exists the potential for some unnecessary redundancies in future flood control solutions.
- Long-term maintenance assurances needed for some facilities may require public expenditures.
- Depending on the phasing of development and the selected flood control solutions, the potential exists for large areas of development to be constructed within FEMA floodplains.

Social/ Environmental/ Aesthetic/ Multi-Use Criteria

- Continuity of trails and other multiple-use elements of flood control facilities is not assured.
- Aesthetic treatment will be left to individual developments.
- The cumulative impacts of development may not be recognized in environmental permitting or mitigation requirements.

Outcome

Public Safety

Alternative A has a designated sedimentation area at the apices compared to other alternatives which have basins. The presence of the basins provides design certainty aiding in the control of the flows coming down the hills at the apices. This key advantage makes the basin based alternatives more preferable over Alternative A. Alternative C represents the concrete channel option without any detention at the apex. This alternative is favored slightly better compared to Alternatives A and D as it would have higher design certainty due to the concrete channels starting all the way from the apex. Alternative B5 represents the off-line basin option at the apex. This alternative ranks lower than the on-line basin alternatives. This is mainly due to uncertainties related to the functionality of the side-weirs/gates to split and let the larger flows enter the off-line basins. The on-line basins, on the other hand, have a well defined inlet taking the flow into the basins. In addition, the longer dimension of the on-line basins is perpendicular to the flow direction. This reduces the uncertainty of flow not entering the on-line basin.

For the purpose of discussing public safety aspects, the types of channel cross-sections can be categorized as leveed corridors or excavated channels. The excavated channel can have earthen or concrete lining. All the alternatives except C and D are ranked similarly. Alternative C represents the concrete channel option is ranked lower. The concrete channels tend to be narrower and deeper than the other alternatives with higher velocities. The higher velocities have negative influence on public safety with the possibility of larger damage when some type failure occurs. In addition, there is higher probability of people getting stuck in the flood waters. These factors resulted in a lowered ranking for the concrete channel.

Alternative D represents the developer initiated flood control measure. This alternative has a considerable uncertainty over the implementation of adequate and reliable system-wide flood control as it leaves the development of solutions to third parties. The continuity of the design certainty from an upstream development and the immediately downstream development may not be well determined due differences in developer priorities, phasing, and other issues. As a result, Alternative D ranks lower than the leveed corridor while it still ranks higher than the concrete channel alternative (C). In conclusion, the leveed corridor arises as the preferred alternative from the channel cross-section point of view.

Economics

The cost estimates for the various alternatives were used to determine the relative merits of each alternative in terms of economics. Land cost, excavation cost, levee-fill cost, and the channel-lining cost represent the major cost contributors. Alternatives B3 and C represent excavated earthen and concrete channels. The channel excavation costs for these alternatives are significantly higher than the levee-fill costs for the leveed-corridor alternatives. This is a direct result of the large lengths of the channels to convey the flow from the apices to the outfall. This makes the excavated channel alternatives less favorable compared to leveed corridor alternatives from the cost point of view. In addition to the excavation costs, Alternative C also involves the channel lining cost even though Alternative C has not only a sedimentation basin at the apex. The motivating notion behind Alternative C is to avoid having a basin at the apex and, instead, conveying the flow quickly through the concrete channel. Due to large lengths of the channels, lining the channel with concrete is significantly more expensive than placing a basin at the apex. These factors makes Alternative C economically less favorable compared the earthen excavated channel or the other alternatives where a basin is present at the apices.

Alternative A represents the non-structural solution at the apex with the designated sedimentation area. As the designated sedimentation is not amenable for any other use, the cost of land set aside is not subsidized by additional usage. The designated sedimentation areas are significantly large due to hydraulic and sedimentation uncertainties at the apices. As a result, Alternative A fairs unfavorably with regards to cost. In conclusion, the alternatives with basins at the apices and leveed-corridors as the means of conveyance represent the preferred alternative in terms of cost.

Social/ Environmental/ Aesthetic/ Multi-Use Criteria

The on-line basins and the excavated channel alternatives scored lower than the other alternatives for the social, environmental, aesthetic, and multi-use criteria. Excavation was viewed as having a greater environmental and aesthetic impact than the alternatives without excavation. The D Alternative was viewed as having a relatively higher score because of the perception that a greater number of corridors would be provided than compared to the regional facilities proposed in the other alternatives. However, this scoring did not reflect the fact that the "extra" corridors would be required for preservation as part of the development plan with or without the regional facility.

Summary

Table 14 shows the weighted scoring results from the strategy evaluation process. The result was a clear preference for the basin alternatives at the apices with the levee/wall corridors as the conveyance mechanism downstream (alternatives B1, B2, B4, & B5). The B4 alternatives represent the alignment variations which were evaluated in the sub-area specific evaluation described in Section 11 and are strategically similar to the B1 alternative. The B5 alternative, though scoring the same as B1 and B2, is considered less preferable due to the potential public safety and performance concerns. Therefore, the sub-area specific evaluation focused on the B1 and B2 options with an emphasis on the relative strengths and weaknesses of the various alignments. The D Alternative was carried forward to the sub-area evaluation as a requirement of the ADMP process.

Table 14 Strategy Selection Matrix

Alternative Measure		Evaluation Criteria			Ranking
Alternative Measure	**Alternative**	**Public Safety**	**Economic**	**Social/Environmental**	**Total Score**
Example (Rank 1-3 where 1 = least preferred)	**A**	**3**	**2**	**1**	**6 of possible 9**
APEX	A	1	1	3	5
	B1/B2	3	3	2	8
	B3	3	1	2	6
	B4	3	3	2	8
	B5	2	3	3	8
	C	2	1	1	4
	D	1	2	3	6
CROSS SECTION	A	3	1	2	6
	B1/B2	3	3	2	8
	B3	3	1	2	6
	B4	3	3	2	8
	B5	3	3	2	8
	C	2	1	1	4
	D	2	2	3	7
Combined Score for Apex and Cross Section	A				11
	B1/B2				16
	B3				12
	B4				16
	B5				16
	C				8
	D				13
Primary Preferred Alternative	B1/B2/B5/B4				
Secondary Preferred Alternative	D				

11.2.2 Sub-Area Evaluation

The FRS #1 sub-area was primarily an alignment variation alternative evaluation. In addition to the alignments, the small basin (B2) and off-line basin (B5) apex strategies were also carried over to the sub-area evaluation for the FRS #1 sub-area.

During the sub-area evaluation process, the nine "Form" criteria were lumped into four related categories: Environmental, Permitting, Visual/Aesthetic, & Recreation/Multiple Use which were used to assess the preferred alternative for the sub-area. Table 15 shows the results of the social, environmental, aesthetic, and multi-use criteria evaluation using the four "Form" categories. Table 16 shows the results of the public safety and economic criteria evaluation. Table 17 shows the results preferred alternative for each sub-area based on the outcome from the evaluation of both "Form" and "Function" by the project team.

The B1 alternative was selected as the preferred alternative according to the Form criteria. It is also suggested that additional corridors could be investigated along with the B1 alternative. The important merits were the larger basin size and connectivity opportunities to the Regional Park. A larger basin was felt to provide greater recreational and/or habitat opportunities than the smaller basin alternatives. The B1 alternative was preferred according to the Function evaluation.

Table 15 Alternative Evaluation Matrix by Sub-area (Form)

Alternative Measure		Function Criteria	Economic Criteria	Form Criteria				Ranking	
Alternative Measure	Alt.	Public Safety	Economic	Environmental	Permitting	Visual/ Aesthetic	Recreation / Multi-Use	Total Score	Preferred Alternative
Example (Rank from 1-3; 1 = least preferred)	B5	3	3	3	2	1	1	7 of possible 12	
FRS 1 Sub-Area	B1/B2			3	1	3	3	10	B1/Explore Additional Corridors
	B5			3	1	3	3	10	
	B4			N/A	N/A	N/A	N/A	N/A	
	D			3	1	1	2	7	

Table 16 Alternative Evaluation Matrix by Sub-area (Function)

Alternative Measure		Function Criteria	Economic Criteria	Form Criteria	Ranking	
Alternative Measure	Alternative	Public Safety	Economic	Social/ Environmental	Total Score	Preferred Alternative
Example (Rank from 1-3 where 1 = least preferred)	B1	3	2	1	6 of possible 9	
FRS 1 Sub-Area	B2	1	3		4	B4-3
	B5	1	3		4	
	B4-1	1	3		4	
	B4-2	2	2		4	
	B4-3	3	1		4	
	D	1	2		3	

Table 17 Alternative Evaluation Matrix by Sub-area (Combined)

Alternative Measure		Preferred Alternative		Preliminary Recommended Alternative
Alternative Measure	Alternative	Form	Function	
FRS 1 Sub-Area	B2	B1/Explore Additional Corridors	B4-3	B4-3
	B5			
	B4-1			
	B4-2			
	B4-3			
	D			

11.2.3 Preliminary Recommended Alternative for FRS #1 Sub-area

The B1 alternative was selected as the recommended alternative for the FRS #1 sub-area. Non-structural elements also comprise portions of the recommended alternative and will be emphasized through the incorporation of existing wash capacity in Step 3 (see Section 12 also).

12 RECOMMENDATIONS FOR STEP 3 FOR THE FRS #1 SUB-AREA

Based on the outcome of the Step 2 alternatives evaluation a number of items for consideration in the refinement of the recommended alterative are suggested for Step 3 for the FRS #1 sub-area. These recommendations are based on input received during the development of the proposed alternatives, the team evaluation process, and input from stakeholders and the public.

- On-line big basins are the preferred solution to control alluvial fan uncertainties at the apices.
- Multiple downstream levee/wall corridors are preferred whenever possible.
- There is a need to balance earthwork by project. For Step 3, a project will be considered the apex-to-outfall system for an individual alluvial fan (or fan complex if hydraulically connected).
- Existing channel conveyance should be quantified and incorporated into the recommended alternative designs. This could result in the elimination of some levee/wall reaches where the existing conveyance is adequate or natural lateral containment exists on one or more sides of the corridor. This will also maximize the use of non-structural or nearly non-structural reach management elements.
- The required landscape compatibility enhancements should be included explicitly in the hydrologic and hydraulic design.
- Incorporate the specific sediment data collected in Step 2 into the design calculations.
- Identify the area benefited using the Stage 3 delineations.
- Refine the design details including riprap sizing calculations and the evaluation of basin inlet structures (e.g., energy dissipaters, collection dikes/ ditches, off-line basin outlet structures, etc.)
- Refine the hydrologic models to include more HEC-1 subreaches, ideally one subreach per design reach.
- Discretize the quantities and costs by individual fan system (by "project")

13 SUMMARY

The proposed alternatives for the FRS #1 sub-area of SVADMP were developed and evaluated in Step 2 of the ADMP process. The alternatives included both non-structural and environmentally friendly and aesthetically compatible structural flood control measures. Engineering and landscape compatibility enhancement costs were estimated for all of the proposed alternatives piedmont sub-areas. The proposed alternatives were evaluated for their flood control function, economic costs, environmental impacts, permitting issues, visual and aesthetic characteristics, and recreation and multiple-use opportunities. Preference for natural leveed corridors downstream of on-line detention basins along multiple corridors was expressed by the project team, stakeholders, and the public.

The recommended alternatives will be carried forward for further refinement of the engineering elements and the cost estimates. Special attention will be given to maximizing non-structural, floodplain management approaches along the preferred leveed corridor alignments. Stakeholders and the public will continue to be consulted as to their feedback in attempt to incorporate existing and imminent developer plans into the drainage master plan for the Sun Valley area.

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Appendix A

Design Analyses

SUN VALLEY ADMP
Step 2 - Alt. A
FRS No. 1

FRS No. 1 Sub-area

FEMA Floodplains

Floodplain

Floodway

Alluvial Fan Apices

Concentration Point

Step 2 Excavated Corridors ROW

Step 2 Leveed Corridors ROW

Step 2 Basins

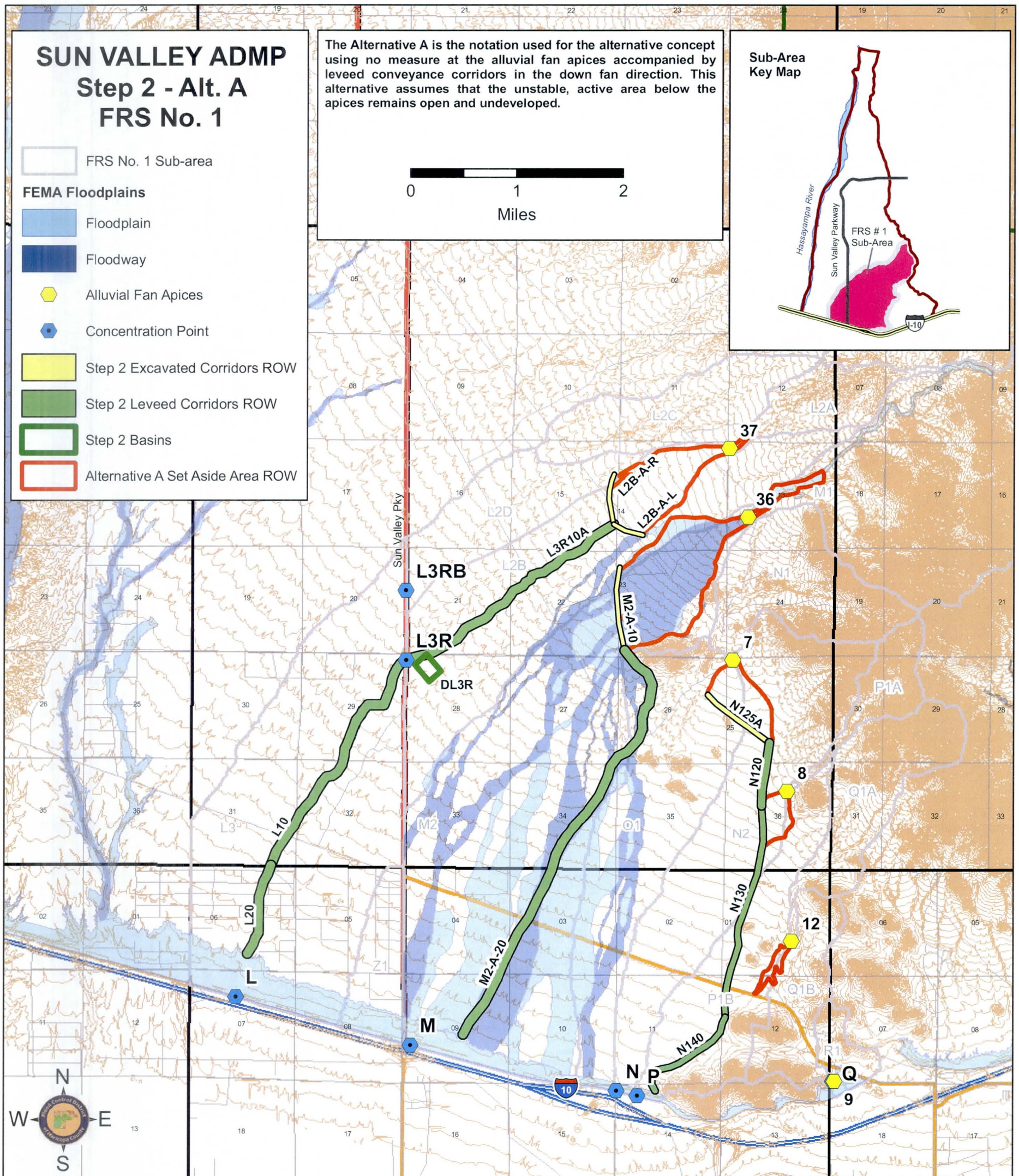
Alternative A Set Aside Area ROW

The Alternative A is the notation used for the alternative concept using no measure at the alluvial fan apices accompanied by leveed conveyance corridors in the down fan direction. This alternative assumes that the unstable, active area below the apices remains open and undeveloped.

0 1 2

Miles

Sub-Area Key Map



Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs (in $1000): Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Base Cost Percentages: Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
L3R10A	Leveed Chl.	3204	141	0	73	2.4	482	5	$ 14,100	$ 6,424	$ 1,070	$ 2,886	$ 24,481	58%	26%	4%	12%	9%
DL3R	Offline Basin	1585	20	216	0	1100	780	6	$ 1,970	$ 1,982	$ 858	$ 816	$ 5,626	35%	35%	15%	15%	2%
L10	Leveed Chl.	3412	144	0	86	2.4	488	5	$ 14,420	$ 6,176	$ 1,184	$ 3,151	$ 24,931	58%	25%	5%	13%	9%
M2-A-20	Leveed Chl.	3930	248	0	127	4.2	482	5	$ 24,750	$ 10,775	$ 1,879	$ 5,016	$ 42,420	58%	25%	4%	12%	15%
N120	Leveed Chl.	1883	31	0	18	0.6	422	5	$ 3,060	$ 1,556	$ 265	$ 851	$ 5,732	53%	27%	5%	15%	2%
N130	Leveed Chl.	2270	153	0	62	2.1	322	5	$ 15,280	$ 4,919	$ 912	$ 2,422	$ 23,533	65%	21%	4%	10%	8%
N140	Leveed Chl.	2705	69	0	38	1.1	328	5	$ 6,880	$ 2,519	$ 521	$ 1,366	$ 11,287	61%	22%	5%	12%	4%
L2B-A-R	Excavated Chl.	3063	315	101	7	0.5	265	5	$ 31,490	$ 2,994	$ 577	$ 1,218	$ 36,279	87%	8%	2%	3%	13%
L2B-A-L	Excavated Chl.	3063	8	61	4	0.3	265	5	$ 770	$ 1,865	$ 356	$ 958	$ 3,949	19%	47%	9%	24%	1%
L20	Leveed Chl.	3069	53	0	31	0.9	488	5	$ 5,250	$ 2,230	$ 432	$ 1,246	$ 9,158	57%	24%	5%	14%	3%
M2-A-10	Excavated Chl.	3607	610	415	14	0.8	269	5	$ 61,000	$ 10,288	$ 985	$ 1,804	$ 74,077	82%	14%	1%	2%	26%
N125A	Excavated Chl.	1253	178	84	13	0.7	169	5	$ 17,760	$ 2,651	$ 528	$ 913	$ 21,852	81%	12%	2%	4%	8%
		TOTAL	1970	877	473				$ 196,730	$ 54,379	$ 9,567	$ 22,650	**$ 283,325**	69%	19%	3%	8%	100%
All Channels			1950	661	473	16.0			$ 194,760	$ 52,397	$ 8,709	$ 21,833	$ 277,699	70%	19%	3%	8%	98%
All Online Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins			20	216	0				$ 1,970	$ 1,982	$ 858	$ 816	$ 5,626	35%	35%	15%	15%	2%

Channel Cost per mile (in $1000)	$17,356	Basins Cost per ac. ft. (in $1000)	$3.97	

Cost Increase for Landscape Compatibility Enhancement over Base Costs

All Channels % increase	6%	16%	134%				6%	55%	86%	89%	24%
All Online Basins % increase	0%	0%	0%				0%	0%	0%	0%	0%
All Offline Basins % increase	35%	6%	0%				35%	5%	34%	34%	24%
Total % increase	6%	13%	134%				6%	53%	82%	87%	24%

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Costs Summary

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs ($1000): Land Cost	Base Costs ($1000): Constr. Cost	Base Costs ($1000): Lndscp Cost	Base Costs ($1000): 50 Yr Maint. Cost	Base Costs ($1000): Total Cost	Base Cost Percentages: Land Cost %	Base Cost Percentages: Constr. Cost %	Base Cost Percentages: Lndscp Cost %	Base Cost Percentages: 50 Yr Maint. Cost %	Base Cost Percentages: % of Total Cost
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	TOTAL	1970	877	473					$ 196,730	$ 54,379	$ 9,567	$ 22,650	**$ 283,325**	69%	19%	3%	8%	100%
All Channels		1950	661	473	16.0				$ 194,760	$ 52,397	$ 8,709	$ 21,833	$ 277,699	70%	19%	3%	8%	98%
All Online Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins		20	216	0					$ 1,970	$ 1,982	$ 858	$ 816	$ 5,626	35%	35%	15%	15%	2%
Channel Cost per mile (in $1000)		$17,356		Basins Cost per ac. ft. (in $1000)					$3.97									

Cost Summary - Landscape Compatibility Enhanced (LCE)

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	LCE Design Geometry: Length (stor-ft; chl-mi)	LCE Design Geometry: ROW Width (ft)	LCE Design Geometry: Depth (ft)	LCE Costs ($1000): Land Cost	LCE Costs ($1000): Constr. Cost	LCE Costs ($1000): Lndscp Cost	LCE Costs ($1000): 50 Yr Maint. Cost	LCE Costs ($1000): Total Cost	LCE Cost Percentages: Land Cost %	LCE Cost Percentages: Constr. Cost %	LCE Cost Percentages: Lndscp Cost %	LCE Cost Percentages: 50 Yr Maint. Cost %	LCE Cost Percentages: % of Total Cost
L3R10A	Leveed Chl.	3204	156	0	171	2.4	533	5	$ 15,590	$ 10,685	$ 2,216	$ 5,875	$ 34,367	45%	31%	6%	17%	10%
DL3R	Offline Basin	1585	27	228	0	1310	880	6	$ 2,650	$ 2,082	$ 1,153	$ 1,093	$ 6,978	38%	30%	17%	16%	2%
L10	Leveed Chl.	3412	160	0	199	2.4	542	5	$ 16,020	$ 10,738	$ 2,394	$ 6,478	$ 35,630	45%	30%	7%	18%	10%
M2-A-20	Leveed Chl.	3930	274	0	300	4.2	533	5	$ 27,370	$ 18,179	$ 3,892	$ 10,255	$ 59,695	46%	30%	7%	17%	17%
N120	Leveed Chl.	1883	34	0	42	0.6	473	5	$ 3,430	$ 2,597	$ 550	$ 1,591	$ 8,167	42%	32%	7%	19%	2%
N130	Leveed Chl.	2270	166	0	146	2.1	373	5	$ 16,550	$ 8,480	$ 1,888	$ 4,962	$ 31,880	52%	27%	6%	16%	9%
N140	Leveed Chl.	2705	76	0	87	1.1	382	5	$ 7,580	$ 4,502	$ 1,054	$ 2,829	$ 15,965	47%	28%	7%	18%	5%
L2B-A-R	Excavated Chl.	3063	321	113	17	0.5	317	5	$ 32,090	$ 3,651	$ 758	$ 1,576	$ 38,075	84%	10%	2%	4%	11%
L2B-A-L	Excavated Chl.	3063	11	68	10	0.3	317	5	$ 1,140	$ 2,389	$ 468	$ 1,179	$ 5,177	22%	46%	9%	23%	1%
L20	Leveed Chl.	3069	58	0	72	0.9	542	5	$ 5,830	$ 3,884	$ 873	$ 2,458	$ 13,045	45%	30%	7%	19%	4%
M2-A-10	Excavated Chl.	3607	620	475	32	0.8	326	5	$ 62,030	$ 12,300	$ 1,306	$ 2,460	$ 78,097	79%	16%	2%	3%	22%
N125A	Excavated Chl.	1253	187	108	30	0.7	346	5	$ 18,720	$ 3,822	$ 826	$ 1,521	$ 24,889	75%	15%	3%	6%	7%
	TOTAL	2090	992	1106					$ 209,000	$ 83,308	$ 17,379	$ 42,278	**$ 351,965**	59%	24%	5%	12%	100%
All Channels		2063	764	1106	16.0				$ 206,350	$ 81,226	$ 16,226	$ 41,185	$ 344,987	60%	24%	5%	12%	98%
All Online Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins		27	228	0					$ 2,650	$ 2,082	$ 1,153	$ 1,093	$ 6,978	38%	30%	17%	16%	2%
Channel Cost per mile (in $1000)		$21,562		Basins Cost per ac. ft. (in $1000)					$5.06									
All Channels % increase		6%	16%	134%					6%	55%	86%	89%	24%					
All Online Basins % increase		0%	0%	0%					0%	0%	0%	0%	0%					
All Offline Basins % increase		35%	6%	0%					35%	5%	34%	34%	24%					
Total % increase		6%	13%	134%					6%	53%	82%	87%	24%					

Hydrology - 6-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
R1	BASIN	506			4.2	0.28	47	12	4	2	1.525	1.527	1.527	1.527	23	23	23	23
Q1B	BASIN	851			4.5	0.94	155	39	13	6	1.533	1.544	1.544	1.544	77	77	77	77
DUMMY	COMBINE	1020			4.5	1.22	192	48	16	7	1.459	1.469	1.469	1.469	95	96	96	96
L1	BASIN	2128			4.7	3.55	543	139	46	20	1.424	1.453	1.453	1.453	269	275	275	275
L1-L2A	ROUTE	2066	14.4	40.14	4.9	3.55	543	139	46	20	1.423	1.453	1.453	1.453	269	275	275	275
L2A	BASIN	692			4.5	0.69	113	28	9	4	1.516	1.516	1.516	1.516	56	56	56	56
L2BR	COMBINE	2391			4.9	4.24	623	159	53	23	1.366	1.391	1.391	1.391	309	314	314	314
L2BR-A	ROUTE	2316	101.5	61.14	5	4.24	621	159	53	23	1.362	1.391	1.391	1.391	308	314	314	314
L2AL2B	ROUTE	2101	101.2	139.42	5.6	4.24	610	159	53	23	1.337	1.391	1.391	1.391	302	314	314	314
L2B	BASIN	1532			5	4.08	418	104	35	15	0.952	0.952	0.952	0.952	207	207	207	207
L3R	COMBINE	2718			5.6	8.32	899	236	79	34	1.005	1.057	1.057	1.057	446	469	469	469
DL3R	DIVERT	1585			5.4	8.32	786	208	69	30	0.879	0.931	0.931	0.931	390	413	413	413
L2BL3	ROUTE	1579	101.1	134.56	6.5	8.32	752	208	69	30	0.841	0.931	0.931	0.931	373	413	413	413
L2C	BASIN	754			4.8	1.33	161	40	13	6	1.125	1.125	1.125	1.125	80	80	80	80
L2C-2D	ROUTE	712	13	29.17	5.2	1.33	161	40	13	6	1.125	1.125	1.125	1.125	80	80	80	80
L2D	BASIN	706			4.7	1.23	136	34	11	5	1.025	1.025	1.025	1.025	67	67	67	67
L3RB	COMBINE	1043			5	2.56	260	65	22	9	0.945	0.946	0.946	0.946	129	129	129	129
L2D-L3	ROUTE	650	12.5	187.08	8.3	2.56	258	65	22	9	0.936	0.946	0.946	0.946	128	129	129	129
L3	BASIN	1832			5.2	5.85	581	146	49	21	0.923	0.926	0.926	0.926	288	289	289	289
L	COMBINE	2233			6.2	16.73	1253	347	116	50	0.697	0.772	0.772	0.772	621	688	688	688
M1	BASIN	2809			4.8	5.69	790	203	68	29	1.291	1.327	1.327	1.327	392	402	402	402
M1-M2A	ROUTE	2736	101.6	88.03	5	5.69	787	203	68	29	1.287	1.327	1.327	1.327	390	402	402	402
M1-M2	ROUTE	2367	101.3	278.93	6.1	5.69	749	203	68	29	1.224	1.327	1.327	1.327	371	402	402	402
M2	BASIN	1849			5.4	7.44	633	159	53	23	0.791	0.795	0.795	0.795	314	315	315	315
M	COMBINE	2935			6.1	13.12	1164	318	106	46	0.825	0.901	0.901	0.901	577	631	631	631
N1	BASIN	1253			4.5	1.52	210	53	18	8	1.281	1.286	1.286	1.286	104	105	105	105
N1-N1A	ROUTE	1156	101.1	29.33	4.6	1.52	209	53	18	8	1.277	1.286	1.286	1.286	104	105	105	105
N1-P1A	ROUTE	1049	100.9	21.68	4.9	1.52	209	53	18	8	1.274	1.286	1.286	1.286	104	105	105	105
N2A	BASIN	1253			4.5	1.52	210	53	18	8	1.281	1.286	1.286	1.286	104	105	105	105
CN2AR	COMBINE	1586			4.8	3.05	376	95	32	14	1.147	1.162	1.162	1.162	186	189	189	189
P1A	BASIN	575			4.4	0.5	89	22	7	3	1.655	1.663	1.663	1.663	44	44	44	44
P1A-A2	ROUTE	553	100.6	5.22	4.5	0.5	89	22	7	3	1.653	1.663	1.663	1.663	44	44	44	44
CN2A	COMBINE	1822			4.8	3.55	437	111	37	16	1.146	1.164	1.164	1.164	217	220	220	220
P1A-1B	ROUTE	1635	101.5	137.03	5.4	3.55	431	111	37	16	1.129	1.164	1.164	1.164	214	220	220	220
P1B	BASIN	852			5	1.94	244	62	21	9	1.172	1.194	1.194	1.194	121	123	123	123
PR	COMBINE	2007			5.4	5.49	597	156	52	22	1.012	1.058	1.058	1.058	296	310	310	310
Q1A	BASIN	990			4.5	1.3	193	49	16	7	1.385	1.396	1.396	1.396	96	97	97	97
Q1A-P	ROUTE	971	102.8	17.51	4.7	1.3	193	49	16	7	1.383	1.396	1.396	1.396	96	97	97	97
P	COMBINE	2255			5.4	6.78	726	189	63	27	0.996	1.039	1.039	1.039	360	376	376	376
N2B	BASIN	1193			5.1	3.33	366	93	31	13	1.023	1.045	1.045	1.045	181	185	185	185
O1	BASIN	1057			5.3	3.09	343	88	29	13	1.033	1.059	1.059	1.059	170	174	174	174
Z1	BASIN	694			4.5	0.66	100	25	8	4	1.405	1.406	1.406	1.406	50	50	50	50

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
R1	BASIN	387			12.2	0.28	37	10	3	1	1.223	1.322	1.322	1.322	19	20	20	20
Q1B	BASIN	740			12.5	0.94	134	38	13	5	1.325	1.498	1.5	1.5	66	75	75	75
DUMMY	COMBINE	902			12.5	1.22	170	48	16	7	1.294	1.448	1.45	1.45	84	94	94	94
L1	BASIN	2267			12.7	3.55	527	150	50	22	1.382	1.572	1.576	1.576	261	297	298	298
L1-L2A	ROUTE	2154	14.4	41.37	12.9	3.55	527	150	50	22	1.381	1.571	1.576	1.576	261	297	298	298
L2A	BASIN	570			12.5	0.69	92	23	8	3	1.236	1.236	1.236	1.236	46	46	46	46
L2BR	COMBINE	2519			12.9	4.24	616	172	57	25	1.351	1.509	1.513	1.513	305	341	342	342
L2BR-A	ROUTE	2418	101.6	62.83	13	4.24	614	172	57	25	1.346	1.508	1.513	1.513	304	341	342	342
L2AL2B	ROUTE	2138	101.2	140.85	13.6	4.24	601	172	57	25	1.319	1.507	1.513	1.513	298	341	342	342
L2B	BASIN	1700			13	4.08	449	112	37	16	1.024	1.024	1.024	1.024	223	223	223	223
L3R	COMBINE	3204			13.5	8.32	1020	282	94	41	1.141	1.259	1.263	1.263	506	559	560	560
DL3R	DIVERT	1585			12.9	8.32	842	237	79	34	0.941	1.06	1.063	1.063	417	470	471	471
L2BL3	ROUTE	1585	101.1	134.86	14.5	8.32	811	237	79	34	0.907	1.059	1.063	1.063	402	470	471	471
L2C	BASIN	692			12.8	1.33	145	36	12	5	1.013	1.013	1.013	1.013	72	72	72	72
L2C-2D	ROUTE	651	12.9	27.24	13.2	1.33	145	36	12	5	1.013	1.013	1.013	1.013	72	72	72	72
L2D	BASIN	655			12.7	1.23	124	31	10	4	0.934	0.934	0.934	0.934	61	61	61	61
L3RB	COMBINE	1104			13	2.56	266	66	22	10	0.965	0.965	0.965	0.965	132	132	132	132
L2D-L3	ROUTE	705	12.5	201.22	16.1	2.56	263	66	22	10	0.956	0.965	0.965	0.965	130	132	132	132
L3	BASIN	2129			13.2	5.85	658	166	56	24	1.045	1.058	1.058	1.058	326	330	330	330
L	COMBINE	3069			13.5	16.73	1609	452	151	65	0.894	1.006	1.009	1.009	798	897	900	900
M1	BASIN	3301			12.8	5.69	825	236	79	34	1.349	1.543	1.548	1.548	409	468	469	469
M1-M2A	ROUTE	3126	101.8	95.42	13	5.69	822	236	79	34	1.343	1.542	1.548	1.548	407	468	469	469
M1-M2	ROUTE	2537	101.4	291.33	14	5.69	787	235	79	34	1.287	1.539	1.548	1.548	390	467	469	469
M2	BASIN	2347			13.4	7.44	786	198	66	29	0.983	0.989	0.99	0.99	390	392	392	392
M	COMBINE	3930			14	13.12	1489	422	141	61	1.055	1.195	1.199	1.199	739	836	839	839
N1	BASIN	1211			12.5	1.52	192	52	17	7	1.172	1.269	1.27	1.27	95	103	103	103
N1-N1A	ROUTE	1091	101.1	28.37	12.6	1.52	192	52	17	7	1.171	1.268	1.27	1.27	95	103	103	103
N1-P1A	ROUTE	974	100.8	20.7	12.9	1.52	192	52	17	7	1.17	1.268	1.27	1.27	95	103	103	103
N2A	BASIN	1211			12.5	1.52	192	52	17	7	1.172	1.269	1.27	1.27	95	103	103	103
CN2AR	COMBINE	1614			12.8	3.05	380	103	34	15	1.159	1.257	1.26	1.26	188	204	205	205
P1A	BASIN	441			12.4	0.5	73	21	7	3	1.351	1.542	1.545	1.545	36	41	41	41
P1A-A2	ROUTE	414	100.5	4.42	12.5	0.5	73	21	7	3	1.351	1.542	1.545	1.545	36	41	41	41
CN2A	COMBINE	1883			12.8	3.55	450	123	41	18	1.179	1.291	1.294	1.294	223	244	245	245
P1A-1B	ROUTE	1727	101.5	141.79	13.4	3.55	442	123	41	18	1.159	1.289	1.294	1.294	219	244	245	245
P1B	BASIN	842			13	1.94	231	61	20	9	1.108	1.174	1.175	1.175	114	121	121	121
PR	COMBINE	2296			13.3	5.49	659	183	61	26	1.117	1.237	1.242	1.242	327	362	363	363
Q1A	BASIN	915			12.5	1.3	173	48	16	7	1.242	1.372	1.374	1.374	86	95	95	95
Q1A-P	ROUTE	888	102.7	16.51	12.7	1.3	173	48	16	7	1.241	1.371	1.374	1.374	86	95	95	95
P	COMBINE	2705			13.3	6.78	826	229	77	33	1.132	1.255	1.26	1.26	410	454	456	456
N2B	BASIN	1331			13.1	3.33	378	99	33	14	1.057	1.102	1.103	1.103	187	195	196	196
O1	BASIN	1163			13.3	3.09	349	91	30	13	1.05	1.095	1.096	1.096	173	180	180	180
Z1	BASIN	558			12.5	0.66	80	21	7	3	1.127	1.161	1.161	1.161	40	41	41	41

Channels Hydraulics Summary

		Design Geometry						Hydraulics									
Structure ID	Type	Initial Slope (ft/ft)	Long-term Slope (ft/ft)	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Chnl Mannings n	Flow Rate (cfs)	Wetted Perimeter (ft)	Wetted XS Area (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flow Depth (ft)	Freeboard (ft)	Top Width (ft)	Velocity (ft/s)	Froude Number	Shear Stress (lb/sq. ft)
L3R10A	Leveed	0.0143	0.0050	2.40	3	4.5	0.045	3204	409.6	616.6	1.5	1.5	1.5	3.0	409	5.2	0.75	0.48
L10	Leveed	0.0093	0.0040	2.40	3	5.0	0.045	3412	411.4	730.1	1.8	1.8	1.8	3.2	411	4.7	0.62	0.45
M2-A-20	Leveed	0.0117	0.0050	4.20	3	4.5	0.045	3930	411.6	741.7	1.8	1.8	1.8	2.7	411	5.3	0.70	0.57
N120	Leveed	0.0133	0.0050	0.60	3	4.5	0.045	1883	347.9	428.4	1.2	1.2	1.2	3.3	347	4.4	0.70	0.39
N130	Leveed	0.0132	0.0050	2.10	3	4.5	0.045	2270	250.9	421.8	1.7	1.7	1.7	2.8	250	5.4	0.73	0.54
N140	Leveed	0.0072	0.0040	1.10	3	5.0	0.045	2705	254.5	564.9	2.2	2.2	2.3	2.7	254	4.8	0.57	0.57
L2B-A-R	Excavated	0.0081	0.0040	0.50	3	4.5	0.045	3063	183.6	637.7	3.5	3.5	3.7	0.8	182	4.8	0.45	0.93
L2B-A-L	Excavated	0.0104	0.0040	0.30	3	4.5	0.045	3063	183.6	637.7	3.5	3.5	3.7	0.8	182	4.8	0.45	0.93
L20	Leveed	0.0084	0.0040	0.90	3	5.0	0.045	3069	411.0	705.9	1.7	1.7	1.7	3.3	410	4.3	0.58	0.43
M2-A-10	Excavated	0.0137	0.0050	0.80	3	5.0	0.045	3607	184.3	658.9	3.6	3.6	3.8	1.2	183	5.5	0.51	1.20
N125A	Excavated	0.0063	0.0030	0.70	3	5.0	0.045	1253	86.2	300.6	3.5	3.5	4.1	0.9	85	4.2	0.39	0.78

Basins Hydraulics Summary

			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac.	Peak Inflow into Basin (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Freeboard (ft)
DL3R	Offline Basin	0.0140	1100	780	6.0	90.0	89.0	89.0	1619	0	2.8	3.2

Open Channel

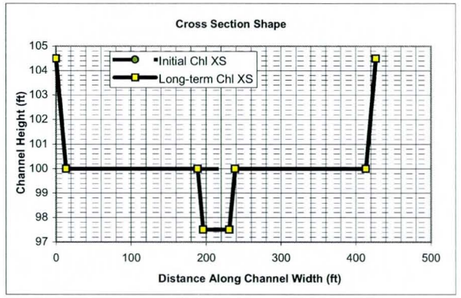
Structure ID	L3R10A	HEC1 ID	L2AL2B

Longitundal Geometry

Length	12738.0	ft
U/S Elev	1420.3	ft
D/S Elev	1238.5	ft
Initial Channel Slope	0.0143	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

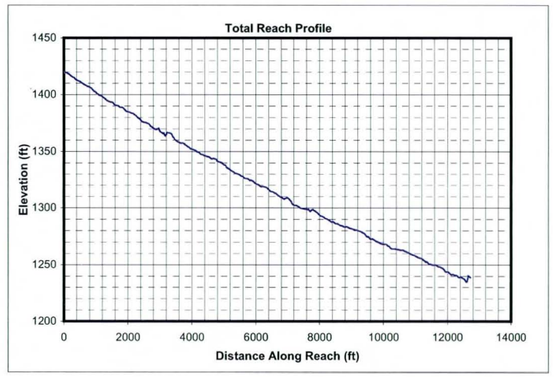
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	400	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	413.5	413.5	413.5	427
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	175	3	35	7	3	175	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	188.5	196	231	238.5	413.5	427
Y	104.5	100	100	97.5	97.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	L3R								TOTAL
HEC1 Peak-Flow	3204								3204
Weighting Factor	1.00								
Flow into Channel	3204								3204

Reach Sediment Inflow Characteristics

U/S Contributing ID	L2AL2B_L2B-A-R								TOTAL
Flow Volume (ac. ft)	342.00								342
Sediment Conc. (ppm)	1614								
Sediment Volume (ac. ft)	0.21								0.21
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.21								0.21

Hydrology

Drainage Area	4.077	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	3204	cfs	
Long-term Max. Chnl Capacity	12705	cfs	
Q2 Channel	320	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	427	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
320	402.4	153.9	0.4	100.0	100.4	2.1	0.4	402.3	0.4	0.12	0.59
961	404.7	297.9	0.7	100.0	100.7	3.2	0.7	404.4	0.7	0.23	0.66
2403	408.1	518.1	1.3	100.0	101.3	4.6	1.3	407.7	1.3	0.40	0.73
3204	409.6	616.6	1.5	100.0	101.5	5.2	1.5	409.1	1.5	0.48	0.75

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
320	48.8	90.6	1.9	97.5	99.7	3.5	2.2	48.1	1.9	0.68	0.45
961	405.6	408.5	1.0	97.5	100.8	2.4	3.3	404.5	1.0	1.01	0.41
2403	410.3	711.2	1.7	97.5	101.5	3.4	4.0	409.0	1.7	1.25	0.45
3204	412.4	847.0	2.1	97.5	101.8	3.8	4.3	411.0	2.1	1.35	0.46

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
	L2AL2B_L2B-A-R									
320	642									642
961	2667									2667
2403	9031									9031
3204	13328									13328

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
320	1.74	1.0991	1.0441	Erosive	Erosive	Erosive	0.2	Stable	6.9	Stable	Stable
961	1.74	1.3012	1.2361	Erosive	Erosive	Erosive	0.3	Stable	7.6	Stable	Stable
2403	1.74	1.4693	1.3959	Erosive	Erosive	Erosive	0.3	Stable	9.2	Stable	Stable
3204	1.74	1.5219	1.4458	Erosive	Erosive	Erosive	0.4	Stable	9.8	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	320	961	2403	3204	320	961	2403	3204	320	961	2403	3204
Bray - Equation #1	50	89	144	168	1.8	2.6	3.6	3.9	3.5	4.1	4.7	4.9
Bray - Equation #2	65	117	189	220	2.0	2.9	3.9	4.3	2.4	2.8	3.2	3.4
Hey	15	28	47	55	5.8	8.8	12.4	13.8				
Ackers & Charlton/Lacey	41	64	95	107					2.1	2.5	2.9	3.1
Parker	123	213	337	389	1.5	2.4	3.5	3.9				
Chang	88	171	298	354	0.1	-0.3	-0.8	-1.1				
Kellerhals	32	56	88	102	2.7	4.2	6.1	6.9	3.6	4.1	4.4	4.6
AMAFCA/Schumm	48	405	409	411								
Moody & Odem	21	21	21	21	1.2	1.2	1.2	1.2				
BUREC	23.1	34.9	49.2	54.8	6	9	13	15	3.5	4.6	5.8	6.3
Average	51	120	168	188	2.7	3.9	5.4	6.0	3.1	3.6	4.2	4.4
Values As Designed	48	405	409	411	2.2	3.3	4.0	4.3	3.5	2.4	3.4	3.8
Difference with Design	3	-285	-241	-223	0.5	0.6	1.4	1.6	-0.5	1.3	0.9	0.7

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
320	2663	1639	3364	4957	6545	805	705	453	9529	752	2921	3121
961	14586	6569	12087	31980	10371	4339	2767	2949	30130	3478	15769	12275
2403	59867	19019	29472	150956	14598	15677	7279	11121	76485	13104	57151	41339
3204	93228	26270	38632	245555	16171	23333	9710	16475	102238	19947	84342	61446

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
320	3084	1898	3895	5740	7579	932	816	524	11034	871	3382	3614
961	5630	2536	4665	12344	4003	1675	1068	1138	11629	1343	6086	4738
2403	9243	2936	4550	23306	2254	2420	1124	1717	11809	2023	8824	6382
3204	10795	3042	4473	28433	1873	2702	1124	1908	11838	2310	9766	7115

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
320	1945	814	1143	3874	1148	382	258	469	2059	402	2267	1342
961	3392	1728	2828	5661	6200	644	584	744	5757	729	3935	2927
2403	13907	5791	8553	26669	9260	2746	1933	3352	15361	2839	16259	9697
3204	21640	8268	11800	43342	10403	4165	2685	5148	20698	4377	24825	14305

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
320	2253	942	1323	4486	1329	442	298	543	2384	465	2625	1554
961	1309	667	1091	2185	2393	249	225	287	2222	281	1519	1130
2403	2147	894	1321	4117	1430	424	298	518	2372	438	2510	1497
3204	2506	957	1366	5019	1205	482	311	596	2397	507	2875	1656

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
320	0.0021	0.0032	138	0.42	0.047	0.0007	30	0.036	0.0005	0.0159	0.0007	0.0016	0.0051	0.0003	0.0022	0.0142	0.0053
961	0.0009	0.0016	191	0.58	0.050	0.0004	31	0.036	0.0003	0.0159	0.0003	0.0008	0.0051	0.0002	0.0009	0.0143	0.0051
2403	0.0005	0.0010	251	0.76	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0051	0.0001	0.0005	0.0143	0.0050
3204	0.0004	0.0008	273	0.83	0.054	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0051	0.0001	0.0004	0.0143	0.0050

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	118.1	ft
Height of Drop Structure	3	ft
No . of Drop Structures	40	
Distance between structs.	318	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	4.08	sq. mi
Total Sediment Yield Volume	7.75	ac ft

Sedimentation Basins

Length	318 ft	Depth	3 ft
Width	427 ft	Side slope	3 ft/ft
Total Volume per Basin		8.91	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		3	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
320	1.1	-0.6	0.2	24.6	2.2	1.9	3.5	0.0050	0.2	1.5	2.5	5.6
961	1.1	-1.1	0.1	24.6	3.3	1.0	2.4	0.0050	0.3	1.5	2.5	5.7
2403	1.1	-1.1	0.2	24.6	4.0	1.7	3.4	0.0050	0.4	1.5	2.5	5.9
3204	1.1	-1.2	0.2	24.6	4.3	2.1	3.8	0.0050	0.5	1.5	2.5	6.0

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	2138	cfs
Stage at Peak Flow	101.2	ft
Volume at Peak Flow	342.0	ac. ft

Freeboard

Max. Flow Depth	1.5	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	7.95	ac. ft
Outflowing Sediment Volume	0.21	ac. ft
Deposited(+)/Eroded(-) Volume	7.74	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	12738	12738
Side Slope (?H:1V)	3	3
Channel Width (ft)	427	427
Channel XS Area (sq. ft)	1967	1967
Channel Perimeter (ft)	429	429

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	12738	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	4246	sq. Yd
Volume	12738	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	12738	12738
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	59444	123134
Left Levee Volume (cu. Yd)	58500	137759
Right Levee Length (ft)	12738	12738
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	59444	123134
Right Levee Volume (cu. Yd)	58500	137759
Total Levee Surface Area (sq. Yd)	118888	246268
Total Levee Volume (cu. Yd)	117000	275518

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	12738	12738
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	19815	46706
Left Levee Lining Volume (cu. Yd)	9907	23353
Right Levee Length (ft)	12738	12738
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	19815	46706
Right Levee Lining Volume (cu. Yd)	9907	23353
Total Lining Area (sq. Yd)	39629	93412
Total Lining Volume (cu. Yd)	19814	46706

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	427	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	7.6	ft	
Structure Height	10.6	ft	
Number of Structures	40		
Volume per structure	503	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 37,725		
Area per structure	142	sq. Yd	
Total Area	5,693	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	3	
Total Volume per Basin	14375	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 57,500	
Other Cost	$ -	
Total cost per basin	$ 57,500	
Area per basin	15,109	sq. Yd
Total Area	45,327	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	117,000	cu. Yd	$ 7.00	$ 819,000	118,888	sq. Yd	$ 9.00	$ 1,069,992	118,888	sq. Yd	$ 11.67	$ 1,387,027
Levee - LC Enhancement	Fill	158,518	cu. Yd	$ 7.00	$ 1,109,626	127,380	sq. Yd	$ 9.00	$ 1,146,420	158,518	sq. Yd	$ 11.67	$ 1,849,377
Levee Lining	Riprap	19,814	cu. Yd	$ 75.00	$ 1,486,050	39,629	sq. Yd	$ -	$ -	39,629	sq. Yd	$ 20.83	$ 825,611
Levee Lining -LC Enhancement	Riprap	26,892	cu. Yd	$ 75.00	$ 2,016,900	53,783	sq. Yd	$ -	$ -	53,783	sq. Yd	$ 20.83	$ 1,120,472
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	12,738	cu. Yd	$ 75.00	$ 955,350	4,246	sq. Yd	$ -	$ -	4,246	sq. Yd	$ 25.00	$ 106,150
Drop Structures	Riprap	40	EA	$ 37,725.00	$ 1,509,000	5,693	sq. Yd	$ -	$ -	5,693	sq. Yd	$ 33.33	$ 189,767
Drop Str. - LC Enhancement	Riprap	40	EA	$ 3,772.50	$ 150,900	569	sq. Yd	$ -	$ -	569	sq. Yd	$ 33.33	$ 18,977
Sedimentation Basins		3	EA	$ 57,500.00	$ 172,500	45,327	sq. Yd	$ -	$ -	45,327	sq. Yd	$ 8.33	$ 377,725
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,069,992	Base Maintenance Cost			$ 2,886,279
						LC Enhancement Cost			$ 1,146,420	LC Enhancement Cost			$ 2,988,826
						Total Landscape Cost			$ 2,216,412	Total Maintenance Cost			$ 5,875,105

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 4,941,900	$ 3,277,426	$ 8,219,326
Contingency Cost (25% of Construction Cost)	$ 1,235,475	$ 819,357	$ 2,054,832
Engineering Design Cost (5% of Construction Cost)	$ 247,095	$ 163,871	$ 410,966
Total Construction Cost	$ 6,424,470	$ 4,260,654	$ 10,685,124

Land Cost

Channel Length	12738	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	427	124.9	$100,000	$ 12,490,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	16.1	$100,000	$ 1,610,000
Levee LC Enhancement	51	14.9	$100,000	$ 1,490,000
Other	0	0	$100,000	$ -
Total	533	155.9		$ 15,590,000

Total Cost

Base Total Cost	$	24,480,741
Total Landscape Enhancement Cost	$	9,885,899
Total Cost Including LC Enh.	$	34,366,641

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	141	$100,000	$ 14,100,000
LC Enhancement Cost	acre	14.9	$100,000	$ 1,490,000
Total Land Cost	acre	155.9	$100,000	$ 15,590,000

Offline Basin

HEC1 ID	DL3R

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.0	sq. mi
Total Sediment Yield Volume	0.0	ac ft

Required Minimum Sediment Volume

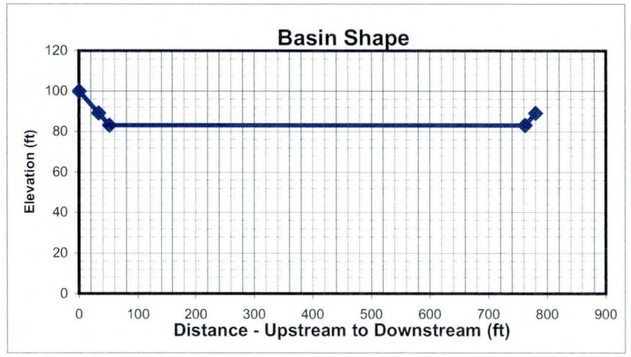
Sediment Volume	0.0	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.014	0.014
Basin Length (ft)	1100	1210
Basin Width (ft)	780	780
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	6	6
Freeboard (ft)	1	1
Effective Basin Width (ft)	747.24	714.48
Top Area (acres)	19.7	21.7
U/S-D/S Height Difference (ft)	10.9	10.9
Excess Area on Upstream (acres)	0.9	1.8

			Base	LC Enhanced
Bottom Length (ft)	1064	Allocated Storage Volume (ac. ft)	90.0	90.2
Bottom Width (ft)	711.24	Total Available Volume (ac. ft) (incl. Freeboard)	108.7	109.8
		Total Excavation Volume (ac. ft)	216.3	228.2

Stage-Storage-Discharge

Stage (ft)	0	1.6	2.5	3.3	4.5	5	5.7	7.5	8.3	9	9.6	
Inflow (cfs)	0	360	720	1080	1440	1585	1820	2520	2880	3240	3600	
Outflow (cfs)	0	0	0	0	0	0	235	935	1295	1655	2015	



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Peak flow before diversion (cfs)	2718	3204	3204
Peak flow after diversion (cfs)	1585	1585	1585
Diverted Peak Flow (cfs)	1133	1619	1619
Total Diverted Flow Volume (ac. ft)	56.0	89	89.0
Peak Stage	2.8	ft	

Volume Check			***Stage Check***	
Total Volume needed	89.0	ac. ft	Depth Needed	3.8
Total Volume Provided	90.0	ac. ft	Depth Provided	6

Volume OK?	Yes	Depth OK?	Yes

Culvert at Sta. 195+10

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
Landscape Enhancement	294800	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	1100	ft
Base Total ROW Width	780	ft
LC Enh. Total ROW Length	1310	ft
LC Enh. Total ROW Length	880	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	348964	368163
Excavated Area (sq. Yd)	95333	128089

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	53	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	594	sq. Yd
Material Volume	297	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	667	ft
Unit Cost	160	per ft
Cost per outlet	$106,720	
Other Cost	$ -	
Total Cost	$106,720	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		348,964	cu. Yd	$ 4.00	$ 1,395,856	95,333	sq. Yd	$ 9.00	$ 857,997	95,333	sq. Yd	$ 8.33	$ 794,442
Basin - LC Enhanced		19,199	cu. Yd	$ 4.00	$ 76,796	32,756	sq. Yd	$ 9.00	$ 294,804	32,756	sq. Yd	$ 8.33	$ 272,967
Inlet	Riprap	297	sq. Yd	$ 75.00	$ 22,275	594	sq. Yd	$ -	$ -	594	sq. Yd	$ 33.33	$ 19,800
Inlet - LC Enhanced (20%Total)					$ 4,455				$ -				$ 3,960
Outlet	Pipe	1	EA	$ 106,720	$ 106,720	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhanced (5%Total)					$ 5,336				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 857,997	Base Maintenance Cost			$ 816,458
						LC Enh. Landscape Cost			$ 294,804	LC Enh. Maintenance Cost			$ 277,038
						Total Landscape Cost			$1,152,801	Total Maintenance Cost			$ 1,093,496

Construction Cost Component	Base	LC Enhanced	Total
Construction Cost	$ 1,524,851	$ 76,796	$ 1,601,647
Contingency Cost (25% of Construction Cost)	$ 381,213	$ 19,199	$ 400,412
Engineering Design Cost (5% of Construction Cost)	$ 76,243	$ 3,840	$ 80,082
Total Construction Cost	$ 1,982,306	$ 99,835	$ 2,082,141

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	6.8	$100,000	$ 676,768
Basin	19.7	$100,000	$ 1,970,000
Other		$100,000	$ -
Total	26.5	$100,000	$ 2,650,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	19.7	$100,000	$ 1,969,697
LC Enhancement Cost	acre	6.8	$100,000	$ 680,303
Total Land Cost	acre	26.5	$100,000	$ 2,650,000

Total Cost

Base Total Cost	$ 5,626,459
Total LC Enhancement Cost	$ 1,351,979
Total Cost Including LC Enh.	$ 6,978,438

Open Channel

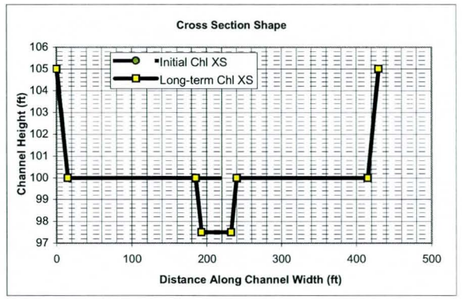
Structure ID	L10	HEC1 ID	L2BL3

Longitundal Geometry

Length	12870.8	ft
U/S Elev	1238.5	ft
D/S Elev	1119.1	ft
Initial Channel Slope	0.0093	ft/ft
Long-term Channel Slope	0.0040	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	6



Initial Channel XS Geometry

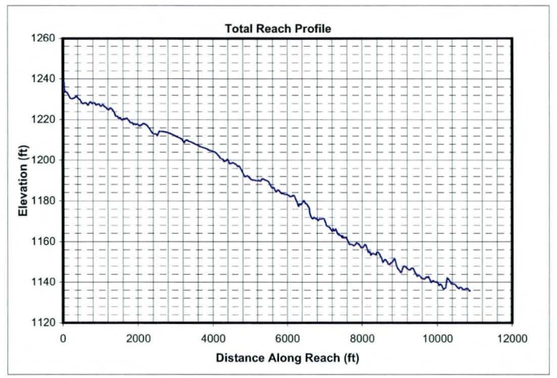
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	400	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	415	415	415	430
Y	105	100	100	100	100	100	100	105

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	170	3	40	7.5	3	175	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	185	192.5	232.5	240	415	430
Y	105	100	100	97.5	97.5	100	100	105



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	L2BL3	L2D-L3	L3						TOTAL
HEC1 Peak-Flow	1585	705	2129						4419
Weighting Factor	1.00	1.00	0.53						
Flow into Channel	1585	705	1122						3412

Reach Sediment Inflow Characteristics

U/S Contributing ID	L2AL2B_L3R10A								TOTAL
Flow Volume (ac. ft)	342.00								342
Sediment Conc. (ppm)	1656								
Sediment Volume (ac. ft)	0.21								0.21
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.21								0.21

Hydrology

Drainage Area	13.962	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	3412	cfs	
Long-term Max. Chnl Capacity	13563	cfs	
Q2 Channel	341	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	430	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
341	402.9	181.9	0.5	100.0	100.5	1.9	0.5	402.7	0.5	0.11	0.49
1024	405.5	352.4	0.9	100.0	100.9	2.9	0.9	405.3	0.9	0.22	0.55
2559	409.6	613.2	1.5	100.0	101.5	4.2	1.5	409.1	1.5	0.38	0.60
3412	411.4	730.1	1.8	100.0	101.8	4.7	1.8	410.8	1.8	0.45	0.62

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
341	54.2	104.9	1.9	97.5	99.7	3.3	2.2	53.5	2.0	0.56	0.41
1024	406.1	453.8	1.1	97.5	100.8	2.3	3.3	405.0	1.1	0.83	0.38
2559	411.3	790.5	1.9	97.5	101.7	3.2	4.2	410.0	1.9	1.04	0.41
3412	413.6	941.6	2.3	97.5	102.0	3.6	4.5	412.2	2.3	1.13	0.42

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)								TOTAL
	L2AL2B_L3R10A								
341	1342								1342
1024	2927								2927
2559	9697								9697
3412	14305								14305

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
341	1.74	1.1504	1.0929	Erosive	Erosive	Erosive	0.2	Stable	6.3	Stable	Stable
1024	1.74	1.3524	1.2848	Erosive	Erosive	Erosive	0.3	Stable	7.0	Stable	Stable
2559	1.74	1.5203	1.4442	Erosive	Erosive	Erosive	0.4	Stable	8.5	Stable	Stable
3412	1.74	1.5728	1.4941	Erosive	Erosive	Erosive	0.4	Stable	9.2	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	341	1024	2559	3412	341	1024	2559	3412	341	1024	2559	3412
Bray - Equation #1	51	92	149	173	1.9	2.7	3.6	4.0	3.6	4.2	4.7	4.9
Bray - Equation #2	68	121	196	228	2.0	2.9	4.0	4.4	2.5	2.9	3.3	3.4
Hey	16	29	49	57	5.9	9.0	12.7	14.2				
Ackers & Charlton/Lacey	42	66	97	110					2.1	2.5	3.0	3.1
Parker	127	220	348	401	1.6	2.5	3.6	4.1				
Chang	85	166	289	343	0.2	-0.1	-0.6	-0.8				
Kellerhals	33	58	91	105	2.8	4.3	6.3	7.0	3.7	4.1	4.5	4.6
AMAFCA/Schumm	54	406	410	413								
Moody & Odem	33	33	33	33	1.4	1.4	1.4	1.4				
BUREC	24.7	37.3	52.5	58.5	7	10	14	16	3.3	4.3	5.5	5.9
Average	53	123	171	192	2.8	4.1	5.6	6.2	3.0	3.6	4.2	4.4
Values As Designed	53	405	410	412	2.2	3.3	4.2	4.5	3.3	2.3	3.2	3.6
Difference with Design	0	-282	-239	-220	0.5	0.7	1.5	1.7	-0.2	1.3	0.9	0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
341	1614	995	1814	2707	5320	356	353	251	5027	426	1727	1872
1024	8828	4319	7405	17447	8721	2275	1662	1883	16515	2020	10061	7376
2559	36220	12965	19897	82277	12495	8467	4619	7489	42367	7770	38081	24786
3412	56373	18052	25725	133775	13901	12633	6224	11217	56730	11902	56858	36672

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
341	1755	1082	1973	2943	5785	387	383	273	5466	463	1877	2035
1024	3200	1566	2684	6324	3161	825	603	682	5986	732	3647	2673
2559	5251	1880	2885	11928	1812	1228	670	1086	6142	1126	5521	3593
3412	6130	1963	2797	14546	1512	1374	677	1220	6168	1294	6182	3987

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
341	1488	666	912	2771	1129	271	200	377	1545	299	1775	1039
1024	2742	1415	2150	4356	5652	447	427	612	4255	571	3159	2344
2559	11233	4868	6905	20502	8557	2042	1524	2839	11572	2228	13368	7785
3412	17474	6988	9451	33308	9646	3122	2142	4385	15637	3440	20536	11466

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
341	1618	724	992	3013	1228	295	218	410	1680	325	1930	1130
1024	994	513	779	1579	2048	162	155	222	1542	207	1145	850
2559	1629	706	1001	2972	1241	296	221	412	1678	323	1938	1129
3412	1900	760	1028	3622	1049	339	233	477	1700	374	2233	1247

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
341	0.0020	0.0027	120	0.37	0.046	0.0006	29	0.035	0.0004	0.0159	0.0006	0.0014	0.0050	0.0003	0.0021	0.0093	0.0040
1024	0.0009	0.0014	167	0.51	0.049	0.0003	30	0.036	0.0002	0.0159	0.0003	0.0007	0.0050	0.0002	0.0009	0.0093	0.0038
2559	0.0004	0.0008	219	0.67	0.051	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0050	0.0001	0.0005	0.0093	0.0037
3412	0.0004	0.0007	239	0.73	0.052	0.0002	31	0.036	0.0001	0.0159	0.0001	0.0003	0.0050	0.0001	0.0004	0.0093	0.0037

Drop Structures

Design Slope	0.0040	ft/ft
Total Drop Needed	67.9	ft
Height of Drop Structure	3	ft
No . of Drop Structures	23	
Distance between structs.	560	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	3.08	sq. mi
Total Sediment Yield Volume	5.86	ac ft

Sedimentation Basins

Length	560 ft	Depth	3 ft
Width	430 ft	Side slope	3 ft/ft
Total Volume per Basin		15.97	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
341	1.1	-0.7	0.1	24.6	2.2	2.0	3.3	0.0040	0.2	1.5	2.5	5.6
1024	1.1	-1.1	0.1	24.6	3.3	1.1	2.3	0.0040	0.3	1.5	2.5	5.7
2559	1.1	-1.2	0.1	24.6	4.2	1.9	3.2	0.0040	0.5	1.5	2.5	5.9
3412	1.1	-1.3	0.2	24.6	4.5	2.3	3.6	0.0040	0.5	1.5	2.5	6.0

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	1585	cfs
Stage at Peak Flow	101.1	ft
Volume at Peak Flow	471.0	ac. ft

Freeboard

Max. Flow Depth	1.8	ft
Channel Depth as designed	5.0	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	6.07	ac. ft
Outflowing Sediment Volume	0.22	ac. ft
Deposited(+)/Eroded(-) Volume	5.85	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	12871	12871
Side Slope (?H:1V)	3	3
Channel Width (ft)	430	430
Channel XS Area (sq. ft)	2193.8	2193.8
Channel Perimeter (ft)	432	432

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	12871	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	4290	sq. Yd
Volume	12871	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	12871	12871
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	5	6
Left Levee Surface Area (sq. Yd)	65785	133000
Left Levee Volume (cu. Yd)	69122	160172
Right Levee Length (ft)	12871	12871
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5	6
Right Levee Surface Area (sq. Yd)	65785	133000
Right Levee Volume (cu. Yd)	69122	160172
Total Levee Surface Area (sq. Yd)	131570	266000
Total Levee Volume (cu. Yd)	138244	320344

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	12871	12871
Left Levee Lining Width (ft)	16	36
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	22882	51484
Left Levee Lining Volume (cu. Yd)	11441	25742
Right Levee Length (ft)	12871	12871
Right Levee Lining Width (ft)	16	36
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	22882	51484
Right Levee Lining Volume (cu. Yd)	11441	25742
Total Lining Area (sq. Yd)	45764	102968
Total Lining Volume (cu. Yd)	22882	51484

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	430	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	7.9	ft	
Structure Height	10.9	ft	
Number of Structures	23		
Volume per structure	519	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 38,925		
Area per structure	143	sq. Yd	
Total Area	3,297	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	25765	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 103,060	
Other Cost	$ -	
Total cost per basin	$ 103,060	
Area per basin	26,736	sq. Yd
Total Area	53,472	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	138,244	cu. Yd	$ 7.00	$ 967,708	131,570	sq. Yd	$ 9.00	$ 1,184,130	131,570	sq. Yd	$ 11.67	$ 1,534,983
Levee - LC Enhancement	Fill	182,100	cu. Yd	$ 7.00	$ 1,274,700	134,430	sq. Yd	$ 9.00	$ 1,209,870	182,100	sq. Yd	$ 11.67	$ 2,124,500
Levee Lining	Riprap	22,882	cu. Yd	$ 75.00	$ 1,716,150	45,764	sq. Yd	$ -	$ -	45,764	sq. Yd	$ 20.83	$ 953,407
Levee Lining -LC Enhancement	Riprap	28,602	cu. Yd	$ 75.00	$ 2,145,150	57,204	sq. Yd	$ -	$ -	57,204	sq. Yd	$ 20.83	$ 1,191,759
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	12,871	cu. Yd	$ 75.00	$ 965,325	4,290	sq. Yd	$ -	$ -	4,290	sq. Yd	$ 25.00	$ 107,250
Drop Structures	Riprap	23	EA	$ 38,925.00	$ 895,275	3,297	sq. Yd	$ -	$ -	3,297	sq. Yd	$ 33.33	$ 109,900
Drop Str. - LC Enhancement	Riprap	23	EA	$ 3,892.50	$ 89,528	330	sq. Yd	$ -	$ -	330	sq. Yd	$ 33.33	$ 10,990
Sedimentation Basins		2	EA	$ 103,060.00	$ 206,120	53,472	sq. Yd	$ -	$ -	53,472	sq. Yd	$ 8.33	$ 445,600
Other					$ -				$ -				$ -

Base Landscape Cost	$ 1,184,130	Base Maintenance Cost	$ 3,151,141
LC Enhancement Cost	$ 1,209,870	LC Enhancement Cost	$ 3,327,249
Total Landscape Cost	$ 2,394,000	Total Maintenance Cost	$ 6,478,390

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 4,750,578	$ 3,509,378	$ 8,259,956
Contingency Cost (25% of Construction Cost)	$ 1,187,645	$ 877,344	$ 2,064,989
Engineering Design Cost (5% of Construction Cost)	$ 237,529	$ 175,469	$ 412,998
Total Construction Cost	$ 6,175,751	$ 4,562,191	$ 10,737,942

Land Cost

Channel Length	12871 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	430	127.1	$100,000	$ 12,710,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	58	17.1	$100,000	$ 1,710,000
Levee LC Enhancement	54	16	$100,000	$ 1,600,000
Other	0	0	$100,000	$ -
Total	542	160.2		$ 16,020,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	144.2	$100,000	$ 14,420,000
LC Enhancement Cost	acre	16	$100,000	$ 1,600,000
Total Land Cost	acre	160.2	$100,000	$ 16,020,000

Total Cost

Base Total Cost	$ 24,931,022
Total Landscape Enhancement Cost	$ 10,699,310
Total Cost Including LC Enh.	$ 35,630,332

Open Channel

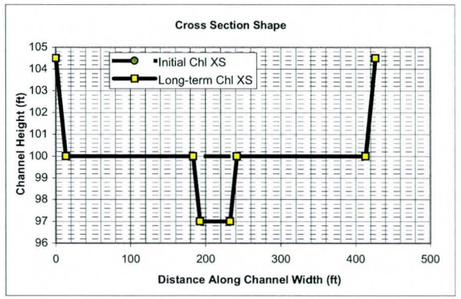
Structure ID	M2-A-20	HEC1 ID	M1-M2

Longitundal Geometry

Length	22366.9	ft
U/S Elev	1344.3	ft
D/S Elev	1083.2	ft
Initial Channel Slope	0.0117	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	16



Initial Channel XS Geometry

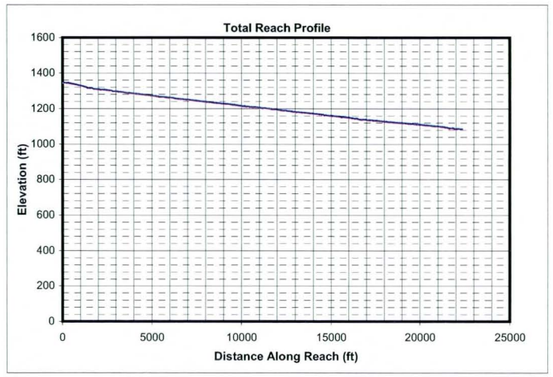
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	400	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	413.5	413.5	413.5	427
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	170	3	40	7.5	3	172	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	183.5	192.5	232.5	241.5	413.5	427
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	M									TOTAL
HEC1 Peak-Flow	3930									3930
Weighting Factor	1.00									
Flow into Channel	3930									3930

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	13.12	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	3930	cfs	
Long-term Max. Chnl Capacity	13143	cfs	
Q2 Channel	393	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	427	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
393	402.9	184.8	0.5	100.0	100.5	2.1	0.5	402.8	0.5	0.14	0.55
1179	405.6	358.1	0.9	100.0	100.9	3.3	0.9	405.3	0.9	0.28	0.62
2948	409.7	623.1	1.5	100.0	101.5	4.7	1.5	409.2	1.5	0.48	0.68
3930	411.6	741.7	1.8	100.0	101.8	5.3	1.8	411.0	1.8	0.57	0.70

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
393	54.4	107.0	2.0	97.0	99.3	3.7	2.3	53.7	2.0	0.71	0.46
1179	405.9	462.0	1.1	97.0	100.8	2.6	3.8	404.7	1.1	1.18	0.42
2948	411.2	804.7	2.0	97.0	101.6	3.7	4.6	409.7	2.0	1.44	0.46
3930	413.6	958.4	2.3	97.0	102.0	4.1	5.0	412.0	2.3	1.56	0.47

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
	M2-A-10									
393	1076									1076
1179	4488									4488
2948	15369									15369
3930	22789									22789

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
393	1.74	1.1552	1.0975	Erosive	Erosive	Erosive	0.2	Stable	7.1	Stable	Stable
1179	1.74	1.3572	1.2894	Erosive	Erosive	Erosive	0.3	Stable	8.3	Stable	Stable
2948	1.74	1.5251	1.4488	Erosive	Erosive	Erosive	0.4	Stable	10.1	Stable	Stable
3930	1.74	1.5775	1.4986	Erosive	Erosive	Erosive	0.4	Stable	10.8	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	393	1179	2948	3930	393	1179	2948	3930	393	1179	2948	3930
Bray - Equation #1	55	99	160	187	1.9	2.8	3.8	4.2	3.6	4.3	4.8	5.0
Bray - Equation #2	73	130	211	245	2.1	3.1	4.2	4.6	2.5	2.9	3.3	3.5
Hey	17	32	53	62	6.2	9.5	13.4	15.0				
Ackers & Charlton/Lacey	44	70	103	116					2.2	2.6	3.0	3.2
Parker	136	236	373	431	1.7	2.6	3.8	4.3				
Chang	99	194	337	400	0.0	-0.3	-1.0	-1.3				
Kellerhals	36	62	98	113	3.0	4.6	6.6	7.4	3.7	4.1	4.5	4.7
AMAFCA/Schumm	54	405	410	413								
Moody & Odem	32	32	32	32	1.4	1.4	1.4	1.4				
BUREC	25.0	37.7	53.1	59.2	7	10	14	16	3.7	4.9	6.1	6.6
Average	57	130	183	206	2.9	4.2	5.8	6.4	3.2	3.8	4.4	4.6
Values As Designed	54	405	410	412	2.3	3.8	4.6	5.0	3.7	2.6	3.7	4.1
Difference with Design	3	-275	-227	-206	0.6	0.4	1.2	1.4	-0.5	1.2	0.7	0.5

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
393	2764	1659	3227	5031	6460	764	674	488	8599	733	3068	3042
1179	15110	6689	11684	32425	10266	4146	2672	3137	27288	3482	16580	12134
2948	61996	19438	28712	152898	14479	15003	7055	11799	69342	13311	60341	41307
3930	96527	26874	37606	248599	16051	22329	9419	17474	92706	20333	89187	61555

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
393	2609	1566	3047	4749	6098	721	637	460	8117	692	2896	2872
1179	4755	2105	3677	10203	3230	1305	841	987	8587	1096	5217	3818
2948	7803	2447	3614	19245	1822	1888	888	1485	8728	1675	7595	5199
3930	9112	2537	3550	23468	1515	2108	889	1650	8752	1919	8419	5811

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
393	2516	1021	1419	5076	1330	489	321	603	2533	517	2912	1703
1179	4647	2279	3754	8008	6808	913	784	1065	7209	984	5461	3810
2948	19041	7431	10741	37686	10053	3696	2443	4554	18990	3862	21982	12771
3930	29636	10554	14875	61223	11267	5572	3363	6926	25536	5364	33367	18880

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
393	2376	964	1340	4791	1255	462	303	569	2392	488	2749	1608
1179	1462	717	1181	2520	2142	287	247	335	2268	310	1719	1199
2948	2397	935	1352	4744	1265	465	308	573	2390	486	2767	1607
3930	2798	996	1404	5780	1064	526	317	654	2411	506	3150	1782

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
393	0.0018	0.0026	136	0.42	0.047	0.0006	30	0.036	0.0004	0.0159	0.0006	0.0013	0.0048	0.0002	0.0019	0.0117	0.0045
1179	0.0008	0.0014	189	0.58	0.050	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0007	0.0048	0.0002	0.0008	0.0117	0.0043
2948	0.0004	0.0008	248	0.76	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0048	0.0001	0.0004	0.0117	0.0042
3930	0.0003	0.0007	270	0.82	0.053	0.0002	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0048	0.0001	0.0003	0.0117	0.0042

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	149.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	50	
Distance between structs.	447	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	7.44	sq. mi
Total Sediment Yield Volume	14.14	ac ft

Sedimentation Basins

Length	447 ft	Depth	3 ft
Width	427 ft	Side slope	3 ft/ft
Total Volume per Basin		12.62	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		4	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
393	1.1	-0.6	0.2	24.6	2.3	2.0	3.7	0.0050	0.3	1.5	3.0	6.3
1179	1.1	-1.2	0.1	24.6	3.8	1.1	2.6	0.0050	0.4	1.5	3.0	6.4
2948	1.1	-1.3	0.2	24.6	4.6	2.0	3.7	0.0050	0.5	1.5	3.0	6.6
3930	1.1	-1.3	0.2	24.6	5.0	2.3	4.1	0.0050	0.6	1.5	3.0	6.7

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	2537	cfs
Stage at Peak Flow	101.4	ft
Volume at Peak Flow	469.0	ac. ft

Freeboard

Max. Flow Depth	1.8	ft
Channel Depth as designed	4.5	ft
Available Freeboard	2.7	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	14.14	ac. ft
Outflowing Sediment Volume	0.32	ac. ft
Deposited(+)/Eroded(-) Volume	13.82	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	22367	22367
Side Slope (?H:1V)	3	3
Channel Width (ft)	427	427
Channel XS Area (sq. ft)	2007.8	2007.8
Channel Perimeter (ft)	429	429

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	22367	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	7456	sq. Yd
Volume	24852	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	22367	22367
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	104379	216214
Left Levee Volume (cu. Yd)	102723	241895
Right Levee Length (ft)	22367	22367
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	104379	216214
Right Levee Volume (cu. Yd)	102723	241895
Total Levee Surface Area (sq. Yd)	208758	432428
Total Levee Volume (cu. Yd)	205446	483790

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	22367	22367
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	34793	82012
Left Levee Lining Volume (cu. Yd)	17397	41006
Right Levee Length (ft)	22367	22367
Left Levee Lining Volume (cu. Yd)	17397	41006
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	34793	82012
Right Levee Lining Volume (cu. Yd)	17397	41006
Total Lining Area (sq. Yd)	69586	164025
Total Lining Volume (cu. Yd)	34794	82012

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	427	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	8.5	ft
Structure Height	11.5	ft
Number of Structures	50	
Volume per structure	547	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 41,025	
Area per structure	142	sq. Yd
Total Area	7,117	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	4	
Total Volume per Basin	20360	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 81,440	
Other Cost	$ -	
Total cost per basin	$ 81,440	
Area per basin	21,224	sq. Yd
Total Area	84,896	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction					Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	205,446	cu. Yd	$ 7.00	$ 1,438,122	208,758	sq. Yd	$ 9.00	$ 1,878,822	208,758	sq. Yd	$ 11.67	$ 2,435,510
Levee - LC Enhancement	Fill	278,344	cu. Yd	$ 7.00	$ 1,948,408	223,670	sq. Yd	$ 9.00	$ 2,013,030	278,344	sq. Yd	$ 11.67	$ 3,247,347
Levee Lining	Riprap	34,794	cu. Yd	$ 75.00	$ 2,609,550	69,586	sq. Yd	$ -	$ -	69,586	sq. Yd	$ 20.83	$ 1,449,713
Levee Lining -LC Enhancement	Riprap	47,218	cu. Yd	$ 75.00	$ 3,541,350	94,438	sq. Yd	$ -	$ -	94,438	sq. Yd	$ 20.83	$ 1,967,468
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	24,852	cu. Yd	$ 75.00	$ 1,863,900	7,456	sq. Yd	$ -	$ -	7,456	sq. Yd	$ 25.00	$ 186,400
Drop Structures	Riprap	50	EA	$ 41,025.00	$ 2,051,250	7,117	sq. Yd	$ -	$ -	7,117	sq. Yd	$ 33.33	$ 237,233
Drop Str. - LC Enhancement	Riprap	50	EA	$ 4,102.50	$ 205,125	712	sq. Yd	$ -	$ -	712	sq. Yd	$ 33.33	$ 23,723
Sedimentation Basins		4	EA	$ 81,440.00	$ 325,760	84,896	sq. Yd	$ -	$ -	84,896	sq. Yd	$ 8.33	$ 707,467
Other					$ -				$ -				$ -

Base Landscape Cost	$ 1,878,822	Base Maintenance Cost	$ 5,016,323
LC Enhancement Cost	$ 2,013,030	LC Enhancement Cost	$ 5,238,538
Total Landscape Cost	$ 3,891,852	Total Maintenance Cost	$ 10,254,861

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 8,288,582	$ 5,694,883	$ 13,983,465
Contingency Cost (25% of Construction Cost)	$ 2,072,146	$ 1,423,721	$ 3,495,866
Engineering Design Cost (5% of Construction Cost)	$ 414,429	$ 284,744	$ 699,173
Total Construction Cost	$ 10,775,157	$ 7,403,348	$ 18,178,505

Land Cost

Channel Length	22367 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	427	219.3	$100,000	$ 21,930,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	28.2	$100,000	$ 2,820,000
Levee LC Enhancement	51	26.2	$100,000	$ 2,620,000
Other	0	0	$100,000	$ -
Total	533	273.7		$ 27,370,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	247.5	$100,000	$ 24,750,000
LC Enhancement Cost	acre	26.2	$100,000	$ 2,620,000
Total Land Cost	acre	273.7	$100,000	$ 27,370,000

Total Cost

Base Total Cost	$ 42,420,302
Total Landscape Enhancement Cost	$ 17,274,915
Total Cost Including LC Enh.	$ 59,695,217

Open Channel

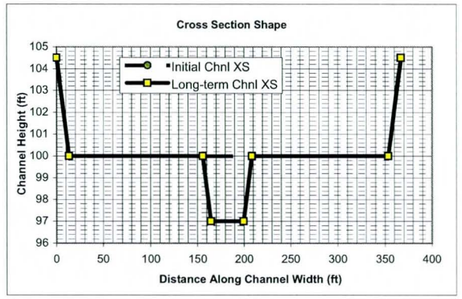
Structure ID	N120	HEC1 ID	N1-P1A

Longitudal Geometry

Length	3160.5	ft
U/S Elev	1318.6	ft
D/S Elev	1276.4	ft
Initial Channel Slope	0.0133	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	2



Initial Channel XS Geometry

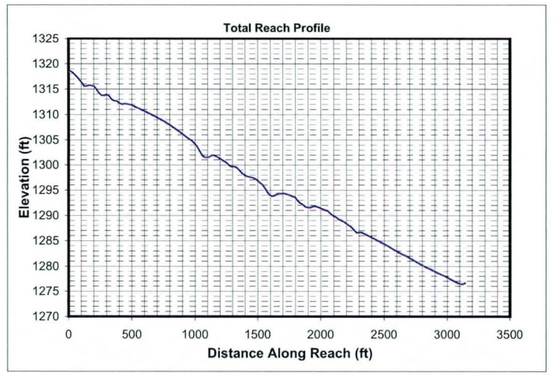
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	340	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	353.5	353.5	353.5	367
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	142	3	35	7.5	3	145	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	155.5	164.5	199.5	208.5	353.5	367
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	CN2A									TOTAL
HEC1 Peak-Flow	1883									1883
Weighting Factor	1.00									
Flow into Channel	1883									1883

Reach Sediment Inflow Characteristics

U/S Contributing ID	N1-P1A_N125A									TOTAL
Flow Volume (ac. ft)	105.00									105
Sediment Conc. (ppm)	1024									
Sediment Volume (ac. ft)	0.04									0.04
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.04									0.04

Hydrology

Drainage Area	4.428	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	1883	cfs	
Long-term Max. Chnl Capacity	11258	cfs	
Q2 Channel	188	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	367	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
188	342.0	106.9	0.3	100.0	100.3	1.8	0.3	341.9	0.3	0.10	0.55
565	343.8	207.0	0.6	100.0	100.6	2.7	0.6	343.6	0.6	0.19	0.62
1412	346.6	359.9	1.0	100.0	101.0	3.9	1.0	346.3	1.0	0.33	0.68
1883	347.9	428.4	1.2	100.0	101.2	4.4	1.2	347.5	1.2	0.39	0.70

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
188	45.1	63.8	1.4	97.0	98.6	2.9	1.6	44.6	1.4	0.50	0.43
565	343.7	277.9	0.8	97.0	100.4	2.0	3.4	342.6	0.8	1.07	0.40
1412	347.5	483.8	1.4	97.0	101.0	2.9	4.0	346.2	1.4	1.26	0.44
1883	349.1	576.0	1.6	97.0	101.3	3.3	4.3	347.7	1.7	1.34	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
	N1-P1A_N125A									
188	176									176
565	723									723
1412	2374									2374
1883	3458									3458

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
188	1.74	1.0371	0.9852	Erosive	Erosive	Erosive	0.2	Stable	5.6	Stable	Stable
565	1.74	1.2392	1.1772	Erosive	Erosive	Erosive	0.3	Stable	7.5	Stable	Stable
1412	1.74	1.4074	1.3370	Erosive	Erosive	Erosive	0.3	Stable	8.9	Stable	Stable
1883	1.74	1.4600	1.3870	Erosive	Erosive	Erosive	0.3	Stable	9.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	188	565	1412	1883	188	565	1412	1883	188	565	1412	1883
Bray - Equation #1	38	67	109	127	1.5	2.2	3.0	3.3	3.3	3.8	4.4	4.5
Bray - Equation #2	49	88	143	166	1.7	2.4	3.3	3.6	2.3	2.6	3.0	3.1
Hey	11	21	35	41	4.7	7.2	10.1	11.3				
Ackers & Charlton/Lacey	32	52	76	85					1.9	2.3	2.7	2.8
Parker	94	163	258	298	1.2	1.9	2.8	3.2				
Chang	63	124	216	257	0.1	-0.1	-0.4	-0.6				
Kellerhals	25	43	68	78	2.2	3.4	4.9	5.5	3.4	3.8	4.2	4.3
AMAFCA/Schumm	45	343	347	348								
Moody & Odem	22	22	22	22	1.2	1.2	1.2	1.2				
BUREC	18.9	28.6	40.3	44.9	5	8	11	12	3.1	4.1	5.1	5.5
Average	40	95	131	147	2.2	3.2	4.5	4.9	2.8	3.3	3.9	4.1
Values As Designed	45	343	346	348	1.6	3.4	4.0	4.3	2.9	2.0	2.9	3.3
Difference with Design	-5	-247	-215	-201	0.6	-0.2	0.4	0.6	-0.1	1.3	1.0	0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
188	1165	760	1520	2015	4504	299	296	159	4827	355	1202	1555
565	6385	3294	6241	13003	7380	1918	1403	1278	15776	1584	7128	5944
1412	26214	9867	16768	61390	10565	7143	3900	5198	40415	5908	26982	19486
1883	40819	13731	21670	99868	11748	10661	5257	7818	54104	8985	40246	28628

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
188	2295	1498	2996	3971	8874	589	584	312	9510	700	2368	3063
565	4193	2163	4099	8539	4847	1259	922	839	10361	1041	4681	3904
1412	6886	2592	4405	16127	2775	1876	1025	1365	10617	1552	7088	5119
1883	8042	2705	4269	19677	2315	2100	1036	1540	10660	1770	7930	5640

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
188	895	429	649	1655	884	179	139	215	1183	188	1061	680
565	1631	858	1389	2576	4406	269	271	314	3215	363	1811	1555
1412	6685	3054	4899	12140	6744	1339	1047	1598	8858	1388	7905	5060
1883	10405	4417	6636	19733	7620	2066	1489	2510	11993	2133	12215	7383

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
188	1764	844	1279	3261	1741	354	273	423	2332	370	2089	1339
565	1071	564	912	1692	2894	177	178	206	2111	239	1189	1021
1412	1756	802	1287	3189	1772	352	275	420	2327	365	2077	1329
1883	2050	870	1307	3888	1501	407	293	495	2363	420	2407	1455

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
188	0.0027	0.0039	120	0.37	0.046	0.0008	29	0.035	0.0006	0.0159	0.0008	0.0020	0.0061	0.0004	0.0029	0.0133	0.0054
565	0.0012	0.0020	167	0.51	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0010	0.0061	0.0002	0.0013	0.0134	0.0052
1412	0.0006	0.0012	219	0.67	0.051	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0006	0.0061	0.0001	0.0006	0.0133	0.0050
1883	0.0005	0.0010	239	0.73	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0061	0.0001	0.0005	0.0133	0.0050

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	26.4	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	351	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.40	sq. mi
Total Sediment Yield Volume	2.66	ac ft

Sedimentation Basins

Length	351 ft	Depth	3 ft	
Width	367 ft	Side slope	3 ft/ft	
Total Volume per Basin		8.44	ac. ft.	
Basin Trap Efficiency		0.6		
No. of Basins		2		

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
188	1.1	-0.5	0.1	24.6	1.6	1.4	2.9	0.0050	0.2	1.5	3.0	6.1
565	1.1	-1.2	0.1	24.6	3.4	0.8	2.0	0.0050	0.3	1.5	3.0	6.3
1412	1.1	-1.2	0.1	24.6	4.0	1.4	2.9	0.0050	0.4	1.5	3.0	6.5
1883	1.1	-1.3	0.1	24.6	4.3	1.7	3.3	0.0050	0.5	1.5	3.0	6.6

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	1049	cfs
Stage at Peak Flow	100.9	ft
Volume at Peak Flow	105.0	ac. ft

Freeboard

Max. Flow Depth	1.2	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	2.70	ac. ft
Outflowing Sediment Volume	0.06	ac. ft
Deposited(+)/Eroded(-) Volume	2.64	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3160	3160
Side Slope (?H:1V)	3	3
Channel Width (ft)	367	367
Channel XS Area (sq. ft)	1722.8	1722.8
Channel Perimeter (ft)	369	369

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3160	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	1053	sq. Yd
Volume	3511	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3160	3160
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	14747	30547
Left Levee Volume (cu. Yd)	14513	34175
Right Levee Length (ft)	3160	3160
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	14747	30547
Right Levee Volume (cu. Yd)	14513	34175
Total Levee Surface Area (sq. Yd)	29494	61094
Total Levee Volume (cu. Yd)	29026	68350

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3160	3160
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	4916	11587
Left Levee Lining Volume (cu. Yd)	2458	5793
Right Levee Length (ft)	3160	3160
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	4916	11587
Right Levee Lining Volume (cu. Yd)	2458	5793
Total Lining Area (sq. Yd)	9831	23173
Total Lining Volume (cu. Yd)	4916	11586

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	367	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.2	ft
Structure Height	9.2	ft
Number of Structures	9	
Volume per structure	374	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 28,050	
Area per structure	122	sq. Yd
Total Area	1,101	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	13617	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 54,468	
Other Cost	$ -	
Total cost per basin	$ 54,468	
Area per basin	14,320	sq. Yd
Total Area	28,640	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	29,026	cu. Yd	$ 7.00	$ 203,182	29,494	sq. Yd	$ 9.00	$ 265,446	29,494	sq. Yd	$ 11.67	$ 344,097
Levee - LC Enhancement	Fill	39,324	cu. Yd	$ 7.00	$ 275,268	31,600	sq. Yd	$ 9.00	$ 284,400	39,324	sq. Yd	$ 11.67	$ 458,780
Levee Lining	Riprap	4,916	cu. Yd	$ 75.00	$ 368,700	9,831	sq. Yd	$ -	$ -	9,831	sq. Yd	$ 20.83	$ 204,815
Levee Lining -LC Enhancement	Riprap	6,670	cu. Yd	$ 75.00	$ 500,250	13,342	sq. Yd	$ -	$ -	13,342	sq. Yd	$ 20.83	$ 277,963
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	3,511	cu. Yd	$ 75.00	$ 263,325	1,053	sq. Yd	$ -	$ -	1,053	sq. Yd	$ 25.00	$ 26,325
Drop Structures	Riprap	9	EA	$ 28,050.00	$ 252,450	1,101	sq. Yd	$ -	$ -	1,101	sq. Yd	$ 33.33	$ 36,700
Drop Str. - LC Enhancement	Riprap	9	EA	$ 2,805.00	$ 25,245	110	sq. Yd	$ -	$ -	110	sq. Yd	$ 33.33	$ 3,670
Sedimentation Basins		2	EA	$ 54,468.00	$ 108,936	28,640	sq. Yd	$ -	$ -	28,640	sq. Yd	$ 8.33	$ 238,667
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 265,446	Base Maintenance Cost			$ 850,603
						LC Enhancement Cost			$ 284,400	LC Enhancement Cost			$ 740,413
						Total Landscape Cost			$ 549,846	Total Maintenance Cost			$ 1,591,016

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,196,593	$ 800,763	$ 1,997,356
Contingency Cost (25% of Construction Cost)	$ 299,148	$ 200,191	$ 499,339
Engineering Design Cost (5% of Construction Cost)	$ 59,830	$ 40,038	$ 99,868
Total Construction Cost	$ 1,555,571	$ 1,040,992	$ 2,596,563

Land Cost

Channel Length	3160 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	367	26.6	$100,000	$ 2,660,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	4	$100,000	$ 400,000
Levee LC Enhancement	51	3.7	$100,000	$ 370,000
Other	0	0	$100,000	$ -
Total	473	34.3		$ 3,430,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	30.6	$100,000	$ 3,060,000
LC Enhancement Cost	acre	3.7	$100,000	$ 370,000
Total Land Cost	acre	34.3	$100,000	$ 3,430,000

Total Cost

Base Total Cost	$	5,731,620
Total Landscape Enhancement Cost	$	2,435,805
Total Cost Including LC Enh.	$	8,167,425

Open Channel

Structure ID	N130

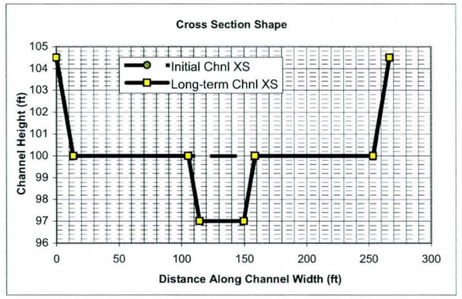
HEC1 ID	P1A-1B

Longitundal Geometry

Length	10853.3	ft
U/S Elev	1276.4	ft
D/S Elev	1133.0	ft
Initial Channel Slope	0.0132	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	11



Initial Channel XS Geometry

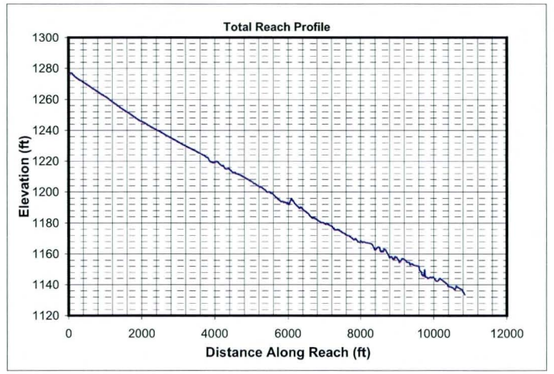
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	240	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	253.5	253.5	253.5	267
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	92	3	35	7.5	3	95	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	105.5	114.5	149.5	158.5	253.5	267
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	P1A-1B	P1B							TOTAL
HEC1 Peak-Flow	1727	852							2579
Weighting Factor	1.00	0.64							
Flow into Channel	1727	543							2270

Reach Sediment Inflow Characteristics

U/S Contributing ID	N1-P1A_N120								TOTAL
Flow Volume (ac. ft)	105.00								105
Sediment Conc. (ppm)	1455								
Sediment Volume (ac. ft)	0.06								0.06
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.06								0.06

Hydrology

Drainage Area	4.428	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	2270	cfs	
Long-term Max. Chnl Capacity	8389	cfs	
Q2 Channel	227	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	267	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
227	242.7	104.6	0.4	100.0	100.4	2.2	0.4	242.6	0.4	0.14	0.58
681	245.3	202.9	0.8	100.0	100.8	3.4	0.8	245.0	0.8	0.26	0.65
1703	249.2	353.9	1.4	100.0	101.4	4.8	1.4	248.7	1.4	0.45	0.71
2270	250.9	421.8	1.7	100.0	101.7	5.4	1.7	250.3	1.7	0.54	0.73

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
227	46.3	72.1	1.6	97.0	98.8	3.1	1.8	45.7	1.6	0.56	0.44
681	244.6	271.4	1.1	97.0	100.6	2.5	3.6	243.5	1.1	1.12	0.42
1703	249.8	474.3	1.9	97.0	101.4	3.6	4.4	248.4	1.9	1.37	0.46
2270	252.2	565.8	2.2	97.0	101.8	4.0	4.8	250.6	2.3	1.49	0.47

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)								TOTAL
	N1-P1A_N120								
227	680								680
681	1555								1555
1703	5060								5060
2270	7383								7383

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
227	1.74	1.1360	1.0792	Erosive	Erosive	Erosive	0.2	Stable	6.0	Stable	Stable
681	1.74	1.3374	1.2705	Erosive	Erosive	Erosive	0.3	Stable	8.1	Stable	Stable
1703	1.74	1.5043	1.4290	Erosive	Erosive	Erosive	0.4	Stable	9.8	Stable	Stable
2270	1.74	1.5563	1.4785	Erosive	Erosive	Erosive	0.4	Stable	10.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	227	681	1703	2270	227	681	1703	2270	227	681	1703	2270
Bray - Equation #1	42	74	120	140	1.6	2.3	3.2	3.5	3.4	3.9	4.5	4.7
Bray - Equation #2	54	97	158	184	1.8	2.6	3.5	3.8	2.3	2.7	3.1	3.2
Hey	12	23	39	46	5.1	7.7	10.9	12.1				
Ackers & Charlton/Lacey	35	56	82	92					2.0	2.4	2.8	2.9
Parker	104	179	283	327	1.3	2.1	3.0	3.4				
Chang	71	139	242	288	0.1	-0.1	-0.6	-0.8				
Kellerhals	27	47	74	86	2.4	3.7	5.3	6.0	3.5	3.9	4.3	4.4
AMAFCA/Schumm	46	244	249	251								
Moody & Odem	22	22	22	22	1.2	1.2	1.2	1.2				
BUREC	20.3	30.7	43.2	48.2	5	8	12	13	3.2	4.3	5.4	5.8
Average	43	91	131	148	2.4	3.5	4.8	5.3	2.9	3.4	4.0	4.2
Values As Designed	46	243	248	251	1.8	3.6	4.4	4.8	3.1	2.5	3.6	4.0
Difference with Design	-2	-152	-117	-102	0.6	-0.1	0.4	0.5	-0.3	0.9	0.4	0.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
227	1852	1109	2241	3463	4076	547	470	329	6044	502	2055	2063
681	10105	4396	7895	22265	6448	2889	1803	2060	19047	2360	10910	8198
1703	41317	12668	19003	104595	9096	10382	4711	7654	48308	8935	39237	27810
2270	64223	17475	24969	169780	10092	15430	6276	11301	64565	13604	57786	41409

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
227	3027	1813	3663	5660	6662	895	768	538	9878	821	3358	3371
681	5505	2395	4301	12130	3513	1574	982	1122	10377	1286	5944	4466
1703	9004	2761	4141	22793	1982	2262	1027	1668	10527	1947	8550	6060
2270	10496	2856	4081	27748	1649	2522	1026	1847	10552	2223	9444	6768

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
227	1178	539	788	2235	969	235	174	285	1440	245	1391	862
681	2617	1297	2129	4494	4023	511	444	596	4148	557	3071	2171
1703	10669	4239	6153	21034	5983	2082	1397	2560	10950	2174	12370	7237
2270	16558	6019	8503	34087	6725	3136	1924	3894	14729	3234	18766	10689

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
227	1925	881	1288	3653	1584	385	284	465	2353	401	2273	1408
681	1426	706	1160	2448	2192	279	242	324	2260	304	1673	1183
1703	2325	924	1341	4584	1304	454	304	558	2386	474	2696	1577
2270	2706	984	1390	5571	1099	513	314	636	2407	529	3067	1747

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
227	0.0018	0.0028	141	0.43	0.047	0.0006	30	0.036	0.0004	0.0159	0.0006	0.0014	0.0057	0.0003	0.0020	0.0132	0.0052
681	0.0008	0.0015	195	0.59	0.050	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0007	0.0057	0.0002	0.0009	0.0132	0.0050
1703	0.0004	0.0009	255	0.78	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0057	0.0001	0.0004	0.0132	0.0049
2270	0.0003	0.0007	278	0.85	0.054	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0003	0.0057	0.0001	0.0004	0.0132	0.0048

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	89.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	30	
Distance between structs.	362	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	3.62	sq. mi
Total Sediment Yield Volume	6.88	ac ft

Sedimentation Basins

Length	362 ft	Depth	3 ft
Width	267 ft	Side slope	3 ft/ft
Total Volume per Basin		6.27	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		4	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
227	1.1	-0.5	0.1	24.6	1.8	1.6	3.1	0.0050	0.2	1.5	3.0	6.2
681	1.1	-1.2	0.1	24.6	3.6	1.1	2.5	0.0050	0.4	1.5	3.0	6.4
1703	1.1	-1.2	0.2	24.6	4.4	1.9	3.6	0.0050	0.5	1.5	3.0	6.6
2270	1.1	-1.3	0.2	24.6	4.8	2.3	4.0	0.0050	0.5	1.5	3.0	6.7

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	1727	cfs
Stage at Peak Flow	101.5	ft
Volume at Peak Flow	245.0	ac. ft

Freeboard

Max. Flow Depth	1.7	ft
Channel Depth as designed	4.5	ft
Available Freeboard	2.8	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	6.94	ac. ft
Outflowing Sediment Volume	0.16	ac. ft
Deposited(+)/Eroded(-) Volume	6.78	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	10853	10853
Side Slope (?H:1V)	3	3
Channel Width (ft)	267	267
Channel XS Area (sq. ft)	1272.8	1272.8
Channel Perimeter (ft)	269	269

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	10853	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	3618	sq. Yd
Volume	12059	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	10853	10853
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	50647	104912
Left Levee Volume (cu. Yd)	49843	117373
Right Levee Length (ft)	10853	10853
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	50647	104912
Right Levee Volume (cu. Yd)	49843	117373
Total Levee Surface Area (sq. Yd)	101294	209824
Total Levee Volume (cu. Yd)	99686	234746

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	10853	10853
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	16882	39794
Left Levee Lining Volume (cu. Yd)	8441	19897
Right Levee Length (ft)	10853	10853
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	16882	39794
Right Levee Lining Volume (cu. Yd)	8441	19897
Total Lining Area (sq. Yd)	33765	79589
Total Lining Volume (cu. Yd)	16882	39794

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	267	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	8.3	ft	
Structure Height	11.3	ft	
Number of Structures	30		
Volume per structure	335	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 25,125		
Area per structure	89	sq. Yd	
Total Area	2,670	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	4	
Total Volume per Basin	10116	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 40,464	
Other Cost	$ -	
Total cost per basin	$ 40,464	
Area per basin	10,733	sq. Yd
Total Area	42,932	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	99,686	cu. Yd	$ 7.00	$ 697,802	101,294	sq. Yd	$ 9.00	$ 911,646	101,294	sq. Yd	$ 11.67	$ 1,181,763
Levee - LC Enhancement	Fill	135,060	cu. Yd	$ 7.00	$ 945,420	108,530	sq. Yd	$ 9.00	$ 976,770	135,060	sq. Yd	$ 11.67	$ 1,575,700
Levee Lining	Riprap	16,882	cu. Yd	$ 75.00	$ 1,266,150	33,765	sq. Yd	$ -	$ -	33,765	sq. Yd	$ 20.83	$ 703,435
Levee Lining -LC Enhancement	Riprap	22,912	cu. Yd	$ 75.00	$ 1,718,400	45,824	sq. Yd	$ -	$ -	45,824	sq. Yd	$ 20.83	$ 954,662
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	12,059	cu. Yd	$ 75.00	$ 904,425	3,618	sq. Yd	$ -	$ -	3,618	sq. Yd	$ 25.00	$ 90,450
Drop Structures	Riprap	30	EA	$ 25,125.00	$ 753,750	2,670	sq. Yd	$ -	$ -	2,670	sq. Yd	$ 33.33	$ 89,000
Drop Str. - LC Enhancement	Riprap	30	EA	$ 2,512.50	$ 75,375	267	sq. Yd	$ -	$ -	267	sq. Yd	$ 33.33	$ 8,900
Sedimentation Basins		4	EA	$ 40,464.00	$ 161,856	42,932	sq. Yd	$ -	$ -	42,932	sq. Yd	$ 8.33	$ 357,767
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 911,646	Base Maintenance Cost			$ 2,422,415
						LC Enhancement Cost			$ 976,770	LC Enhancement Cost			$ 2,539,262
						Total Landscape Cost			$ 1,888,416	Total Maintenance Cost			$ 4,961,677

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,783,983	$ 2,739,195	$ 6,523,178
Contingency Cost (25% of Construction Cost)	$ 945,996	$ 684,799	$ 1,630,795
Engineering Design Cost (5% of Construction Cost)	$ 189,199	$ 136,960	$ 326,159
Total Construction Cost	$ 4,919,178	$ 3,560,954	$ 8,480,131

Land Cost

Channel Length	10853 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	267	66.5	$100,000	$ 6,650,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	13.7	$100,000	$ 1,370,000
Levee LC Enhancement	51	12.7	$100,000	$ 1,270,000
Active fan area set aside for Fan 8	0	72.6	$100,000	$ 7,260,000
Total	373	165.5		$ 16,550,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	152.8	$100,000	$ 15,280,000
LC Enhancement Cost	acre	12.7	$100,000	$ 1,270,000
Total Land Cost	acre	165.5	$100,000	$ 16,550,000

Total Cost

Base Total Cost	$ 23,533,239
Total Landscape Enhancement Cost	$ 8,346,986
Total Cost Including LC Enh.	$ 31,880,225

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Sub-area: FRS #1, Alternative: A
Open Channel Structure ID: N130

Open Channel

Structure ID	N140

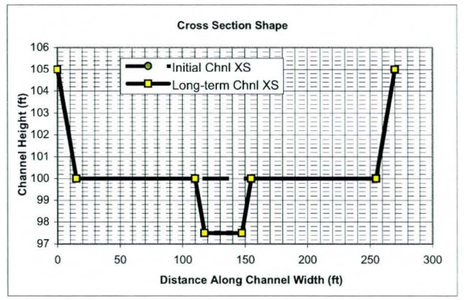
HEC1 ID	P1A-1B

Longitudal Geometry

Length	5668.0	ft
U/S Elev	1133.0	ft
D/S Elev	1092.0	ft
Initial Channel Slope	0.0072	ft/ft
Long-term Channel Slope	0.0040	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	11



Initial Channel XS Geometry

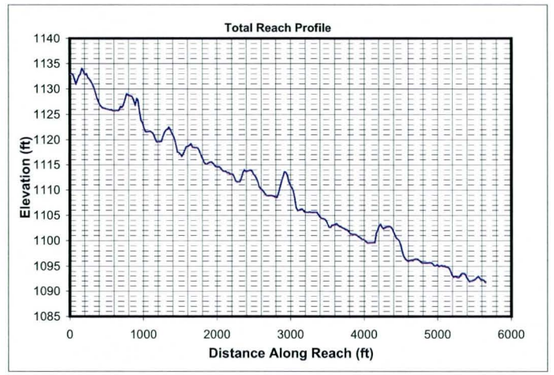
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	240	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	255	255	255	270
Y	105	100	100	100	100	100	100	105

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	95	3	30	7.5	3	100	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	110	117.5	147.5	155	255	270
Y	105	100	100	97.5	97.5	100	100	105



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	P									TOTAL
HEC1 Peak-Flow	2705									2705
Weighting Factor	1.00									
Flow into Channel	2705									2705

Reach Sediment Inflow Characteristics

U/S Contributing ID	P1A-1B_N130									TOTAL
Flow Volume (ac. ft)	245.00									245
Sediment Conc. (ppm)	1747									
Sediment Volume (ac. ft)	0.16									0.16
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.16									0.16

Hydrology

Drainage Area		sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	2705	cfs	
Long-term Max. Chnl Capacity	8408	cfs	
Q2 Channel	271	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	270	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
271	243.6	139.4	0.6	100.0	100.6	1.9	0.6	243.5	0.6	0.14	0.45
812	247.0	271.1	1.1	100.0	101.1	3.0	1.1	246.7	1.1	0.28	0.50
2029	252.2	473.6	1.9	100.0	101.9	4.3	1.9	251.6	1.9	0.48	0.55
2705	254.5	564.9	2.2	100.0	102.3	4.8	2.3	253.7	2.2	0.57	0.57

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
271	44.5	84.3	1.9	97.5	99.8	3.2	2.3	43.7	1.9	0.57	0.41
812	246.8	323.5	1.3	97.5	100.9	2.5	3.4	245.7	1.3	0.86	0.39
2029	253.0	566.2	2.2	97.5	101.9	3.6	4.4	251.5	2.3	1.10	0.42
2705	255.7	675.7	2.6	97.5	102.4	4.0	4.9	254.1	2.7	1.21	0.43

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)								TOTAL
	P1A-1B_N130								
271	862								862
812	2171								2171
2029	7237								7237
2705	10689								10689

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
271	1.74	1.2235	1.1624	Erosive	Erosive	Erosive	0.3	Stable	6.3	Stable	Stable
812	1.74	1.4245	1.3533	Erosive	Erosive	Erosive	0.3	Stable	7.3	Stable	Stable
2029	1.74	1.5905	1.5110	Erosive	Erosive	Erosive	0.4	Stable	9.0	Stable	Stable
2705	1.74	1.6423	1.5601	Erosive	Erosive	Erosive	0.4	Stable	9.7	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	271	812	2029	2705	271	812	2029	2705	271	812	2029	2705
Bray - Equation #1	46	81	132	153	1.7	2.5	3.4	3.7	3.5	4.0	4.6	4.8
Bray - Equation #2	60	107	173	201	1.9	2.7	3.7	4.0	2.4	2.8	3.2	3.3
Hey	14	26	43	50	5.4	8.2	11.6	13.0				
Ackers & Charlton/Lacey	38	60	88	99					2.0	2.4	2.9	3.0
Parker	113	196	309	357	1.4	2.2	3.3	3.7				
Chang	73	144	251	298	0.2	0.0	-0.4	-0.6				
Kellerhals	30	51	81	94	2.6	4.0	5.7	6.4	3.6	4.0	4.4	4.5
AMAFCA/Schumm	44	246	252	254								
Moody & Odem	0	0	0	0	0.0	0.0	0.0	0.0				
BUREC	22.6	34.2	48.2	53.6	6	9	13	14	3.1	4.1	5.1	5.5
Average	44	94	138	156	2.4	3.6	5.0	5.6	2.9	3.5	4.0	4.2
Values As Designed	44	246	252	254	2.3	3.4	4.4	4.9	3.2	2.5	3.6	4.0
Difference with Design	0	-151	-114	-98	0.1	0.1	0.6	0.7	-0.3	1.0	0.4	0.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
271	1052	628	1058	1717	3182	207	206	178	2713	257	1143	1122
812	5708	2724	4377	11012	5250	1327	977	1276	8969	1249	6599	4497
2029	23283	8189	11837	51560	7580	4930	2724	4999	23047	4856	24957	15269
2705	36136	11403	15294	83570	8460	7344	3673	7462	30869	6363	37261	22530

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
271	1443	861	1451	2355	4364	284	283	245	3722	352	1568	1539
812	2610	1245	2001	5034	2400	606	447	583	4100	571	3017	2056
2029	4258	1498	2165	9429	1386	901	498	914	4215	888	4564	2792
2705	4956	1564	2098	11462	1160	1007	504	1023	4234	873	5110	3090

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
271	1153	520	719	2148	913	210	157	292	1223	233	1378	813
812	2508	1251	1886	4163	3890	440	391	598	3490	513	2959	2008
2029	10203	4120	5589	19438	5829	1828	1264	2565	9288	2016	12018	6742
2705	15829	5859	7712	31471	6565	2761	1750	3901	12509	2296	18279	9903

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
271	1581	714	987	2946	1252	288	215	401	1677	320	1890	1115
812	1147	572	862	1903	1778	201	179	274	1596	235	1353	918
2029	1866	753	1022	3555	1066	334	231	469	1698	369	2198	1233
2705	2171	804	1058	4316	900	379	240	535	1716	315	2507	1358

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Sf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
271	0.0016	0.0021	120	0.36	0.046	0.0004	29	0.035	0.0003	0.0159	0.0004	0.0011	0.0054	0.0003	0.0017	0.0072	0.0035
812	0.0007	0.0011	166	0.51	0.049	0.0002	30	0.036	0.0002	0.0159	0.0002	0.0006	0.0054	0.0002	0.0008	0.0072	0.0033
2029	0.0004	0.0006	217	0.66	0.051	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0003	0.0054	0.0001	0.0004	0.0072	0.0033
2705	0.0003	0.0005	236	0.72	0.052	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0003	0.0054	0.0001	0.0003	0.0072	0.0032

Drop Structures

Design Slope	0.0040	ft/ft
Total Drop Needed	18.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	7	
Distance between structs.	810	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	2.00	sq. mi
Total Sediment Yield Volume	3.80	ac ft

Sedimentation Basins

Length	810 ft	Depth	3 ft
Width	270 ft	Side slope	3 ft/ft
Total Volume per Basin		14.39	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
271	1.1	-0.7	0.1	24.6	2.3	1.9	3.2	0.0040	0.2	1.5	2.5	5.6
812	1.1	-1.1	0.1	24.6	3.4	1.3	2.5	0.0040	0.4	1.5	2.5	5.7
2029	1.1	-1.2	0.2	24.6	4.4	2.3	3.6	0.0040	0.5	1.5	2.5	5.9
2705	1.1	-1.3	0.2	24.6	4.9	2.7	4.0	0.0040	0.5	1.5	2.5	6.1

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	1727	cfs
Stage at Peak Flow	101.5	ft
Volume at Peak Flow	245.0	ac. ft

Freeboard

Max. Flow Depth	2.3	ft
Channel Depth as designed	5.0	ft
Available Freeboard	2.7	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	3.96	ac. ft
Outflowing Sediment Volume	0.13	ac. ft
Deposited(+)/Eroded(-) Volume	3.84	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5668	5668
Side Slope (?H:1V)	3	3
Channel Width (ft)	270	270
Channel XS Area (sq. ft)	1368.8	1368.8
Channel Perimeter (ft)	272	272

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5668	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	1889	sq. Yd
Volume	6298	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5668	5668
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	5	6
Left Levee Surface Area (sq. Yd)	28970	58569
Left Levee Volume (cu. Yd)	30439	70535
Right Levee Length (ft)	5668	5668
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5	6
Right Levee Surface Area (sq. Yd)	28970	58569
Right Levee Volume (cu. Yd)	30439	70535
Total Levee Surface Area (sq. Yd)	57940	117138
Total Levee Volume (cu. Yd)	60878	141070

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5668	5668
Left Levee Lining Width (ft)	16	36
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	10076	22672
Left Levee Lining Volume (cu. Yd)	5038	11336
Right Levee Length (ft)	5668	5668
Right Levee Lining Width (ft)	16	36
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	10076	22672
Right Levee Lining Volume (cu. Yd)	5038	11336
Total Lining Area (sq. Yd)	20153	45344
Total Lining Volume (cu. Yd)	10076	22672

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	270	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	9.1	ft
Structure Height	12.1	ft
Number of Structures	7	
Volume per structure	363	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 27,225	
Area per structure	90	sq. Yd
Total Area	630	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	23216	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 92,864	
Other Cost	$ -	
Total cost per basin	$ 92,864	
Area per basin	24,291	sq. Yd
Total Area	24,291	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	60,878	cu. Yd	$ 7.00	$ 426,146	57,940	sq. Yd	$ 9.00	$ 521,460	57,940	sq. Yd	$ 11.67	$ 675,967
Levee - LC Enhancement	Fill	80,192	cu. Yd	$ 7.00	$ 561,344	59,198	sq. Yd	$ 9.00	$ 532,782	80,192	sq. Yd	$ 11.67	$ 935,573
Levee Lining	Riprap	10,076	cu. Yd	$ 75.00	$ 755,700	20,153	sq. Yd	$ -	$ -	20,153	sq. Yd	$ 20.83	$ 419,852
Levee Lining -LC Enhancement	Riprap	12,596	cu. Yd	$ 75.00	$ 944,700	25,191	sq. Yd	$ -	$ -	25,191	sq. Yd	$ 20.83	$ 524,815
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	6,298	cu. Yd	$ 75.00	$ 472,350	1,889	sq. Yd	$ -	$ -	1,889	sq. Yd	$ 25.00	$ 47,225
Drop Structures	Riprap	7	EA	$ 27,225.00	$ 190,575	630	sq. Yd	$ -	$ -	630	sq. Yd	$ 33.33	$ 21,000
Drop Str. - LC Enhancement	Riprap	7	EA	$ 2,722.50	$ 19,058	63	sq. Yd	$ -	$ -	63	sq. Yd	$ 33.33	$ 2,100
Sedimentation Basins		1	EA	$ 92,864.00	$ 92,864	24,291	sq. Yd	$ -	$ -	24,291	sq. Yd	$ 8.33	$ 202,425
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 521,460	Base Maintenance Cost			$ 1,366,469
						LC Enhancement Cost			$ 532,782	LC Enhancement Cost			$ 1,462,488
						Total Landscape Cost			$ 1,054,242	Total Maintenance Cost			$ 2,828,957

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,937,635	$ 1,525,102	$ 3,462,737
Contingency Cost (25% of Construction Cost)	$ 484,409	$ 381,275	$ 865,684
Engineering Design Cost (5% of Construction Cost)	$ 96,882	$ 76,255	$ 173,137
Total Construction Cost	$ 2,518,926	$ 1,982,632	$ 4,501,557

Land Cost

Channel Length	5668	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	270	35.1	$100,000	$ 3,510,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	58	7.5	$100,000	$ 750,000
Levee LC Enhancement	54	7	$100,000	$ 700,000
Active fan area set aside for Fan 12	0	26.2	$100,000	$ 2,620,000
Total	382	75.8		$ 7,580,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	68.8	$100,000	$ 6,880,000
LC Enhancement Cost	acre	7	$100,000	$ 700,000
Total Land Cost	acre	75.8	$100,000	$ 7,580,000

Total Cost

Base Total Cost	$	11,286,854
Total Landscape Enhancement Cost	$	4,677,902
Total Cost Including LC Enh.	$	15,964,756

Open Channel

Structure ID	L2B-A-R

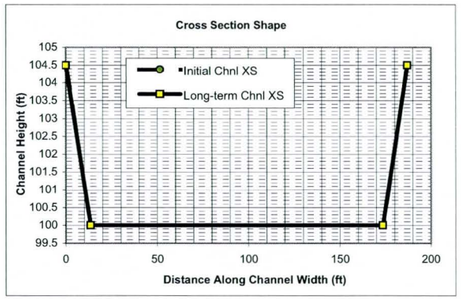
HEC1 ID	L2B-A-R

Longitundal Geometry

Length	2517.8	ft
U/S Elev	1440.7	ft
D/S Elev	1420.3	ft
Initial Channel Slope	0.0081	ft/ft
Long-term Channel Slope	0.0040	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	



Initial Channel XS Geometry

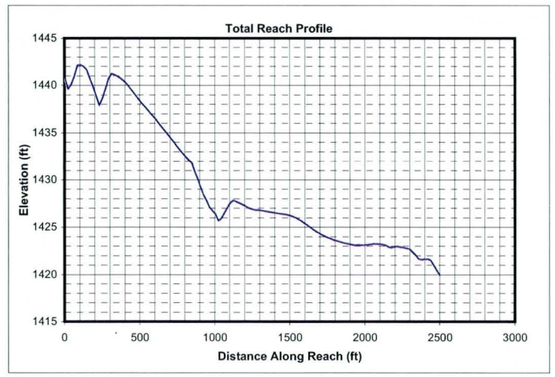
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	160	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	173.5	173.5	173.5	187
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	160	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	173.5	173.5	173.5	187
Y	104.5	100	100	100	100	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	L2BR	L2B							TOTAL
HEC1 Peak-Flow	2519	1700							4219
Weighting Factor	1.00	0.32							
Flow into Channel	2519	544							3063

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	5.369	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	3063	cfs	
Long-term Max. Chnl Capacity	4217	cfs	
Q2 Channel	306	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	187	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
306	166.0	153.8	0.9	100.0	100.9	2.0	0.9	165.7	0.9	0.24	0.36
919	171.5	301.3	1.8	100.0	101.8	3.0	1.8	170.9	1.8	0.45	0.40
2297	179.9	532.2	3.0	100.0	103.1	4.3	3.1	178.8	3.0	0.78	0.44
3063	183.6	637.7	3.5	100.0	103.7	4.8	3.7	182.4	3.5	0.93	0.45

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
306	166.0	153.8	0.9	100.0	100.9	2.0	0.9	165.7	0.9	0.24	0.36
919	171.5	301.3	1.8	100.0	101.8	3.0	1.8	170.9	1.8	0.45	0.40
2297	179.9	532.2	3.0	100.0	103.1	4.3	3.1	178.8	3.0	0.78	0.44
3063	183.6	637.7	3.5	100.0	103.7	4.8	3.7	182.4	3.5	0.93	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
306										0
919										0
2297										0
3063										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
306	1.74	1.3726	1.3040	Erosive	Erosive	Erosive	0.3	Stable	3.6	Stable	Stable
919	1.74	1.5703	1.4918	Erosive	Erosive	Erosive	0.4	Stable	5.6	Stable	Stable
2297	1.74	1.7317	1.6451	Erosive	Erosive	Erosive	0.5	Stable	8.0	Stable	Stable
3063	1.74	1.7803	1.6913	Erosive	Erosive	Erosive	0.5	Stable	8.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	306	919	2297	3063	306	919	2297	3063	306	919	2297	3063
Bray - Equation #1	49	87	141	164	1.8	2.6	3.5	3.9	3.5	4.1	4.7	4.9
Bray - Equation #2	64	114	185	215	2.0	2.8	3.8	4.2	2.4	2.8	3.2	3.3
Hey	15	28	46	54	5.7	8.6	12.2	13.6				
Ackers & Charlton/Lacey	40	63	93	105					2.1	2.5	2.9	3.1
Parker	120	208	329	380	1.5	2.4	3.4	3.9				
Chang	79	155	270	322	0.2	-0.1	-0.5	-0.7				
Kellerhals	32	55	86	100	2.7	4.2	6.0	6.7	3.6	4.0	4.4	4.6
AMAFCA/Schumm	166	171	179	183								
Moody & Odem	23	23	23	23	1.2	1.2	1.2	1.2				
BUREC	23.7	35.8	50.5	56.2	6	10	13	15	3.2	4.2	5.3	5.7
Average	61	94	140	160	2.7	3.9	5.4	6.0	3.0	3.5	4.1	4.3
Values As Designed	166	171	179	182	0.9	1.8	3.1	3.7	2.0	3.0	4.3	4.8
Difference with Design	-105	-77	-39	-22	1.7	2.1	2.2	2.2	1.0	0.5	-0.2	-0.5

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
306	692	463	859	3029	3404	133	100	137	3936	319	1543	1329
919	3717	1972	3365	19176	5314	1020	528	936	12377	1556	8439	5309
2297	14911	5872	8946	88163	7552	4025	1515	3599	31377	5811	30711	18407
3063	22994	8158	11590	141813	8428	6080	2055	5348	41934	8541	45321	27479

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
306	839	561	1041	3669	4123	162	121	166	4767	386	1869	1609
919	1501	796	1359	7742	2146	412	213	378	4997	628	3407	2144
2297	2408	948	1445	14238	1220	650	245	581	5067	938	4960	2973
3063	2785	988	1404	17177	1021	736	249	648	5079	1035	5489	3328

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
306	692	389	510	1047	1979	94	100	137	1205	145	761	642
919	3717	1746	2461	6631	3352	678	528	936	4118	741	4435	2667
2297	14911	5314	6726	30487	4963	2543	1515	3599	10681	1682	16921	9031
3063	22994	7419	8906	49038	5590	3782	2055	5348	14328	1815	25326	13328

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
306	839	471	617	1269	2397	114	121	166	1459	176	922	777
919	1501	705	994	2677	1353	274	213	378	1663	299	1791	1077
2297	2408	858	1086	4924	801	411	245	581	1725	272	2733	1458
3063	2785	899	1079	5940	677	458	249	648	1735	220	3068	1614

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
306	0.0011	0.0013	162	0.49	0.049	0.0003	30	0.036	0.0002	0.0159	0.0003	0.0007	0.0052	0.0003	0.0012	0.0040	0.0025
919	0.0005	0.0007	222	0.68	0.052	0.0002	31	0.036	0.0001	0.0159	0.0001	0.0004	0.0052	0.0002	0.0005	0.0040	0.0024
2297	0.0003	0.0004	289	0.88	0.054	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0052	0.0001	0.0003	0.0040	0.0024
3063	0.0002	0.0003	313	0.95	0.055	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0052	0.0001	0.0002	0.0040	0.0024

Drop Structures

Design Slope	0.0040	ft/ft
Total Drop Needed	10.4	ft
Height of Drop Structure	3	ft
No . of Drop Structures	4	
Distance between structs.	629	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	5.37	sq. mi
Total Sediment Yield Volume	10.20	ac ft

Sedimentation Basins

Length	629 ft	Depth	3 ft
Width	187 ft	Side slope	3 ft/ft
Total Volume per Basin		7.61	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		5	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
306	1.1	-0.3	0.1	24.6	0.9	0.9	2.0	0.0040	0.1	1.5	3.0	6.0
919	1.1	-0.5	0.1	24.6	1.8	1.8	3.0	0.0040	0.2	1.5	3.0	6.2
2297	1.1	-0.8	0.3	24.6	3.1	3.0	4.3	0.0040	0.4	1.5	3.0	6.5
3063	1.1	-0.9	0.3	24.6	3.7	3.5	4.8	0.0040	0.4	1.5	3.0	6.6

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	2418	cfs
Stage at Peak Flow	101.6	ft
Volume at Peak Flow	342.0	ac. ft

Freeboard

Max. Flow Depth	3.7	ft
Channel Depth as designed	4.5	ft
Available Freeboard	0.8	ft
Required Freeboard	1	ft

Sediment Volume

Inflowing Sediment Volume	10.20	ac. ft
Outflowing Sediment Volume	0.21	ac. ft
Deposited(+)/Eroded(-) Volume	9.99	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	2518	2518
Side Slope (?H:1V)	3	6
Channel Width (ft)	187	214
Channel XS Area (sq. ft)	780.8	841.55
Channel Perimeter (ft)	189	215

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	163259	181983
Excavated Area (sq. Yd)	52318	59872

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	2518	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	420	sq. Yd
Volume	1399	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	2518	2518
Left Levee Top Width (ft)	0	0
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	0	0
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	2518	2518
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	11751	24341
Right Levee Volume (cu. Yd)	11564	27232
Total Levee Surface Area (sq. Yd)	11751	24341
Total Levee Volume (cu. Yd)	11564	27232

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	2518	2518
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	1.5
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	2518	2518
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	3917	9233
Right Levee Lining Volume (cu. Yd)	1958	4616
Total Lining Area (sq. Yd)	3917	9233
Total Lining Volume (cu. Yd)	1958	4616

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	187	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	11.8	ft
Structure Height	14.8	ft
Number of Structures	4	
Volume per structure	307	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 23,025	
Area per structure	62	sq. Yd
Total Area	249	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	5	
Total Volume per Basin	12277	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 49,108	
Other Cost	$ -	
Total cost per basin	$ 49,108	
Area per basin	13,078	sq. Yd
Total Area	65,390	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	11,564	cu. Yd	$ 7.00	$ 80,948	11,751	sq. Yd	$ 9.00	$ 105,759	11,751	sq. Yd	$ 11.67	$ 137,095
Levee - LC Enhancement	Fill	15,668	cu. Yd	$ 7.00	$ 109,676	12,590	sq. Yd	$ 9.00	$ 113,310	15,668	sq. Yd	$ 11.67	$ 182,793
Levee Lining	Riprap	1,958	cu. Yd	$ 75.00	$ 146,850	3,917	sq. Yd	$ -	$ -	3,917	sq. Yd	$ 20.83	$ 81,602
Levee Lining -LC Enhancement	Riprap	2,658	cu. Yd	$ 75.00	$ 199,350	5,316	sq. Yd	$ -	$ -	5,316	sq. Yd	$ 20.83	$ 110,745
Excavated Channel	Excavated	163,259	cu. Yd	$ 10.00	$ 1,632,590	52,318	sq. Yd	$ 9.00	$ 470,862	52,318	sq. Yd	$ 8.33	$ 435,983
Exc. Chl - LC Enhancement	Excavated	18,724	cu. Yd	$ 10.00	$ 187,240	7,554	sq. Yd	$ 9.00	$ 67,986	7,554	sq. Yd	$ 8.33	$ 62,950
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,399	cu. Yd	$ 75.00	$ 104,925	420	sq. Yd	$ -	$ -	420	sq. Yd	$ 25.00	$ 10,500
Drop Structures	Riprap	4	EA	$ 23,025.00	$ 92,100	249	sq. Yd	$ -	$ -	249	sq. Yd	$ 33.33	$ 8,300
Drop Str. - LC Enhancement	Riprap	4	EA	$ 2,302.50	$ 9,210	25	sq. Yd	$ -	$ -	25	sq. Yd	$ 33.33	$ 830
Sedimentation Basins		5	EA	$ 49,108.00	$ 245,540	65,390	sq. Yd	$ -	$ -	65,390	sq. Yd	$ 8.33	$ 544,917
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 576,621	Base Maintenance Cost			$ 1,218,397
						LC Enhancement Cost			$ 181,296	LC Enhancement Cost			$ 357,319
						Total Landscape Cost			$ 757,917	Total Maintenance Cost			$ 1,575,716

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,302,953	$ 505,476	$ 2,808,429
Contingency Cost (25% of Construction Cost)	$ 575,738	$ 126,369	$ 702,107
Engineering Design Cost (5% of Construction Cost)	$ 115,148	$ 25,274	$ 140,421
Total Construction Cost	$ 2,993,839	$ 657,119	$ 3,650,958

Land Cost

Channel Length	2518	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	50	2.9	$100,000	$ 290,000
Channel	187	10.8	$100,000	$ 1,080,000
Channel LC Enhancement	27	1.6	$100,000	$ 160,000
Levee	27.5	1.6	$100,000	$ 160,000
Levee LC Enhancement	25.5	1.5	$100,000	$ 150,000
Active fan area set aside for Fan 37	0	302.5	$100,000	$ 30,250,000
Total	317	320.9		$ 32,090,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	314.9	$100,000	$ 31,490,000
LC Enhancement Cost	acre	6	$100,000	$ 600,000
Total Land Cost	acre	320.9	$100,000	$ 32,090,000

Total Cost

Base Total Cost	$ 36,278,857
Total Landscape Enhancement Cost	$ 1,795,734
Total Cost Including LC Enh.	$ 38,074,590

Open Channel

Structure ID	L2B-A-L

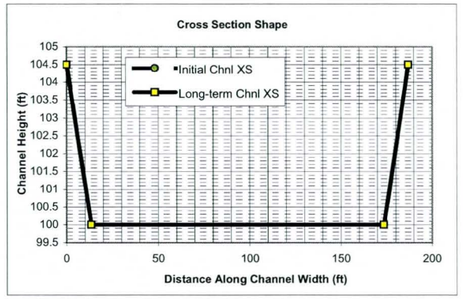
HEC1 ID	L2B-A-L

Longitundal Geometry

Length	1555.7	ft
U/S Elev	1436.5	ft
D/S Elev	1420.3	ft
Initial Channel Slope	0.0104	ft/ft
Long-term Channel Slope	0.0040	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	



Initial Channel XS Geometry

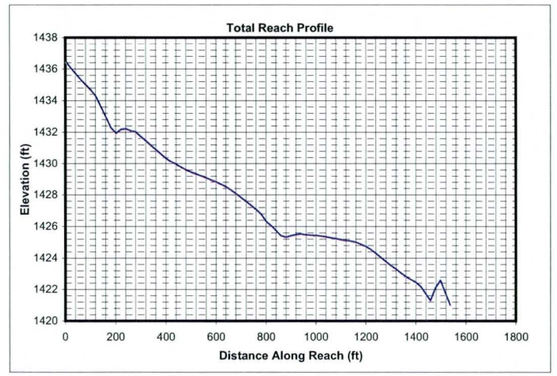
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	160	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	173.5	173.5	173.5	187
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	160	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	173.5	173.5	173.5	187
Y	104.5	100	100	100	100	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	L2BR	L2B							TOTAL
HEC1 Peak-Flow	2519	1700							4219
Weighting Factor	1.00	0.32							
Flow into Channel	2519	544							3063

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	5.369	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	3063	cfs	
Long-term Max. Chnl Capacity	4217	cfs	
Q2 Channel	306	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	187	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
306	166.0	153.8	0.9	100.0	100.9	2.0	0.9	165.7	0.9	0.24	0.36
919	171.5	301.3	1.8	100.0	101.8	3.0	1.8	170.9	1.8	0.45	0.40
2297	179.9	532.2	3.0	100.0	103.1	4.3	3.1	178.8	3.0	0.78	0.44
3063	183.6	637.7	3.5	100.0	103.7	4.8	3.7	182.4	3.5	0.93	0.45

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
306	166.0	153.8	0.9	100.0	100.9	2.0	0.9	165.7	0.9	0.24	0.36
919	171.5	301.3	1.8	100.0	101.8	3.0	1.8	170.9	1.8	0.45	0.40
2297	179.9	532.2	3.0	100.0	103.1	4.3	3.1	178.8	3.0	0.78	0.44
3063	183.6	637.7	3.5	100.0	103.7	4.8	3.7	182.4	3.5	0.93	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
306										0
919										0
2297										0
3063										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
306	1.74	1.3726	1.3040	Erosive	Erosive	Erosive	0.3	Stable	3.6	Stable	Stable
919	1.74	1.5703	1.4918	Erosive	Erosive	Erosive	0.4	Stable	5.6	Stable	Stable
2297	1.74	1.7317	1.6451	Erosive	Erosive	Erosive	0.5	Stable	8.0	Stable	Stable
3063	1.74	1.7803	1.6913	Erosive	Erosive	Erosive	0.5	Stable	8.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	306	919	2297	3063	306	919	2297	3063	306	919	2297	3063
Bray - Equation #1	49	87	141	164	1.8	2.6	3.5	3.9	3.5	4.1	4.7	4.9
Bray - Equation #2	64	114	185	215	2.0	2.8	3.8	4.2	2.4	2.8	3.2	3.3
Hey	15	28	46	54	5.7	8.6	12.2	13.6				
Ackers & Charlton/Lacey	40	63	93	105					2.1	2.5	2.9	3.1
Parker	120	208	329	380	1.5	2.4	3.4	3.9				
Chang	79	155	270	322	0.2	-0.1	-0.5	-0.7				
Kellerhals	32	55	86	100	2.7	4.2	6.0	6.7	3.6	4.0	4.4	4.6
AMAFCA/Schumm	166	171	179	183								
Moody & Odem	23	23	23	23	1.2	1.2	1.2	1.2				
BUREC	23.7	35.8	50.5	56.2	6	10	13	15	3.2	4.2	5.3	5.7
Average	61	94	140	160	2.7	3.9	5.4	6.0	3.0	3.5	4.1	4.3
Values As Designed	166	171	179	182	0.9	1.8	3.1	3.7	2.0	3.0	4.3	4.8
Difference with Design	-105	-77	-39	-22	1.7	2.1	2.2	2.2	1.0	0.5	-0.2	-0.5

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
306	692	490	991	4394	4022	153	100	137	5828	395	1944	1741
919	3717	2055	3775	27820	6161	1197	528	936	18078	1877	10404	6959
2297	14911	6074	9803	127903	8673	5245	1515	3599	45647	6852	37237	24315
3063	22994	8427	12738	205735	9660	8511	2055	5348	60965	10256	54680	36488

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
306	839	594	1200	5323	4872	185	121	166	7059	478	2355	2108
919	1501	830	1524	11232	2487	483	213	378	7299	758	4200	2810
2297	2408	981	1583	20656	1401	847	245	581	7372	1107	6014	3927
3063	2785	1021	1543	24919	1170	1031	249	648	7384	1242	6623	4420

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
306	692	389	510	1047	1979	94	100	137	1205	145	761	642
919	3717	1746	2461	6631	3352	678	528	936	4118	741	4435	2667
2297	14911	5314	6726	30487	4963	2543	1515	3599	10681	1682	16921	9031
3063	22994	7419	8906	49038	5590	3782	2055	5348	14328	1815	25326	13328

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
306	839	471	617	1269	2397	114	121	166	1459	176	922	777
919	1501	705	994	2677	1353	274	213	378	1663	299	1791	1077
2297	2408	858	1086	4924	801	411	245	581	1725	272	2733	1458
3063	2785	899	1079	5940	677	458	249	648	1735	220	3068	1614

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
306	0.0011	0.0013	183	0.56	0.050	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0007	0.0052	0.0003	0.0012	0.0040	0.0025
919	0.0005	0.0007	252	0.77	0.053	0.0002	31	0.036	0.0001	0.0159	0.0001	0.0004	0.0052	0.0002	0.0005	0.0040	0.0024
2297	0.0003	0.0004	327	1.00	0.055	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0052	0.0001	0.0003	0.0040	0.0024
3063	0.0002	0.0003	354	1.08	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0052	0.0001	0.0002	0.0040	0.0024

Drop Structures

Design Slope	0.0040	ft/ft
Total Drop Needed	10.0	ft
Height of Drop Structure	3	ft
No . of Drop Structures	4	
Distance between structs.	389	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	5.37	sq. mi
Total Sediment Yield Volume	10.20	ac ft

Sedimentation Basins

Length	389 ft	Depth	3 ft
Width	187 ft	Side slope	3 ft/ft
Total Volume per Basin		4.66	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		8	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
306	1.1	-0.3	0.1	24.6	0.9	0.9	2.0	0.0040	0.1	1.5	3.0	6.0
919	1.1	-0.5	0.1	24.6	1.8	1.8	3.0	0.0040	0.2	1.5	3.0	6.2
2297	1.1	-0.8	0.3	24.6	3.1	3.0	4.3	0.0040	0.4	1.5	3.0	6.5
3063	1.1	-0.9	0.3	24.6	3.7	3.5	4.8	0.0040	0.4	1.5	3.0	6.6

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	2418	cfs
Stage at Peak Flow	101.6	ft
Volume at Peak Flow	342.0	ac. ft

Freeboard

Max. Flow Depth	3.7	ft
Channel Depth as designed	4.5	ft
Available Freeboard	0.8	ft
Required Freeboard	1	ft

Sediment Volume

Inflowing Sediment Volume	10.20	ac. ft
Outflowing Sediment Volume	0.21	ac. ft
Deposited(+)/Eroded(-) Volume	9.99	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	1556	1556
Side Slope (?H:1V)	3	6
Channel Width (ft)	187	214
Channel XS Area (sq. ft)	780.8	841.55
Channel Perimeter (ft)	189	215

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	98699	109953
Excavated Area (sq. Yd)	32330	36998

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1556	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	259	sq. Yd
Volume	864	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1556	1556
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	7261	15041
Left Levee Volume (cu. Yd)	7146	16828
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	0	0
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	0	0
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	7261	15041
Total Levee Volume (cu. Yd)	7146	16828

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1556	1556
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	0	1.5
Left Levee Lining Area (sq. Yd)	2420	5705
Left Levee Lining Volume (cu. Yd)	0	2853
Right Levee Length (ft)	1556	1556
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	2420	5705
Total Lining Volume (cu. Yd)	0	2853

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	187	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	11.8	ft	
Structure Height	14.8	ft	
Number of Structures	4		
Volume per structure	307	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 23,025		
Area per structure	62	sq. Yd	
Total Area	249	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	8	
Total Volume per Basin	7518	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 30,072	
Other Cost	$ -	
Total cost per basin	$ 30,072	
Area per basin	8,081	sq. Yd
Total Area	64,648	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	7,146	cu. Yd	$ 7.00	$ 50,022	7,261	sq. Yd	$ 9.00	$ 65,349	7,261	sq. Yd	$ 11.67	$ 84,712
Levee - LC Enhancement	Fill	9,682	cu. Yd	$ 7.00	$ 67,774	7,780	sq. Yd	$ 9.00	$ 70,020	9,682	sq. Yd	$ 11.67	$ 112,957
Levee Lining	Riprap	0	cu. Yd	$ 75.00	$ -	2,420	sq. Yd	$ -	$ -	2,420	sq. Yd	$ 20.83	$ 50,426
Levee Lining -LC Enhancement	Riprap	2,853	cu. Yd	$ 75.00	$ 213,975	3,285	sq. Yd	$ -	$ -	3,285	sq. Yd	$ 20.83	$ 68,435
Excavated Channel	Excavated	98,699	cu. Yd	$ 10.00	$ 986,990	32,330	sq. Yd	$ 9.00	$ 290,970	32,330	sq. Yd	$ 8.33	$ 269,417
Exc. Chl - LC Enhancement	Excavated	11,254	cu. Yd	$ 10.00	$ 112,540	4,668	sq. Yd	$ 9.00	$ 42,012	4,668	sq. Yd	$ 8.33	$ 38,900
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	864	cu. Yd	$ 75.00	$ 64,800	259	sq. Yd	$ -	$ -	259	sq. Yd	$ 25.00	$ 6,475
Drop Structures	Riprap	4	EA	$ 23,025.00	$ 92,100	249	sq. Yd	$ -	$ -	249	sq. Yd	$ 33.33	$ 8,300
Drop Str. - LC Enhancement	Riprap	4	EA	$ 2,302.50	$ 9,210	25	sq. Yd	$ -	$ -	25	sq. Yd	$ 33.33	$ 830
Sedimentation Basins		8	EA	$ 30,072.00	$ 240,576	64,648	sq. Yd	$ -	$ -	64,648	sq. Yd	$ 8.33	$ 538,733
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 356,319	Base Maintenance Cost			$ 958,063
						LC Enhancement Cost			$ 112,032	LC Enhancement Cost			$ 221,122
						Total Landscape Cost			$ 468,351	Total Maintenance Cost			$ 1,179,184

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 1,434,488	$ 403,499	$ 1,837,987
Contingency Cost (25% of Construction Cost)	$ 358,622	$ 100,875	$ 459,497
Engineering Design Cost (5% of Construction Cost)	$ 71,724	$ 20,175	$ 91,899
Total Construction Cost	$ 1,864,834	$ 524,549	$ 2,389,383

Land Cost

Channel Length	1556 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	50	1.8	$100,000	$ 180,000
Channel	187	6.7	$100,000	$ 670,000
Channel LC Enhancement	27	1	$100,000	$ 100,000
Levee	27.5	1	$100,000	$ 100,000
Levee LC Enhancement	25.5	0.9	$100,000	$ 90,000
Other	0	0	$100,000	$ -
Total	317	11.4		$ 1,140,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	7.7	$100,000	$ 770,000
LC Enhancement Cost	acre	3.7	$100,000	$ 370,000
Total Land Cost	acre	11.4	$100,000	$ 1,140,000

Total Cost

Base Total Cost	$ 3,949,216
Total Landscape Enhancement Cost	$ 1,227,703
Total Cost Including LC Enh.	$ 5,176,919

Open Channel

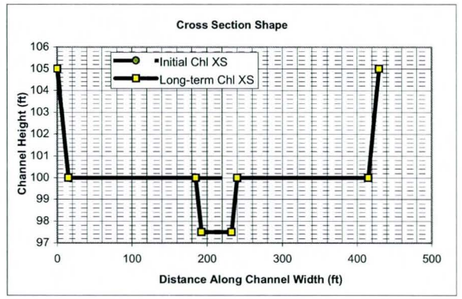
Structure ID	L20	HEC1 ID	L20

Longitundal Geometry

Length	4691.2	ft
U/S Elev	1119.1	ft
D/S Elev	1079.7	ft
Initial Channel Slope	0.0084	ft/ft
Long-term Channel Slope	0.0040	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	



Initial Channel XS Geometry

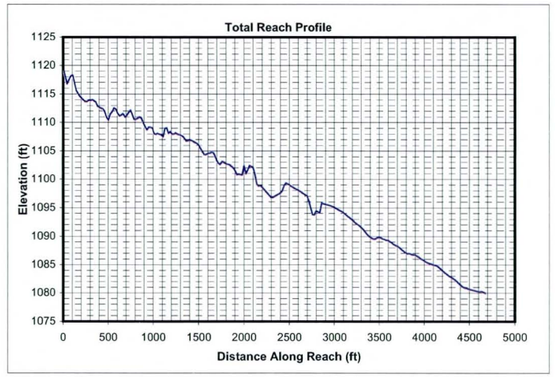
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	400	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	415	415	415	430
Y	105	100	100	100	100	100	100	105

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	170	3	40	7.5	3	175	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	185	192.5	232.5	240	415	430
Y	105	100	100	97.5	97.5	100	100	105



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	L								TOTAL
HEC1 Peak-Flow	3069								3069
Weighting Factor	1.00								
Flow into Channel	3069								3069

Reach Sediment Inflow Characteristics

U/S Contributing ID	L2BL3_L10								TOTAL
Flow Volume (ac. ft)	471.00								471
Sediment Conc. (ppm)	1247								
Sediment Volume (ac. ft)	0.22								0.22
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.22								0.22

Hydrology

Drainage Area	16.73	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	3069	cfs	
Long-term Max. Chnl Capacity	13563	cfs	
Q2 Channel	307	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	430	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
307	402.8	176.0	0.4	100.0	100.4	1.7	0.4	402.6	0.4	0.11	0.46
921	405.4	340.8	0.8	100.0	100.8	2.7	0.8	405.1	0.8	0.21	0.52
2302	409.3	592.9	1.4	100.0	101.5	3.9	1.5	408.8	1.5	0.37	0.57
3069	411.0	705.9	1.7	100.0	101.7	4.3	1.7	410.5	1.7	0.43	0.58

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
307	53.4	97.8	1.8	97.5	99.6	3.1	2.1	52.7	1.9	0.53	0.41
921	405.6	425.7	1.0	97.5	100.8	2.2	3.3	404.6	1.1	0.81	0.37
2302	410.5	741.3	1.8	97.5	101.5	3.1	4.0	409.2	1.8	1.01	0.41
3069	412.7	882.8	2.1	97.5	101.9	3.5	4.4	411.3	2.1	1.09	0.42

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
	L2BL3_L10									
307	1039									1039
921	2344									2344
2302	7785									7785
3069	11466									11466

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
307	1.74	1.1402	1.0832	Erosive	Erosive	Erosive	0.2	Stable	6.0	Stable	Stable
921	1.74	1.3422	1.2751	Erosive	Erosive	Erosive	0.3	Stable	6.8	Stable	Stable
2302	1.74	1.5101	1.4346	Erosive	Erosive	Erosive	0.4	Stable	8.3	Stable	Stable
3069	1.74	1.5626	1.4845	Erosive	Erosive	Erosive	0.4	Stable	8.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	307	921	2302	3069	307	921	2302	3069	307	921	2302	3069
Bray - Equation #1	49	87	141	164	1.8	2.6	3.5	3.9	3.5	4.1	4.7	4.9
Bray - Equation #2	64	114	185	215	2.0	2.8	3.8	4.2	2.4	2.8	3.2	3.3
Hey	15	28	46	54	5.7	8.6	12.2	13.6				
Ackers & Charlton/Lacey	40	63	93	105					2.1	2.5	2.9	3.1
Parker	120	208	330	381	1.5	2.4	3.4	3.9				
Chang	79	155	271	322	0.2	-0.1	-0.5	-0.7				
Kellerhals	32	55	86	100	2.7	4.2	6.0	6.7	3.6	4.0	4.4	4.6
AMAFCA/Schumm	53	405	410	412								
Moody & Odem	35	35	35	35	1.4	1.4	1.4	1.4				
BUREC	23.7	35.8	50.5	56.2	6	10	13	15	3.2	4.2	5.3	5.7
Average	51	119	165	184	2.7	3.9	5.4	6.0	3.0	3.5	4.1	4.3
Values As Designed	53	405	409	411	2.1	3.3	4.0	4.4	3.1	2.2	3.1	3.5
Difference with Design	-2	-286	-245	-227	0.6	0.7	1.4	1.6	-0.2	1.4	1.0	0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
307	1191	734	1184	1914	4753	217	232	166	3735	316	1225	1424
921	6515	3350	5854	12339	7945	1620	1262	1387	12616	1490	7501	5625
2302	26741	10271	16119	58204	11496	6179	3639	5733	32601	5733	29068	18707
3069	41632	14370	21067	94645	12818	9248	4937	8654	43704	8791	43662	27593

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
307	1440	888	1431	2314	5746	262	280	201	4516	382	1481	1722
921	2625	1350	2359	4972	3202	653	509	559	5084	600	3023	2267
2302	4310	1656	2598	9381	1853	996	586	924	5255	924	4685	3015
3069	5033	1737	2547	11441	1549	1118	597	1046	5283	1063	5278	3336

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
307	1275	585	817	2339	1071	233	177	323	1382	257	1524	907
921	2329	1214	1848	3641	5365	362	358	502	3765	489	2648	2047
2302	9546	4250	6179	17145	8178	1740	1338	2408	10346	1900	11385	6765
3069	14852	6124	8401	27859	9233	2675	1894	3743	14002	2931	17552	9933

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
307	1541	707	988	2827	1295	281	214	390	1671	311	1842	1097
921	938	489	745	1467	2162	146	144	202	1517	197	1067	825
2302	1539	685	996	2763	1318	280	216	388	1668	306	1835	1090
3069	1795	740	1016	3368	1116	323	229	453	1693	354	2122	1201

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
307	0.0021	0.0028	113	0.34	0.045	0.0006	29	0.035	0.0004	0.0159	0.0006	0.0015	0.0052	0.0003	0.0022	0.0084	0.0038
921	0.0009	0.0014	156	0.48	0.048	0.0003	30	0.036	0.0002	0.0159	0.0003	0.0007	0.0052	0.0002	0.0010	0.0084	0.0036
2302	0.0005	0.0008	205	0.63	0.051	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0052	0.0001	0.0005	0.0084	0.0035
3069	0.0004	0.0007	223	0.68	0.052	0.0002	31	0.036	0.0001	0.0159	0.0001	0.0003	0.0052	0.0001	0.0004	0.0084	0.0035

Drop Structures

Design Slope	0.0040	ft/ft
Total Drop Needed	20.6	ft
Height of Drop Structure	3	ft
No . of Drop Structures	7	
Distance between structs.	670	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	2.77	sq. mi
Total Sediment Yield Volume	5.26	ac ft

Sedimentation Basins

Length	670 ft	Depth	3 ft
Width	430 ft	Side slope	3 ft/ft
Total Volume per Basin		19.17	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
307	1.1	-0.6	0.1	24.6	2.1	1.9	3.1	0.0040	0.2	1.5	2.5	5.6
921	1.1	-1.1	0.1	24.6	3.3	1.1	2.2	0.0040	0.3	1.5	2.5	5.7
2302	1.1	-1.2	0.1	24.6	4.0	1.8	3.1	0.0040	0.4	1.5	2.5	5.9
3069	1.1	-1.2	0.2	24.6	4.4	2.1	3.5	0.0040	0.5	1.5	2.5	5.9

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	3204	cfs
Stage at Peak Flow	0.0	ft
Volume at Peak Flow	560.0	ac. ft

Freeboard

Max. Flow Depth	1.7	ft
Channel Depth as designed	5.0	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	5.48	ac. ft
Outflowing Sediment Volume	0.25	ac. ft
Deposited(+)/Eroded(-) Volume	5.23	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	4691	4691
Side Slope (?H:1V)	3	3
Channel Width (ft)	430	430
Channel XS Area (sq. ft)	2193.8	2193.8
Channel Perimeter (ft)	432	432

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	4691	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1564	sq. Yd
Volume	4691	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	4691	4691
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	5	6
Left Levee Surface Area (sq. Yd)	23976	48474
Left Levee Volume (cu. Yd)	25192	58377
Right Levee Length (ft)	4691	4691
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5	6
Right Levee Surface Area (sq. Yd)	23976	48474
Right Levee Volume (cu. Yd)	25192	58377
Total Levee Surface Area (sq. Yd)	47952	96948
Total Levee Volume (cu. Yd)	50384	116754

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	4691	4691
Left Levee Lining Width (ft)	16	36
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	8340	18764
Left Levee Lining Volume (cu. Yd)	4170	9382
Right Levee Length (ft)	4691	4691
Right Levee Lining Width (ft)	16	36
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	8340	18764
Right Levee Lining Volume (cu. Yd)	4170	9382
Total Lining Area (sq. Yd)	16679	37528
Total Lining Volume (cu. Yd)	8340	18764

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	430	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	7.4	ft	
Structure Height	10.4	ft	
Number of Structures	7		
Volume per structure	498	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 37,350		
Area per structure	143	sq. Yd	
Total Area	1,003	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	30928	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 123,712	
Other Cost	$ -	
Total cost per basin	$ 123,712	
Area per basin	32,019	sq. Yd
Total Area	32,019	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	50,384	cu. Yd	$ 7.00	$ 352,688	47,952	sq. Yd	$ 9.00	$ 431,568	47,952	sq. Yd	$ 11.67	$ 559,440
Levee - LC Enhancement	Fill	66,370	cu. Yd	$ 7.00	$ 464,590	48,996	sq. Yd	$ 9.00	$ 440,964	66,370	sq. Yd	$ 11.67	$ 774,317
Levee Lining	Riprap	8,340	cu. Yd	$ 75.00	$ 625,500	16,679	sq. Yd	$ -	$ -	16,679	sq. Yd	$ 20.83	$ 347,481
Levee Lining -LC Enhancement	Riprap	10,424	cu. Yd	$ 75.00	$ 781,800	20,849	sq. Yd	$ -	$ -	20,849	sq. Yd	$ 20.83	$ 434,352
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	4,691	cu. Yd	$ 75.00	$ 351,825	1,564	sq. Yd	$ -	$ -	1,564	sq. Yd	$ 25.00	$ 39,100
Drop Structures	Riprap	7	EA	$ 37,350.00	$ 261,450	1,003	sq. Yd	$ -	$ -	1,003	sq. Yd	$ 33.33	$ 33,433
Drop Str. - LC Enhancement	Riprap	7	EA	$ 3,735.00	$ 26,145	100	sq. Yd	$ -	$ -	100	sq. Yd	$ 33.33	$ 3,343
Sedimentation Basins		1	EA	$ 123,712.00	$ 123,712	32,019	sq. Yd	$ -	$ -	32,019	sq. Yd	$ 8.33	$ 266,825
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 431,568	Base Maintenance Cost			$ 1,246,280
						LC Enhancement Cost			$ 440,964	LC Enhancement Cost			$ 1,212,012
						Total Landscape Cost			$ 872,532	Total Maintenance Cost			$ 2,458,292

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,715,175	$ 1,272,535	$ 2,987,710
Contingency Cost (25% of Construction Cost)	$ 428,794	$ 318,134	$ 746,928
Engineering Design Cost (5% of Construction Cost)	$ 85,759	$ 63,627	$ 149,386
Total Construction Cost	$ 2,229,728	$ 1,654,296	$ 3,884,023

Land Cost

Channel Length	4691 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	430	46.3	$100,000	$ 4,630,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	58	6.2	$100,000	$ 620,000
Levee LC Enhancement	54	5.8	$100,000	$ 580,000
Other	0	0	$100,000	$ -
Total	542	58.3		$ 5,830,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	52.5	$100,000	$ 5,250,000
LC Enhancement Cost	acre	5.8	$100,000	$ 580,000
Total Land Cost	acre	58.3	$100,000	$ 5,830,000

Total Cost

Base Total Cost	$ 9,157,575
Total Landscape Enhancement Cost	$ 3,887,271
Total Cost Including LC Enh.	$ 13,044,847

Note: Unit land cost increased to reflect existing homes in area.

Open Channel

Structure ID	M2-A-10

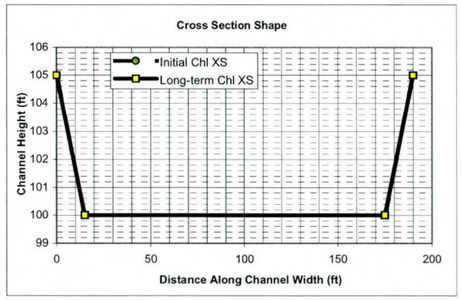
HEC1 ID	M2-A-10

Longitudal Geometry

Length	4173.9	ft
U/S Elev	1401.6	ft
D/S Elev	1344.3	ft
Initial Channel Slope	0.0137	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	



Initial Channel XS Geometry

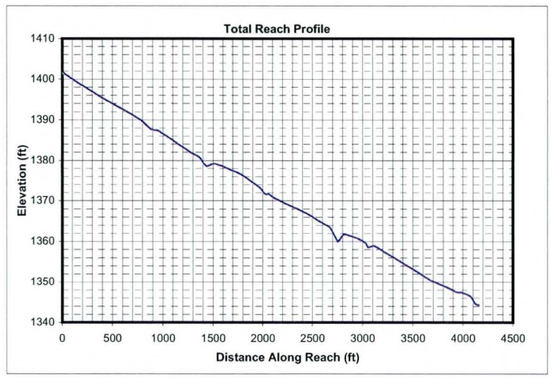
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	160	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	175	175	175	190
Y	105	100	100	100	100	100	100	105

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	160	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	175	175	175	190
Y	105	100	100	100	100	100	100	105



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	M1	M2							TOTAL
HEC1 Peak-Flow	3301	2347							5648
Weighting Factor	1.00	0.13							
Flow into Channel	3301	306							3607

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	6.656	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	3607	cfs	
Long-term Max. Chnl Capacity	5639	cfs	
Q2 Channel	361	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	190	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
361	166.2	158.8	1.0	100.0	101.0	2.3	1.0	165.8	1.0	0.30	0.41
1082	171.9	311.2	1.8	100.0	101.9	3.5	1.9	171.3	1.8	0.59	0.45
2705	180.5	549.8	3.0	100.0	103.2	4.9	3.2	179.4	3.1	1.01	0.50
3607	184.3	658.9	3.6	100.0	103.8	5.5	3.8	183.0	3.6	1.20	0.51

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
361	166.2	158.8	1.0	100.0	101.0	2.3	1.0	165.8	1.0	0.30	0.41
1082	171.9	311.2	1.8	100.0	101.9	3.5	1.9	171.3	1.8	0.59	0.45
2705	180.5	549.8	3.0	100.0	103.2	4.9	3.2	179.4	3.1	1.01	0.50
3607	184.3	658.9	3.6	100.0	103.8	5.5	3.8	183.0	3.6	1.20	0.51

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
361										0
1082										0
2705										0
3607										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
361	1.74	1.3820	1.3129	Erosive	Erosive	Erosive	0.3	Stable	4.1	Stable	Stable
1082	1.74	1.5796	1.5006	Erosive	Erosive	Erosive	0.4	Stable	6.3	Stable	Stable
2705	1.74	1.7407	1.6537	Erosive	Erosive	Erosive	0.5	Stable	9.1	Stable	Stable
3607	1.74	1.7915	1.7019	Erosive	Erosive	Erosive	0.5	Stable	10.2	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	361	1082	2705	3607	361	1082	2705	3607	361	1082	2705	3607
Bray - Equation #1	53	95	153	178	1.9	2.7	3.7	4.1	3.6	4.2	4.8	5.0
Bray - Equation #2	70	124	201	234	2.1	3.0	4.0	4.4	2.5	2.9	3.3	3.4
Hey	16	30	50	59	6.0	9.2	13.0	14.5				
Ackers & Charlton/Lacey	43	68	100	112					2.1	2.6	3.0	3.1
Parker	130	226	357	413	1.6	2.5	3.7	4.1				
Chang	94	184	320	380	0.0	-0.3	-0.9	-1.2				
Kellerhals	34	59	94	108	2.9	4.4	6.4	7.2	3.7	4.1	4.5	4.6
AMAFCA/Schumm	166	171	180	183								
Moody & Odem	25	25	25	25	1.3	1.3	1.3	1.3				
BUREC	24.2	36.5	51.4	57.3	6	10	14	15	3.6	4.8	6.0	6.5
Average	66	102	153	175	2.8	4.1	5.6	6.2	3.1	3.7	4.3	4.5
Values As Designed	166	171	179	183	1.0	1.9	3.2	3.8	2.3	3.5	4.9	5.5
Difference with Design	-100	-69	-26	-8	1.8	2.2	2.4	2.4	0.8	0.2	-0.6	-1.0

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
361	1214	828	1843	9082	4893	391	209	260	10618	696	3572	3055
1082	6512	3242	6242	57457	7361	2423	880	1567	32478	3253	17772	12653
2705	26118	9294	14747	263936	10280	11579	2375	5741	81670	11707	61108	45323
3607	40252	12800	19449	424373	11431	18589	3184	8442	109001	17443	88772	68521

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
361	1249	852	1896	9342	5033	403	215	267	10922	715	3674	3142
1082	2233	1111	2140	19699	2524	831	302	537	11135	1115	6093	4338
2705	3582	1275	2022	36196	1410	1588	326	787	11200	1606	8380	6216
3607	4140	1317	2000	43649	1176	1912	327	868	11211	1794	9131	7048

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
361	1214	671	1026	1997	2438	225	209	260	2138	263	1398	1076
1082	6512	2773	3882	12634	3992	1279	880	1567	6938	1327	7583	4488
2705	26118	8149	10033	58038	5812	4612	2375	5741	17745	2576	27858	15369
3607	40252	11286	13044	93317	6524	6825	3184	8442	23751	2774	41281	22789

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
361	1249	691	1056	2054	2508	232	215	267	2199	270	1437	1107
1082	2233	951	1331	4332	1369	438	302	537	2379	455	2600	1539
2705	3582	1118	1376	7959	797	632	326	787	2434	353	3820	2108
3607	4140	1161	1342	9598	671	702	327	868	2443	285	4246	2344

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
361	0.0010	0.0013	213	0.65	0.051	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0007	0.0049	0.0003	0.0011	0.0050	0.0027
1082	0.0004	0.0007	293	0.89	0.054	0.0002	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0049	0.0002	0.0005	0.0050	0.0026
2705	0.0002	0.0004	381	1.16	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0049	0.0001	0.0002	0.0050	0.0025
3607	0.0002	0.0003	412	1.26	0.058	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0049	0.0001	0.0002	0.0050	0.0025

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	36.4	ft
Height of Drop Structure	3	ft
No . of Drop Structures	13	
Distance between structs.	321	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	6.66	sq. mi
Total Sediment Yield Volume	12.65	ac ft

Sedimentation Basins

Length	321 ft	Depth	3 ft
Width	190 ft	Side slope	3 ft/ft
Total Volume per Basin		3.89	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		11	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
361	1.1	-0.3	0.1	24.6	1.0	1.0	2.3	0.0050	0.1	1.5	3.0	6.0
1082	1.1	-0.5	0.2	24.6	1.9	1.8	3.5	0.0050	0.2	1.5	3.0	6.2
2705	1.1	-0.8	0.3	24.6	3.2	3.1	4.9	0.0050	0.4	1.5	3.0	6.6
3607	1.1	-0.8	0.4	24.6	3.8	3.6	5.5	0.0050	0.5	1.5	3.0	6.7

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	3301	cfs
Stage at Peak Flow	0.0	ft
Volume at Peak Flow	469.0	ac. ft

Freeboard

Max. Flow Depth	3.8	ft
Channel Depth as designed	5.0	ft
Available Freeboard	1.2	ft
Required Freeboard	1.1	ft

Sediment Volume

Inflowing Sediment Volume	12.65	ac. ft
Outflowing Sediment Volume	0.41	ac. ft
Deposited(+)/Eroded(-) Volume	12.23	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	4174	4174
Side Slope (?H:1V)	3	6
Channel Width (ft)	190	220
Channel XS Area (sq. ft)	875	950
Channel Perimeter (ft)	192	221

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	670083	766122
Excavated Area (sq. Yd)	88118	102031

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	4174	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	696	sq. Yd
Volume	2319	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	4174	4174
Left Levee Top Width (ft)	0	0
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	0	0
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	4174	4174
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5	6
Right Levee Surface Area (sq. Yd)	21334	43131
Right Levee Volume (cu. Yd)	22416	51943
Total Levee Surface Area (sq. Yd)	21334	43131
Total Levee Volume (cu. Yd)	22416	51943

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	4174	4174
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	1.5
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	4174	4174
Right Levee Lining Width (ft)	16	36
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	7420	16696
Right Levee Lining Volume (cu. Yd)	3710	8348
Total Lining Area (sq. Yd)	7420	16696
Total Lining Volume (cu. Yd)	3710	8348

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	190	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	12.9	ft
Structure Height	15.9	ft
Number of Structures	13	
Volume per structure	336	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 25,200	
Area per structure	63	sq. Yd
Total Area	823	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	11	
Total Volume per Basin	6276	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 25,104	
Other Cost	$ -	
Total cost per basin	$ 25,104	
Area per basin	6,778	sq. Yd
Total Area	74,558	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	22,416	cu. Yd	$ 7.00	$ 156,912	21,334	sq. Yd	$ 9.00	$ 192,006	21,334	sq. Yd	$ 11.67	$ 248,897
Levee - LC Enhancement	Fill	29,527	cu. Yd	$ 7.00	$ 206,689	21,797	sq. Yd	$ 9.00	$ 196,173	29,527	sq. Yd	$ 11.67	$ 344,482
Levee Lining	Riprap	3,710	cu. Yd	$ 75.00	$ 278,250	7,420	sq. Yd	$ -	$ -	7,420	sq. Yd	$ 20.83	$ 154,593
Levee Lining -LC Enhancement	Riprap	4,638	cu. Yd	$ 75.00	$ 347,850	9,276	sq. Yd	$ -	$ -	9,276	sq. Yd	$ 20.83	$ 193,241
Excavated Channel	Excavated	670,083	cu. Yd	$ 10.00	$ 6,700,830	88,118	sq. Yd	$ 9.00	$ 793,062	88,118	sq. Yd	$ 8.33	$ 734,317
Exc. Chl - LC Enhancement	Excavated	96,039	cu. Yd	$ 10.00	$ 960,390	13,913	sq. Yd	$ 9.00	$ 125,217	13,913	sq. Yd	$ 8.33	$ 115,942
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	2,319	cu. Yd	$ 75.00	$ 173,925	696	sq. Yd	$ -	$ -	696	sq. Yd	$ 25.00	$ 17,400
Drop Structures	Riprap	13	EA	$ 25,200.00	$ 327,600	823	sq. Yd	$ -	$ -	823	sq. Yd	$ 33.33	$ 27,433
Drop Str. - LC Enhancement	Riprap	13	EA	$ 2,520.00	$ 32,760	82	sq. Yd	$ -	$ -	82	sq. Yd	$ 33.33	$ 2,743
Sedimentation Basins		11	EA	$ 25,104.00	$ 276,144	74,558	sq. Yd	$ -	$ -	74,558	sq. Yd	$ 8.33	$ 621,317
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 985,068	Base Maintenance Cost			$ 1,803,956
						LC Enhancement Cost			$ 321,390	LC Enhancement Cost			$ 656,407
						Total Landscape Cost			$ 1,306,458	Total Maintenance Cost			$ 2,460,363

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 7,913,661	$ 1,547,689	$ 9,461,350
Contingency Cost (25% of Construction Cost)	$ 1,978,415	$ 386,922	$ 2,365,338
Engineering Design Cost (5% of Construction Cost)	$ 395,683	$ 77,384	$ 473,068
Total Construction Cost	$ 10,287,759	$ 2,011,996	$ 12,299,755

Land Cost

Channel Length	4174 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	50	4.8	$100,000	$ 480,000
Channel	190	18.2	$100,000	$ 1,820,000
Channel LC Enhancement	30	2.9	$100,000	$ 290,000
Levee	29	2.8	$100,000	$ 280,000
Levee LC Enhancement	27	2.6	$100,000	$ 260,000
Active fan area set aside for Fan 36	0	589	$100,000	$ 58,900,000
Total	326	620.3		$ 62,030,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	610	$100,000	$ 61,000,000
LC Enhancement Cost	acre	10.3	$100,000	$ 1,030,000
Total Land Cost	acre	620.3	$100,000	$ 62,030,000

Total Cost

Base Total Cost	$ 74,076,783
Total Landscape Enhancement Cost	$ 4,019,793
Total Cost Including LC Enh.	$ 78,096,576

Open Channel

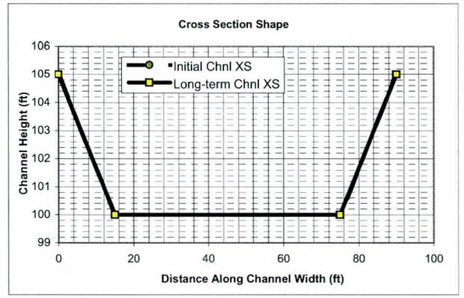
Structure ID	N125A	HEC1 ID	N125A

Longitudinal Geometry

Length	3879.1	ft
U/S Elev	1342.8	ft
D/S Elev	1318.6	ft
Initial Channel Slope	0.0063	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	



Initial Channel XS Geometry

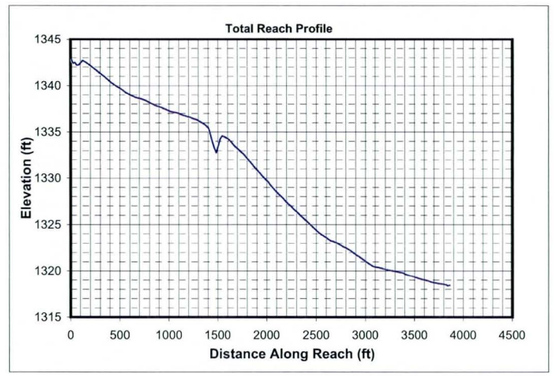
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	60	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	75	75	75	90
Y	105	100	100	100	100	100	100	105

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	60	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	75	75	75	90
Y	105	100	100	100	100	100	100	105



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	N1								TOTAL
HEC1 Peak-Flow	1253								1253
Weighting Factor	1.00								
Flow into Channel	1253								1253

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	3.05	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	1253	cfs	
Long-term Max. Chnl Capacity	1740	cfs	
Q2 Channel	125	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	90	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
125	66.8	68.2	1.0	100.0	101.1	1.8	1.1	66.5	1.0	0.20	0.32
376	73.0	136.6	1.9	100.0	102.1	2.8	2.1	72.4	1.9	0.39	0.35
940	82.2	248.2	3.0	100.0	103.5	3.8	3.5	81.1	3.1	0.66	0.38
1253	86.2	300.6	3.5	100.0	104.1	4.2	4.1	84.9	3.5	0.78	0.39

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
125	66.8	68.2	1.0	100.0	101.1	1.8	1.1	66.5	1.0	0.20	0.32
376	73.0	136.6	1.9	100.0	102.1	2.8	2.1	72.4	1.9	0.39	0.35
940	82.2	248.2	3.0	100.0	103.5	3.8	3.5	81.1	3.1	0.66	0.38
1253	86.2	300.6	3.5	100.0	104.1	4.2	4.1	84.9	3.5	0.78	0.39

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
125										0
376										0
940										0
1253										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
125	1.74	1.4032	1.3331	Erosive	Erosive	Erosive	0.3	Stable	3.4	Stable	Stable
376	1.74	1.5912	1.5117	Erosive	Erosive	Erosive	0.4	Stable	5.2	Stable	Stable
940	1.74	1.7403	1.6533	Erosive	Erosive	Erosive	0.5	Stable	7.3	Stable	Stable
1253	1.74	1.7851	1.6959	Erosive	Erosive	Erosive	0.5	Stable	8.2	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	125	376	940	1253	125	376	940	1253	125	376	940	1253
Bray - Equation #1	30	54	88	102	1.3	1.9	2.6	2.9	3.1	3.6	4.1	4.3
Bray - Equation #2	40	71	115	134	1.5	2.1	2.8	3.1	2.1	2.5	2.8	2.9
Hey	9	17	28	33	4.0	6.1	8.7	9.7				
Ackers & Charlton/Lacey	27	43	64	72					1.8	2.2	2.5	2.6
Parker	77	133	211	243	1.0	1.6	2.4	2.7				
Chang	41	81	143	170	0.3	0.3	0.1	0.0				
Kellerhals	20	35	55	64	1.9	2.9	4.2	4.7	3.3	3.7	4.0	4.2
AMAFCA/Schumm	67	72	81	85								
Moody & Odem	19	19	19	19	1.1	1.1	1.1	1.1				
BUREC	17.9	27.0	38.1	42.4	5	7	10	11	2.3	3.0	3.8	4.1
Average	35	55	84	96	2.0	2.9	4.0	4.5	2.5	3.0	3.5	3.6
Values As Designed	66	72	81	85	1.1	2.1	3.5	4.1	1.8	2.8	3.8	4.2
Difference with Design	-32	-17	3	12	0.9	0.8	0.5	0.3	0.7	0.2	-0.3	-0.5

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
125	191	127	199	813	1218	21	19	36	1057	90	429	382
376	991	566	969	4952	1997	235	135	262	3384	431	2398	1484
940	3809	1710	2597	21688	2996	951	414	1014	8627	1573	8738	4920
1253	5781	2383	3580	34244	3411	1432	569	1505	11542	2347	12878	7243

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
125	565	376	590	2406	3606	62	57	108	3131	265	1269	1130
376	978	559	956	4887	1971	232	133	258	3340	426	2366	1464
940	1504	675	1025	8562	1183	376	163	400	3406	621	3450	1942
1253	1712	706	1060	10139	1010	424	168	446	3417	695	3813	2145

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
125	191	103	111	270	672	15	19	36	290	28	200	176
376	991	492	650	1645	1210	157	135	262	1058	167	1192	723
940	3809	1528	1840	7206	1904	605	414	1014	2792	452	4546	2374
1253	5781	2141	2524	11378	2191	898	569	1505	3757	499	6791	3458

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
125	565	306	329	800	1990	44	57	108	859	83	592	521
376	978	486	641	1624	1194	155	133	258	1044	165	1176	714
940	1504	603	726	2845	752	239	163	400	1102	178	1795	937
1253	1712	634	747	3369	649	266	168	446	1112	148	2011	1024

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
125	0.0011	0.0012	149	0.45	0.048	0.0003	30	0.036	0.0002	0.0159	0.0002	0.0007	0.0070	0.0004	0.0014	0.0030	0.0028
376	0.0005	0.0006	201	0.61	0.051	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0003	0.0070	0.0003	0.0006	0.0030	0.0026
940	0.0003	0.0004	256	0.78	0.053	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0070	0.0002	0.0003	0.0029	0.0026
1253	0.0002	0.0003	275	0.84	0.054	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0070	0.0001	0.0002	0.0029	0.0026

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	12.6	ft
Height of Drop Structure	3	ft
No . of Drop Structures	5	
Distance between structs.	776	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.50	sq. mi
Total Sediment Yield Volume	2.85	ac ft

Sedimentation Basins

Length	776 ft	Depth	3 ft
Width	90 ft	Side slope	3 ft/ft
Total Volume per Basin		4.28	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		3	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
125	1.1	-0.4	0.0	24.6	1.1	1.0	1.8	0.0030	0.1	1.5	2.0	4.7
376	1.1	-0.7	0.1	24.6	2.1	1.9	2.8	0.0030	0.2	1.5	2.0	4.9
940	1.1	-1.0	0.2	24.6	3.5	3.1	3.8	0.0030	0.4	1.5	2.0	5.2
1253	1.1	-1.1	0.2	24.6	4.1	3.5	4.2	0.0030	0.5	1.5	2.0	5.3

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	3930	cfs
Stage at Peak Flow	0.0	ft
Volume at Peak Flow	839.0	ac. ft

Freeboard

Max. Flow Depth	4.1	ft
Channel Depth as designed	5.0	ft
Available Freeboard	0.9	ft
Required Freeboard	1.1	ft

Sediment Volume

Inflowing Sediment Volume	2.85	ac. ft
Outflowing Sediment Volume	0.32	ac. ft
Deposited(+)/Eroded(-) Volume	2.53	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	3879	3879
Side Slope (?H:1V)	3	6
Channel Width (ft)	90	120
Channel XS Area (sq. ft)	375	450
Channel Perimeter (ft)	92	121

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	135468	173441
Excavated Area (sq. Yd)	38790	51720

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3879	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	647	sq. Yd
Volume	1940	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3879	3879
Left Levee Top Width (ft)	0	0
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	0	0
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	3879	3879
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5	6
Right Levee Surface Area (sq. Yd)	19826	40083
Right Levee Volume (cu. Yd)	20832	48272
Total Levee Surface Area (sq. Yd)	19826	40083
Total Levee Volume (cu. Yd)	20832	48272

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3879	3879
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	3879	3879
Right Levee Lining Width (ft)	16	36
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	6896	15516
Right Levee Lining Volume (cu. Yd)	3448	7758
Total Lining Area (sq. Yd)	6896	15516
Total Lining Volume (cu. Yd)	3448	7758

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	90	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	10.9	ft
Structure Height	13.9	ft
Number of Structures	5	
Volume per structure	139	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 10,425	
Area per structure	30	sq. Yd
Total Area	150	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	3	
Total Volume per Basin	6905	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 27,620	
Other Cost	$ -	
Total cost per basin	$ 27,620	
Area per basin	7,758	sq. Yd
Total Area	23,274	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	20,832	cu. Yd	$ 7.00	$ 145,824	19,826	sq. Yd	$ 9.00	$ 178,434	19,826	sq. Yd	$ 11.67	$ 231,303
Levee - LC Enhancement	Fill	27,440	cu. Yd	$ 7.00	$ 192,080	20,257	sq. Yd	$ 9.00	$ 182,313	27,440	sq. Yd	$ 11.67	$ 320,133
Levee Lining	Riprap	3,448	cu. Yd	$ 75.00	$ 258,600	6,896	sq. Yd	$ -	$ -	6,896	sq. Yd	$ 20.83	$ 143,667
Levee Lining -LC Enhancement	Riprap	4,310	cu. Yd	$ 75.00	$ 323,250	8,620	sq. Yd	$ -	$ -	8,620	sq. Yd	$ 20.83	$ 179,583
Excavated Channel	Excavated	135,468	cu. Yd	$ 10.00	$ 1,354,680	38,790	sq. Yd	$ 9.00	$ 349,110	38,790	sq. Yd	$ 8.33	$ 323,250
Exc. Chl - LC Enhancement	Excavated	37,973	cu. Yd	$ 10.00	$ 379,730	12,930	sq. Yd	$ 9.00	$ 116,370	12,930	sq. Yd	$ 8.33	$ 107,750
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,940	cu. Yd	$ 75.00	$ 145,500	647	sq. Yd	$ -	$ -	647	sq. Yd	$ 25.00	$ 16,175
Drop Structures	Riprap	5	EA	$ 10,425.00	$ 52,125	150	sq. Yd	$ -	$ -	150	sq. Yd	$ 33.33	$ 5,000
Drop Str. - LC Enhancement	Riprap	5	EA	$ 1,042.50	$ 5,213	15	sq. Yd	$ -	$ -	15	sq. Yd	$ 33.33	$ 500
Sedimentation Basins		3	EA	$ 27,620.00	$ 82,860	23,274	sq. Yd	$ -	$ -	23,274	sq. Yd	$ 8.33	$ 193,950
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 527,544	Base Maintenance Cost			$ 913,345
						LC Enhancement Cost			$ 298,683	LC Enhancement Cost			$ 607,967
						Total Landscape Cost			$ 826,227	Total Maintenance Cost			$ 1,521,312

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,039,589	$ 900,273	$ 2,939,862
Contingency Cost (25% of Construction Cost)	$ 509,897	$ 225,068	$ 734,965
Engineering Design Cost (5% of Construction Cost)	$ 101,979	$ 45,014	$ 146,993
Total Construction Cost	$ 2,651,466	$ 1,170,354	$ 3,821,820

Land Cost

Channel Length	3879 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	120	10.7	$100,000	$ 1,070,000
LC Enhancement Buffer	50	4.5	$100,000	$ 450,000
Channel	90	8	$100,000	$ 800,000
Channel LC Enhancement	30	2.7	$100,000	$ 270,000
Levee	29	2.6	$100,000	$ 260,000
Levee LC Enhancement	27	2.4	$100,000	$ 240,000
Active fan area set aside for Fan 7	0	156.3	$100,000	$ 15,630,000
Total	346	187.2		$ 18,720,000

Total Cost

Base Total Cost	$ 21,852,355
Total Landscape Enhancement Cost	$ 3,037,004
Total Cost Including LC Enh.	$ 24,889,359

Right of Way

Preservation Corridor Width	120 ft
Maintenance Access	0 ft
Landscape Enhancement Buffer	50 ft
Other	0 ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	177.6	$100,000	$ 17,760,000
LC Enhancement Cost	acre	9.6	$100,000	$ 960,000
Total Land Cost	acre	187.2	$100,000	$ 18,720,000

SUN VALLEY ADMP
Step 2 - Alt. B2
FRS No. 1

FRS No. 1 Sub-area

FEMA Floodplains

Floodplain

Floodway

Alluvial Fan Apices

Concentration Point

Step 2 Excavated Corridors ROW

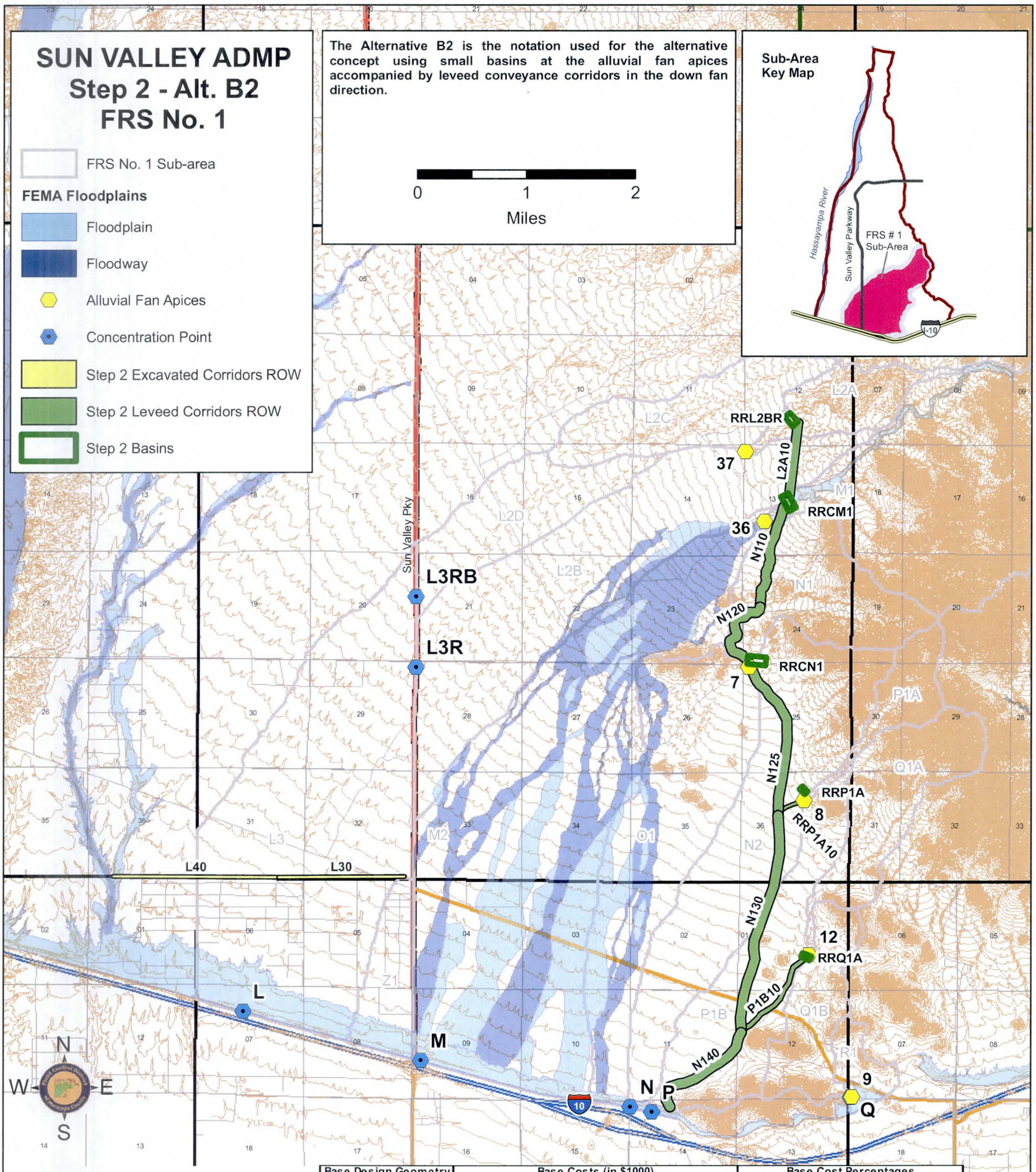
Step 2 Leveed Corridors ROW

Step 2 Basins

The Alternative B2 is the notation used for the alternative concept using small basins at the alluvial fan apices accompanied by leveed conveyance corridors in the down fan direction.

0 1 2

Miles



Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs ($1000): Land Cost	Base Costs ($1000): Constr. Cost	Base Costs ($1000): Lndscp Cost	Base Costs ($1000): 50 Yr Maint. Cost	Base Costs ($1000): Total Cost	Base Cost Percentages: Land Cost %	Base Cost Percentages: Constr. Cost %	Base Cost Percentages: Lndscp Cost %	Base Cost Percentages: 50 Yr Maint. Cost %	Base Cost Percentages: % of Total Cost
RRL2BR	Online Basin	2241	5	59	0	600	350	10	$ 480	$ 636	$ 210	$ 218	$ 1,544	31%	41%	14%	14%	1%
L2A10	Leveed Chl.	2326	41	0	22	0.7	462	5	$ 4,110	$ 1,874	$ 325	$ 888	$ 7,197	57%	26%	5%	12%	7%
RRCM1	Online Basin	4579	7	102	0	800	400	11	$ 730	$ 1,007	$ 320	$ 323	$ 2,380	31%	42%	13%	14%	2%
N110	Leveed Chl.	5030	60	0	31	1	482	5	$ 6,030	$ 3,693	$ 457	$ 1,205	$ 11,386	53%	32%	4%	11%	10%
N120	Leveed Chl.	4690	47	0	28	0.8	488	5	$ 4,730	$ 2,381	$ 389	$ 1,049	$ 8,549	55%	28%	5%	12%	8%
RRCN1	Online Basin	4273	8	110	0	900	400	11	$ 830	$ 1,097	$ 360	$ 358	$ 2,645	31%	41%	14%	14%	2%
N125	Leveed Chl.	4298	91	0	54	1.5	488	5	$ 9,080	$ 4,390	$ 745	$ 1,885	$ 16,101	56%	27%	5%	12%	15%
RRP1A	Online Basin	516	2	10	0	350	200	5	$ 160	$ 162	$ 70	$ 78	$ 470	34%	34%	15%	17%	0%
N130	Leveed Chl.	4805	123	0	84	2.1	494	6	$12,310	$ 6,343	$ 1,064	$ 2,758	$ 22,474	55%	28%	5%	12%	21%
N140	Leveed Chl.	4581	64	0	38	1.1	491	5	$ 6,380	$ 2,780	$ 521	$ 1,464	$ 11,145	57%	25%	5%	13%	10%
RRQ1A	Online Basin	908	2	18	0	450	220	6	$ 230	$ 226	$ 99	$ 109	$ 664	35%	34%	15%	16%	1%
P1B10	Leveed Chl.	1105	29	0	29	1	242	5	$ 2,850	$ 1,973	$ 430	$ 1,036	$ 6,289	45%	31%	7%	16%	6%
L30	Excavated Chl.	2162	24	97	0	1.2	204	7	$ 2,360	$ 2,835	$ 940	$ 1,768	$ 7,903	30%	36%	12%	22%	7%
L40	Excavated Chl.	2162	31	121	0	1.5	204	7	$ 3,110	$ 2,896	$ 1,240	$ 1,182	$ 8,429	37%	34%	15%	14%	8%
RRP1A10	Leveed Chl.	516	6	0	7	0.3	176	4	$ 590	$ 522	$ 114	$ 285	$ 1,511	39%	35%	8%	19%	1%
	TOTAL	540	517	293					$53,980	$ 32,816	$ 7,286	$ 14,606	**$ 108,688**	50%	30%	7%	13%	100%
All Channels		516	218	293	11.2				$51,550	$ 29,688	$ 6,227	$ 13,520	$ 100,985	51%	29%	6%	13%	93%
All Online Basins		24	299	0					$ 2,430	$ 3,128	$ 1,059	$ 1,086	$ 7,703	32%	41%	14%	14%	7%
All Offline Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)		$9,016		Basins Cost per ac. ft. (in $1000)					$3.54									

Cost Increase for Landscape Compatibility Enhancement over Base Costs

All Channels % increase	17%	19%	132%				16%	57%	76%	89%	42%	
All Online Basins % increase	88%	10%	0%				84%	8%	84%	78%	53%	
All Offline Basins % increase	0%	0%	0%				0%	0%	0%	0%	0%	
Total % increase	20%	14%	132%				19%	53%	77%	88%	43%	

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Costs Summary

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs ($1000): Land Cost	Base Costs ($1000): Constr. Cost	Base Costs ($1000): Lndscp Cost	Base Costs ($1000): 50 Yr Maint. Cost	Base Costs ($1000): Total Cost	Base Cost Percentages: Land Cost %	Base Cost Percentages: Constr. Cost %	Base Cost Percentages: Lndscp Cost %	Base Cost Percentages: 50 Yr Maint. Cost %	Base Cost Percentages: % of Total Cost
RRL2BR	Online Basin	2241	5	59	0	600	350	10	$ 480	$ 636	$ 210	$ 218	$ 1,544	31%	41%	14%	14%	1%
L2A10	Leveed Chl.	2326	41	0	22	0.7	462	5	$ 4,110	$ 1,874	$ 325	$ 888	$ 7,197	57%	26%	5%	12%	7%
RRCM1	Online Basin	4579	7	102	0	800	400	11	$ 730	$ 1,007	$ 320	$ 323	$ 2,380	31%	42%	13%	14%	2%
N110	Leveed Chl.	5030	60	0	31	1	482	5	$ 6,030	$ 3,693	$ 457	$ 1,205	$ 11,386	53%	32%	4%	11%	10%
N120	Leveed Chl.	4690	47	0	28	0.8	488	5	$ 4,730	$ 2,381	$ 389	$ 1,049	$ 8,549	55%	28%	5%	12%	8%
RRCN1	Online Basin	4273	8	110	0	900	400	11	$ 830	$ 1,097	$ 360	$ 358	$ 2,645	31%	41%	14%	14%	2%
N125	Leveed Chl.	4298	91	0	54	1.5	488	5	$ 9,080	$ 4,390	$ 745	$ 1,885	$ 16,101	56%	27%	5%	12%	15%
RRP1A	Online Basin	516	2	10	0	350	200	5	$ 160	$ 162	$ 70	$ 78	$ 470	34%	34%	15%	17%	0%
N130	Leveed Chl.	4805	123	0	84	2.1	494	6	$ 12,310	$ 6,343	$ 1,064	$ 2,758	$ 22,474	55%	28%	5%	12%	21%
N140	Leveed Chl.	4581	64	0	38	1.1	491	5	$ 6,380	$ 2,780	$ 521	$ 1,464	$ 11,145	57%	25%	5%	13%	10%
RRQ1A	Online Basin	908	2	18	0	450	220	6	$ 230	$ 226	$ 99	$ 109	$ 664	35%	34%	15%	16%	1%
P1B10	Leveed Chl.	1105	29	0	29	1	242	5	$ 2,850	$ 1,973	$ 430	$ 1,036	$ 6,289	45%	31%	7%	16%	6%
L30	Excavated Chl.	2162	24	97	0	1.2	204	7	$ 2,360	$ 2,835	$ 940	$ 1,768	$ 7,903	30%	36%	12%	22%	7%
L40	Excavated Chl.	2162	31	121	0	1.5	204	7	$ 3,110	$ 2,896	$ 1,240	$ 1,182	$ 8,429	37%	34%	15%	14%	8%
RRP1A10	Leveed Chl.	516	6	0	7	0.3	176	4	$ 590	$ 522	$ 114	$ 285	$ 1,511	39%	35%	8%	19%	1%
	TOTAL	540	517	293					$ 53,980	$ 32,816	$ 7,286	$ 14,606	**$ 108,688**	50%	30%	7%	13%	100%
All Channels		516	218	293	11.2				$ 51,550	$ 29,688	$ 6,227	$ 13,520	$ 100,985	51%	29%	6%	13%	93%
All Online Basins		24	299	0					$ 2,430	$ 3,128	$ 1,059	$ 1,086	$ 7,703	32%	41%	14%	14%	7%
All Offline Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)		$9,016		Basins Cost per ac. ft. (in $1000)					$3.54									

Cost Summary - Landscape Compatibility Enhanced (LCE)

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	LCE Design Geometry: Length (stor-ft; chl-mi)	LCE Design Geometry: ROW Width (ft)	LCE Design Geometry: Depth (ft)	LCE Costs ($1000): Land Cost	LCE Costs ($1000): Constr. Cost	LCE Costs ($1000): Lndscp Cost	LCE Costs ($1000): 50 Yr Maint. Cost	LCE Costs ($1000): Total Cost	LCE Cost Percentages: Land Cost %	LCE Cost Percentages: Constr. Cost %	LCE Cost Percentages: Lndscp Cost %	LCE Cost Percentages: 50 Yr Maint. Cost %	LCE Cost Percentages: % of Total Cost
RRL2BR	Online Basin	2241	9	65	0	870	450	10	$ 900	$ 690	$ 392	$ 391	$ 2,372	38%	29%	17%	16%	2%
L2A10	Leveed Chl.	2326	46	0	52	0.7	513	5	$ 4,560	$ 3,156	$ 674	$ 1,796	$ 10,187	45%	31%	7%	18%	7%
RRCM1	Online Basin	4579	13	113	0	1120	500	11	$ 1,280	$ 1,100	$ 560	$ 550	$ 3,490	37%	32%	16%	16%	2%
N110	Leveed Chl.	5030	67	0	73	1	533	5	$ 6,670	$ 5,609	$ 947	$ 2,489	$ 15,715	42%	36%	6%	16%	10%
N120	Leveed Chl.	4690	53	0	65	0.8	542	5	$ 5,250	$ 3,910	$ 786	$ 2,143	$ 12,089	43%	32%	6%	18%	8%
RRCN1	Online Basin	4273	14	119	0	1220	500	11	$ 1,400	$ 1,176	$ 610	$ 594	$ 3,781	37%	31%	16%	16%	2%
N125	Leveed Chl.	4298	101	0	125	1.5	542	5	$ 10,080	$ 7,311	$ 1,507	$ 3,983	$ 22,881	44%	32%	7%	17%	15%
RRP1A	Online Basin	516	4	11	0	550	300	5	$ 380	$ 173	$ 165	$ 168	$ 886	43%	20%	19%	19%	1%
N130	Leveed Chl.	4805	137	0	191	2.1	551	6	$ 13,730	$ 10,804	$ 2,149	$ 5,954	$ 32,637	42%	33%	7%	18%	21%
N140	Leveed Chl.	4581	71	0	87	1.1	545	5	$ 7,080	$ 4,784	$ 1,054	$ 2,928	$ 15,846	45%	30%	7%	18%	10%
RRQ1A	Online Basin	908	5	21	0	700	320	6	$ 520	$ 250	$ 224	$ 227	$ 1,222	43%	20%	18%	19%	1%
P1B10	Leveed Chl.	1105	35	0	69	1	293	5	$ 3,450	$ 3,629	$ 891	$ 2,233	$ 10,203	34%	36%	9%	22%	7%
L30	Excavated Chl.	2162	36	116	0	1.2	257	7	$ 3,610	$ 3,224	$ 1,178	$ 1,988	$ 10,000	36%	32%	12%	20%	6%
L40	Excavated Chl.	2162	48	144	0	1.5	257	7	$ 4,750	$ 3,371	$ 1,555	$ 1,473	$ 11,149	43%	30%	14%	13%	7%
RRP1A10	Leveed Chl.	516	8	0	17	0.3	224	4	$ 750	$ 943	$ 237	$ 586	$ 2,517	30%	37%	9%	23%	2%
	TOTAL	647	589	679					$ 64,410	$ 50,131	$ 12,929	$ 27,504	**$ 154,974**	42%	32%	8%	18%	100%
All Channels		602	260	679	11.2				$ 59,930	$ 46,742	$ 10,978	$ 25,573	$ 143,223	42%	33%	8%	18%	92%
All Online Basins		45	329	0					$ 4,480	$ 3,389	$ 1,950	$ 1,931	$ 11,751	38%	29%	17%	16%	8%
All Offline Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)		$12,788		Basins Cost per ac. ft. (in $1000)					$5.93									
All Channels % increase		17%	19%	132%					16%	57%	76%	89%	42%					
All Online Basins % increase		88%	10%	0%					84%	8%	84%	78%	53%					
All Offline Basins % increase		0%	0%	0%					0%	0%	0%	0%	0%					
Total % increase		20%	14%	132%					19%	53%	77%	88%	43%					

Hydrology - 6-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
R1	BASIN	506			4.2	0.28	47	12	4	2	1.525	1.527	1.527	1.527	23	23	23	23
Q1B	BASIN	851			4.5	0.94	155	39	13	6	1.533	1.544	1.544	1.544	77	77	77	77
DUMMY	COMBINE	1020			4.5	1.22	192	48	16	7	1.459	1.469	1.469	1.469	95	96	96	96
L1	BASIN	2128			4.7	3.55	543	139	46	20	1.424	1.453	1.453	1.453	269	275	275	275
L1-L2A	ROUTE	2066	14.4	40.14	4.9	3.55	543	139	46	20	1.423	1.453	1.453	1.453	269	275	275	275
L2A	BASIN	692			4.5	0.69	113	28	9	4	1.516	1.516	1.516	1.516	56	56	56	56
L2BR	COMBINE	2391			4.9	4.24	623	159	53	23	1.366	1.391	1.391	1.391	309	314	314	314
RRL2BR	STORAGE	2172	6.5	24.03	5	4.24	623	159	53	23	1.366	1.391	1.391	1.391	309	314	314	314
L2A-M1	ROUTE	2153	101.3	43.44	5.2	4.24	622	159	53	23	1.364	1.391	1.391	1.391	308	314	314	314
M1	BASIN	2809			4.8	5.69	790	203	68	29	1.291	1.327	1.327	1.327	392	402	402	402
CM1	COMBINE	4159			5	9.92	1286	332	111	48	1.205	1.243	1.243	1.243	638	658	658	658
RRCM1	STORAGE	3976	5.5	30.46	5.1	9.92	1286	332	111	48	1.205	1.243	1.243	1.243	638	658	658	658
M1-N1	ROUTE	3898	101.6	141.32	5.5	9.92	1279	332	111	48	1.198	1.243	1.243	1.243	634	658	658	658
N1	BASIN	1253			4.5	1.52	210	53	18	8	1.281	1.286	1.286	1.286	104	105	105	105
CN1	COMBINE	3998			5.4	11.45	1391	362	121	52	1.13	1.177	1.177	1.177	690	719	719	719
RRCN1	STORAGE	3757	7.1	45.83	5.6	11.45	1391	362	121	52	1.13	1.177	1.177	1.177	690	719	719	719
N1-P1A	ROUTE	3713	101.7	128.03	6	11.45	1379	362	121	52	1.12	1.177	1.177	1.177	684	719	719	719
N2A	BASIN	1253			4.5	1.52	210	53	18	8	1.281	1.286	1.286	1.286	104	105	105	105
CN2AR	COMBINE	3722			5.9	12.97	1476	392	131	56	1.058	1.124	1.124	1.124	732	777	777	777
P1A	BASIN	575			4.4	0.5	89	22	7	3	1.655	1.663	1.663	1.663	44	44	44	44
RRP1A	STORAGE	516	2.9	3.68	4.5	0.5	89	22	7	3	1.655	1.663	1.663	1.663	44	44	44	44
CN2A	COMBINE	3734			5.9	13.47	1519	404	135	58	1.048	1.116	1.116	1.116	753	802	802	802
P1A-1B	ROUTE	3660	101.8	272	6.5	13.47	1485	404	135	58	1.025	1.116	1.116	1.116	736	802	802	802
P1B	BASIN	852			5	1.94	244	62	21	9	1.172	1.194	1.194	1.194	121	123	123	123
PR	COMBINE	3743			6.5	15.41	1567	437	146	63	0.945	1.055	1.055	1.055	777	867	867	867
Q1A	BASIN	990			4.5	1.3	193	49	16	7	1.385	1.396	1.396	1.396	96	97	97	97
RRQ1A	STORAGE	908	3.7	6.34	4.7	1.3	193	49	16	7	1.385	1.396	1.396	1.396	96	97	97	97
Q1A-P	ROUTE	883	101.3	25.02	4.9	1.3	193	49	16	7	1.382	1.396	1.396	1.396	96	97	97	97
P	COMBINE	3809			6.4	16.71	1664	464	155	67	0.926	1.032	1.032	1.032	825	920	920	920
N2B	BASIN	1193			5.1	3.33	366	93	31	13	1.023	1.045	1.045	1.045	181	185	185	185
O1	BASIN	1057			5.3	3.09	343	88	29	13	1.033	1.059	1.059	1.059	170	174	174	174
M2	BASIN	1849			5.4	7.44	633	159	53	23	0.791	0.795	0.795	0.795	314	315	315	315
Z1	BASIN	694			4.5	0.66	100	25	8	4	1.405	1.406	1.406	1.406	50	50	50	50
L2B	BASIN	1532			5	4.08	418	104	35	15	0.952	0.952	0.952	0.952	207	207	207	207
L2B-L3	ROUTE	1196	12.8	208.54	6.9	4.08	416	104	35	15	0.948	0.952	0.952	0.952	206	207	207	207
L2C	BASIN	754			4.8	1.33	161	40	13	6	1.125	1.125	1.125	1.125	80	80	80	80
L2C-2D	ROUTE	712	13	29.17	5.2	1.33	161	40	13	6	1.125	1.125	1.125	1.125	80	80	80	80
L2D	BASIN	706			4.7	1.23	136	34	11	5	1.025	1.025	1.025	1.025	67	67	67	67
L3RB	COMBINE	1043			5	2.56	260	65	22	9	0.945	0.946	0.946	0.946	129	129	129	129
L2D-L3	ROUTE	650	12.5	187.08	8.3	2.56	258	65	22	9	0.936	0.946	0.946	0.946	128	129	129	129
L3	BASIN	1832			5.2	5.85	581	146	49	21	0.923	0.926	0.926	0.926	288	289	289	289
L	COMBINE	1638			5.3	12.49	963	250	83	36	0.717	0.745	0.745	0.745	478	496	496	496

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
R1	BASIN	387			12.2	0.28	37	10	3	1	1.223	1.322	1.322	1.322	19	20	20	20
Q1B	BASIN	740			12.5	0.94	134	38	13	5	1.325	1.498	1.5	1.5	66	75	75	75
DUMMY	COMBINE	902			12.5	1.22	170	48	16	7	1.294	1.448	1.45	1.45	84	94	94	94
L1	BASIN	2267			12.7	3.55	527	150	50	22	1.382	1.572	1.576	1.576	261	297	298	298
L1-L2A	ROUTE	2154	14.4	41.37	12.9	3.55	527	150	50	22	1.381	1.571	1.576	1.576	261	297	298	298
L2A	BASIN	570			12.5	0.69	92	23	8	3	1.236	1.236	1.236	1.236	46	46	46	46
L2BR	COMBINE	2519			12.9	4.24	616	172	57	25	1.351	1.509	1.513	1.513	305	341	342	342
RRL2BR	STORAGE	2241	7	25.79	13	4.24	616	172	57	25	1.351	1.509	1.513	1.513	305	341	342	342
L2A-M1	ROUTE	2205	101.3	44.07	13.2	4.24	615	172	57	25	1.348	1.509	1.513	1.513	305	341	342	342
M1	BASIN	3301			12.8	5.69	825	236	79	34	1.349	1.543	1.548	1.548	409	468	469	469
CM1	COMBINE	5070			12.9	9.92	1425	404	135	59	1.335	1.516	1.522	1.522	707	802	806	806
RRCM1	STORAGE	4579	7.3	41.24	13	9.92	1425	404	135	59	1.335	1.516	1.522	1.522	707	802	806	806
M1-N1	ROUTE	4462	101.7	153.07	13.4	9.92	1417	404	135	59	1.328	1.515	1.522	1.522	703	802	806	806
N1	BASIN	1211			12.5	1.52	192	52	17	7	1.172	1.269	1.27	1.27	95	103	103	103
CN1	COMBINE	4690			13.3	11.45	1581	450	151	65	1.284	1.463	1.471	1.471	784	893	898	898
RRCN1	STORAGE	4273	9.1	60.42	13.6	11.45	1581	450	151	65	1.284	1.463	1.471	1.471	784	893	898	898
N1-P1A	ROUTE	4230	101.8	138.8	13.9	11.45	1571	450	151	65	1.276	1.462	1.471	1.471	779	893	898	898
N2A	BASIN	1211			12.5	1.52	192	52	17	7	1.172	1.269	1.27	1.27	95	103	103	103
CN2AR	COMBINE	4298			13.9	12.97	1724	496	166	72	1.236	1.421	1.43	1.43	855	983	989	989
P1A	BASIN	441			12.4	0.5	73	21	7	3	1.351	1.542	1.545	1.545	36	41	41	41
RRP1A	STORAGE	410	1.8	2.21	12.5	0.5	73	21	7	3	1.351	1.542	1.545	1.545	36	41	41	41
CN2A	COMBINE	4326			13.9	13.47	1786	514	172	74	1.232	1.418	1.427	1.427	886	1019	1026	1026
P1A-1B	ROUTE	4260	101.9	298.19	14.4	13.47	1757	513	172	74	1.213	1.416	1.427	1.427	871	1018	1026	1026
P1B	BASIN	842			13	1.94	231	61	20	9	1.108	1.174	1.175	1.175	114	121	121	121
PR	COMBINE	4454			14.3	15.41	1913	565	190	82	1.154	1.365	1.376	1.376	949	1122	1131	1131
Q1A	BASIN	915			12.5	1.3	173	48	16	7	1.242	1.372	1.374	1.374	86	95	95	95
RRQ1A	STORAGE	836	3.1	5.26	12.7	1.3	173	48	16	7	1.242	1.372	1.374	1.374	86	95	95	95
Q1A-P	ROUTE	816	101.2	23.86	12.9	1.3	173	48	16	7	1.24	1.371	1.374	1.374	86	95	95	95
P	COMBINE	4581			14.3	16.71	2062	606	204	88	1.147	1.349	1.362	1.362	1022	1202	1213	1213
N2B	BASIN	1331			13.1	3.33	378	99	33	14	1.057	1.102	1.103	1.103	187	195	196	196
O1	BASIN	1163			13.3	3.09	349	91	30	13	1.05	1.095	1.096	1.096	173	180	180	180
M2	BASIN	2347			13.4	7.44	786	198	66	29	0.983	0.989	0.99	0.99	390	392	392	392
Z1	BASIN	558			12.5	0.66	80	21	7	3	1.127	1.161	1.161	1.161	40	41	41	41
L2B	BASIN	1700			13	4.08	449	112	37	16	1.024	1.024	1.024	1.024	223	223	223	223
L2B-L3	ROUTE	1323	12.9	226.51	14.8	4.08	447	112	37	16	1.02	1.024	1.024	1.024	222	223	223	223
L2C	BASIN	692			12.8	1.33	145	36	12	5	1.013	1.013	1.013	1.013	72	72	72	72
L2C-2D	ROUTE	651	12.9	27.24	13.2	1.33	145	36	12	5	1.013	1.013	1.013	1.013	72	72	72	72
L2D	BASIN	655			12.7	1.23	124	31	10	4	0.934	0.934	0.934	0.934	61	61	61	61
L3RB	COMBINE	1104			13	2.56	266	66	22	10	0.965	0.965	0.965	0.965	132	132	132	132
L2D-L3	ROUTE	705	12.5	201.22	16.1	2.56	263	66	22	10	0.956	0.965	0.965	0.965	130	132	132	132
L3	BASIN	2129			13.2	5.85	658	166	56	24	1.045	1.058	1.058	1.058	326	330	330	330
L	COMBINE	2162			13.3	12.49	1287	335	112	48	0.958	0.997	0.997	0.997	638	664	664	664

Channels Hydraulics Summary

		Design Geometry						Hydraulics										
Structure ID	Type	Initial Slope (ft/ft)	Long-term Slope (ft/ft)	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Chnl Mannings n	Flow Rate (cfs)	Wetted Perimeter (ft)	Wetted XS Area (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flow Depth (ft)	Freeboard (ft)	Top Width (ft)	Velocity (ft/s)	Froude Number	Shear Stress (lb/sq. ft)
L2A10	Leveed	0.0128	0.0050	0.70	3	4.5	0.045	2326	388.5	514.2	1.3	1.3	1.3	3.2	388	4.5	0.69	0.42
N110	Leveed	0.0234	0.0070	1.00	3	4.5	0.045	5030	410.9	697.4	1.7	1.7	1.7	2.8	410	7.2	0.97	0.75
N120	Leveed	0.0129	0.0050	0.80	3	5.0	0.045	4690	412.5	800.6	1.9	1.9	2.0	3.0	412	5.9	0.74	0.62
N125	Leveed	0.0131	0.0050	1.50	3	5.0	0.045	4298	411.8	755.7	1.8	1.8	1.9	3.1	411	5.7	0.74	0.58
N130	Leveed	0.0132	0.0050	2.10	3	5.5	0.045	4805	412.6	807.0	2.0	2.0	2.0	3.5	412	6.0	0.75	0.62
N140	Leveed	0.0072	0.0030	1.10	3	5.0	0.045	4581	414.6	942.1	2.3	2.3	2.3	2.7	414	4.9	0.57	0.43
P1B10	Leveed	0.0112	0.0050	1.00	3	4.5	0.045	1105	169.5	245.9	1.5	1.5	1.5	3.0	169	4.5	0.66	0.47
L30	Excavated	0.0048	0.0048	1.20	3	6.5	0.045	2162	146.5	447.6	3.1	3.1	5.0	1.5	145	4.8	0.48	1.49
L40	Excavated	0.0040	0.0040	1.50	3	6.5	0.045	2162	147.7	474.3	3.2	3.2	5.2	1.3	146	4.6	0.45	1.29
RRP1A10	Leveed	0.0196	0.0080	0.30	3	4.0	0.045	516	106.7	109.4	1.0	1.0	1.1	2.9	106	4.7	0.82	0.53

Basins Hydraulics Summary

			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac.	Peak Inflow into Basin (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Freeboard (ft)
RRL2BR	Online Basin	0.0240	600	350	10.0	34.3	25.8	342.0	2519	2241	7.0	3.0
RRCM1	Online Basin	0.0250	800	400	11.0	58.6	41.2	806.0	5070	4579	7.3	3.7
RRCN1	Online Basin	0.0210	900	400	11.0	67.3	60.4	898.0	4690	4273	9.1	1.9
RRP1A	Online Basin	0.0222	350	200	5.0	5.2	3.7	44.0	575	516	2.9	2.1
RRQ1A	Online Basin	0.0300	450	220	6.0	8.8	6.3	97.0	990	908	3.7	2.3

Online Basin

HEC1 ID	RRL2BR

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	4.2	sq. mi
Total Sediment Yield Volume	8.1	ac ft

Required Minimum Sediment Volume

Sediment Volume	8.1	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.024	0.024
Basin Length (ft)	600	770
Basin Width (ft)	350	350
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	10	10
Freeboard (ft)	1	1
Effective Basin Width (ft)	325	300
Top Area (acres)	4.8	6.2
U/S-D/S Height Difference (ft)	8.4	8.4
Excess Area on Upstream (acres)	0.4	0.9

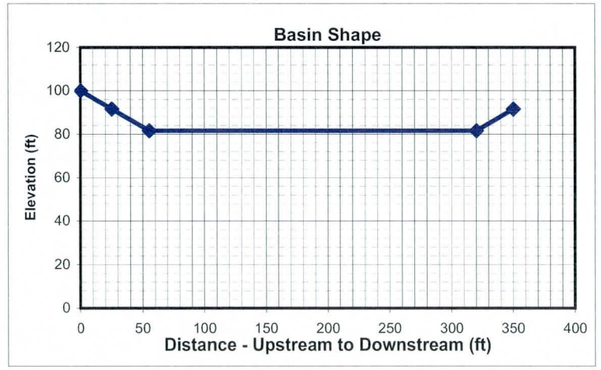
			Base	LC Enhanced
Bottom Length (ft)	540	Allocated Storage Volume (ac. ft)	34.3	34.2
Bottom Width (ft)	265	Total Available Volume (ac. ft) (incl. Freeboard)	38.7	39.4
		Total Excavation Volume (ac. ft)	59.0	65.4

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	5.00	ft
Invert Elevation	0.00	ft
Number of pipes	9	

Stage-Storage-Discharge

Elevation	0	2	4	5	6	8	9	10	11	12
Volume	0.00	6.79	14.05	17.85	21.77	29.97	34.26	38.67	43.21	47.88
Outflow	0.0	1203.3	1701.8	1902.6	2084.2	2406.6	2552.6	2690.7	2822.0	2947.5



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	314.0	342	342.0
Peak Inflow (cfs)	2391	2519	2519.0
Peak Outflow (cfs)	2172	2241	2241.0
Stage at Peak Outflow (ft)	6.5	7	7.0
Volume at Peak Outflow (ac. ft)	24.0	25.79	25.8

Volume Check

Total Volume needed	33.9	ac. ft
Total Volume Provided	34.3	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	8.0	ft
Depth Provided	10	ft
Depth OK?	Yes	

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	181500	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	600	ft
Base Total ROW Width	350	ft
LC Enh. Total ROW Length	870	ft
LC Enh. Total ROW Length	450	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	95187	105512
Excavated Area (sq. Yd)	23333	43500

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	58	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	647	sq. Yd
Material Volume	324	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	526	ft
Unit Cost	160	per ft
Cost per outlet	$84,160	
Other Cost	$ -	
Total Cost	$84,160	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		95,187	cu. Yd	$ 4.00	$ 380,748	23,333	sq. Yd	$ 9.00	$ 209,997	23,333	sq. Yd	$ 8.33	$ 194,442
Basin - LC Enhancement		10,325	cu. Yd	$ 4.00	$ 41,300	20,167	sq. Yd	$ 9.00	$ 181,503	20,167	sq. Yd	$ 8.33	$ 168,058
Inlet	Riprap	324	sq. Yd	$ 75.00	$ 24,300	647	sq. Yd	$ -	$ -	647	sq. Yd	$ 33.33	$ 21,567
Inlet - LC Enhancement (20%Inlet)					$ 4,860				$ -				$ 4,313
Outlet	Pipe	1	EA	$ 84,160	$ 84,160	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 4,208				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 209,997	Base Maintenance Cost			$ 218,225
						LC Enh. Landscape Cost			$ 181,503	LC Enh. Maintenance Cost			$ 172,483
						Total Landscape Cost			$ 391,500	Total Maintenance Cost			$ 390,708

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 489,208	$ 41,300	$ 530,508
Contingency Cost (25% of Construction Cost)	$ 122,302	$ 10,325	$ 132,627
Engineering Design Cost (5% of Construction Cost)	$ 24,460	$ 2,065	$ 26,525
Total Construction Cost	$ 635,970	$ 53,690	$ 689,660

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	4.2	$100,000	$ 420,000
Basin	4.8	$100,000	$ 480,000
Other		$100,000	$ -
Total	9.0	$100,000	$ 900,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	4.8	$100,000	$ 480,000
LC Enhancement Cost	acre	4.2	$100,000	$ 420,000
Total Land Cost	acre	9	$100,000	$ 900,000

Total Cost

Base Total Cost	$ 1,544,192
Total LC Enhancement Cost	$ 827,676
Total Cost Including LC Enh.	$ 2,371,868

Open Channel

Structure ID	L2A10

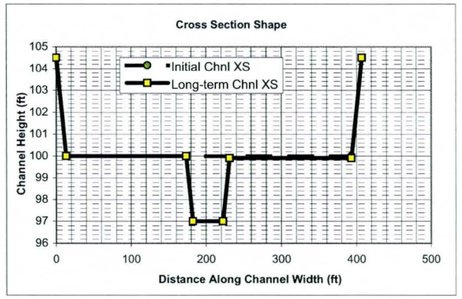
HEC1 ID	L2A-M1

Longitudal Geometry

Length	3875.0	ft
U/S Elev	1616.0	ft
D/S Elev	1566.2	ft
Initial Channel Slope	0.0128	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	3



Initial Channel XS Geometry

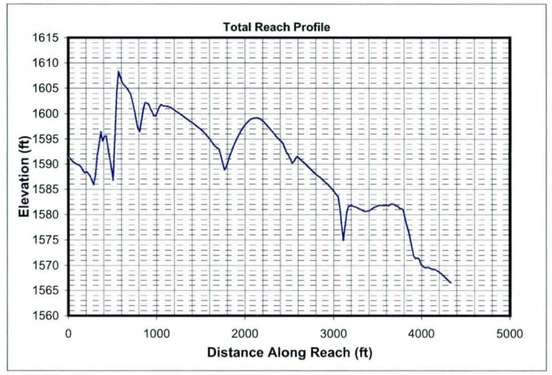
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	380	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	393.5	393.5	393.5	407
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	160	3	40	7.5	3	162	4.6	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	173.5	182.5	222.5	231.2	393.2	407
Y	104.5	100	100	97	97	99.9	99.9	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RRL2BR	L2B							TOTAL
HEC1 Peak-Flow	2241	1700							3941
Weighting Factor	1.00	0.05							
Flow into Channel	2241	85							2326

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	4.24	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	2326	cfs	
Long-term Max. Chnl Capacity	12747	cfs	
Q2 Channel	233	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	407	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
233	382.1	128.4	0.3	100.0	100.3	1.8	0.3	382.0	0.3	0.11	0.55
698	384.1	248.5	0.6	100.0	100.7	2.8	0.7	383.9	0.6	0.20	0.62
1745	387.1	432.0	1.1	100.0	101.1	4.0	1.1	386.8	1.1	0.35	0.67
2326	388.5	514.2	1.3	100.0	101.3	4.5	1.3	388.0	1.3	0.42	0.69

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
233	50.7	75.9	1.5	97.0	98.7	3.1	1.7	50.1	1.5	0.53	0.44
698	383.7	329.7	0.9	97.0	100.4	2.1	3.4	382.6	0.9	1.07	0.40
1745	387.7	573.8	1.5	97.0	101.1	3.0	4.1	386.4	1.5	1.27	0.44
2326	389.5	683.2	1.8	97.0	101.4	3.4	4.4	388.1	1.8	1.36	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
233										0
698										0
1745										0
2326										0

Allowable Velocity

Channel Lining: Natural - Coarse Gravel (noncolloidal)

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
233	1.74	1.0592	1.0062	Erosive	Erosive	Erosive	0.2	Stable	5.8	Stable	Stable
698	1.74	1.2613	1.1983	Erosive	Erosive	Erosive	0.3	Stable	7.6	Stable	Stable
1745	1.74	1.4296	1.3581	Erosive	Erosive	Erosive	0.3	Stable	9.0	Stable	Stable
2326	1.74	1.4822	1.4081	Erosive	Erosive	Erosive	0.3	Stable	9.6	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	6

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	233	698	1745	2326	233	698	1745	2326	233	698	1745	2326
Bray - Equation #1	42	75	122	142	1.6	2.4	3.2	3.5	3.4	4.0	4.5	4.7
Bray - Equation #2	55	98	160	186	1.8	2.6	3.5	3.8	2.3	2.7	3.1	3.2
Hey	13	24	39	46	5.1	7.8	11.0	12.3				
Ackers & Charlton/Lacey	36	56	83	93					2.0	2.4	2.8	2.9
Parker	105	181	287	331	1.3	2.1	3.1	3.5				
Chang	72	141	246	292	0.1	-0.1	-0.6	-0.8				
Kellerhals	27	48	75	87	2.4	3.7	5.4	6.0	3.5	3.9	4.3	4.4
AMAFCA/Schumm	50	383	387	389								
Moody & Odem	21	21	21	21	1.2	1.2	1.2	1.2				
BUREC	20.5	31.0	43.6	48.6	5	8	12	13	3.3	4.3	5.4	5.8
Average	44	106	146	164	2.4	3.5	4.8	5.3	2.9	3.5	4.0	4.2
Values As Designed	50	383	386	388	1.7	3.4	4.1	4.4	3.1	2.1	3.0	3.4
Difference with Design	-6	-277	-240	-225	0.7	0.0	0.7	1.0	-0.2	1.3	1.0	0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
233	1442	929	1857	2506	5171	374	364	206	5664	426	1510	1859
698	7898	3984	7408	16170	8434	2327	1675	1599	18430	1929	8820	7152
1745	32445	11886	19678	76365	12042	8628	4620	6421	47158	7237	33207	23608
2326	50522	16526	25469	124240	13383	12871	6217	9633	63118	11020	49472	34770

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
233	2299	1482	2961	3997	8248	596	581	329	9034	680	2409	2965
698	4199	2118	3938	8597	4484	1237	890	850	9799	1025	4689	3803
1745	6900	2528	4185	16240	2561	1835	983	1366	10029	1539	7062	5021
2326	8058	2636	4062	19816	2135	2053	992	1536	10067	1758	7891	5546

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
233	1167	544	806	2186	1032	234	176	281	1470	243	1380	865
698	2129	1114	1853	3415	5171	370	361	428	4036	469	2401	1977
1745	8736	3893	6084	16099	7855	1747	1328	2099	11008	1804	10312	6451
2326	13596	5609	8293	26172	8859	2681	1875	3276	14882	2775	15881	9445

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
233	1861	868	1286	3486	1647	373	280	449	2345	388	2201	1380
698	1132	592	985	1816	2749	197	192	228	2146	250	1277	1051
1745	1858	828	1294	3424	1671	372	283	446	2341	384	2193	1372
2326	2169	895	1323	4174	1413	428	299	523	2374	443	2533	1507

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
233	0.0025	0.0036	122	0.37	0.046	0.0007	29	0.035	0.0006	0.0159	0.0008	0.0019	0.0057	0.0003	0.0027	0.0128	0.0052
698	0.0011	0.0019	170	0.52	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0009	0.0057	0.0002	0.0012	0.0128	0.0049
1745	0.0006	0.0011	223	0.68	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0057	0.0001	0.0006	0.0128	0.0048
2326	0.0005	0.0009	243	0.74	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0057	0.0001	0.0005	0.0128	0.0048

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	30.4	ft
Height of Drop Structure	3	ft
No . of Drop Structures	11	
Distance between structs.	352	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.21	sq. mi
Total Sediment Yield Volume	0.40	ac ft

Sedimentation Basins

Length	352 ft	Depth	3 ft
Width	407 ft	Side slope	3 ft/ft
Total Volume per Basin		9.41	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
233	1.1	-0.5	0.1	24.6	1.7	1.5	3.1	0.0050	0.2	1.5	3.0	6.2
698	1.1	-1.2	0.1	24.6	3.4	0.9	2.1	0.0050	0.3	1.5	3.0	6.3
1745	1.1	-1.2	0.1	24.6	4.1	1.5	3.0	0.0050	0.4	1.5	3.0	6.5
2326	1.1	-1.2	0.2	24.6	4.4	1.8	3.4	0.0050	0.5	1.5	3.0	6.6

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	2205	cfs
Stage at Peak Flow	101.3	ft
Volume at Peak Flow	342.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.40	ac. ft
Outflowing Sediment Volume	0.19	ac. ft
Deposited(+)/Eroded(-) Volume	0.21	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3875	3875
Side Slope (?H:1V)	3	3
Channel Width (ft)	407	407
Channel XS Area (sq. ft)	1933.9	1933.9
Channel Perimeter (ft)	409	409

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3875	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	1292	sq. Yd
Volume	4306	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3875	3875
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	18083	37458
Left Levee Volume (cu. Yd)	17796	41907
Right Levee Length (ft)	3875	3875
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	18083	37458
Right Levee Volume (cu. Yd)	17796	41907
Total Levee Surface Area (sq. Yd)	36166	74916
Total Levee Volume (cu. Yd)	35592	83814

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3875	3875
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	6028	14208
Left Levee Lining Volume (cu. Yd)	3014	7104
Right Levee Length (ft)	3875	3875
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	6028	14208
Right Levee Lining Volume (cu. Yd)	3014	7104
Total Lining Area (sq. Yd)	12056	28417
Total Lining Volume (cu. Yd)	6028	14208

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	407	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	6.5	ft	
Structure Height	9.5	ft	
Number of Structures	11		
Volume per structure	432	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 32,400		
Area per structure	136	sq. Yd	
Total Area	1,492	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	15181	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 60,724	
Other Cost	$ -	
Total cost per basin	$ 60,724	
Area per basin	15,931	sq. Yd
Total Area	15,931	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	35,592	cu. Yd	$ 7.00	$ 249,144	36,166	sq. Yd	$ 9.00	$ 325,494	36,166	sq. Yd	$ 11.67	$ 421,937
Levee - LC Enhancement	Fill	48,222	cu. Yd	$ 7.00	$ 337,554	38,750	sq. Yd	$ 9.00	$ 348,750	48,222	sq. Yd	$ 11.67	$ 562,590
Levee Lining	Riprap	6,028	cu. Yd	$ 75.00	$ 452,100	12,056	sq. Yd	$ -	$ -	12,056	sq. Yd	$ 20.83	$ 251,157
Levee Lining -LC Enhancement	Riprap	8,180	cu. Yd	$ 75.00	$ 613,500	16,361	sq. Yd	$ -	$ -	16,361	sq. Yd	$ 20.83	$ 340,856
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	4,306	cu. Yd	$ 75.00	$ 322,950	1,292	sq. Yd	$ -	$ -	1,292	sq. Yd	$ 25.00	$ 32,300
Drop Structures	Riprap	11	EA	$ 32,400.00	$ 356,400	1,492	sq. Yd	$ -	$ -	1,492	sq. Yd	$ 33.33	$ 49,733
Drop Str. - LC Enhancement	Riprap	11	EA	$ 3,240.00	$ 35,640	149	sq. Yd	$ -	$ -	149	sq. Yd	$ 33.33	$ 4,973
Sedimentation Basins		1	EA	$ 60,724.00	$ 60,724	15,931	sq. Yd	$ -	$ -	15,931	sq. Yd	$ 8.33	$ 132,758
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 325,494	Base Maintenance Cost			$ 887,886
						LC Enhancement Cost			$ 348,750	LC Enhancement Cost			$ 908,420
						Total Landscape Cost			$ 674,244	Total Maintenance Cost			$ 1,796,306

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,441,318	$ 986,694	$ 2,428,012
Contingency Cost (25% of Construction Cost)	$ 360,330	$ 246,674	$ 607,003
Engineering Design Cost (5% of Construction Cost)	$ 72,066	$ 49,335	$ 121,401
Total Construction Cost	$ 1,873,713	$ 1,282,702	$ 3,156,416

Land Cost

Channel Length	3875 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	407	36.2	$100,000	$ 3,620,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	4.9	$100,000	$ 490,000
Levee LC Enhancement	51	4.5	$100,000	$ 450,000
Other	0	0	$100,000	$ -
Total	513	45.6		$ 4,560,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	41.1	$100,000	$ 4,110,000
LC Enhancement Cost	acre	4.5	$100,000	$ 450,000
Total Land Cost	acre	45.6	$100,000	$ 4,560,000

Total Cost

Base Total Cost	$ 7,197,093
Total Landscape Enhancement Cost	$ 2,989,872
Total Cost Including LC Enh.	$ 10,186,965

Online Basin

HEC1 ID	RRCM1

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID	L2A-M1						Total Volume (ac. ft)
Inflow Volume (ac. ft)	342						342
Volume Fraction	1						
Weighted Volume	342						342
Sediment Conc. (ppm)	1507						
Sediment Volume (ac. ft)	0.19						0.19
Weighting Factor	1						
Weighted Sed. Vol. (ac. ft)	0.19						0.19

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	5.7	sq. mi
Total Sediment Yield Volume	10.8	ac ft

Required Minimum Sediment Volume

Sediment Volume	11.0	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.025	0.025
Basin Length (ft)	800	1020
Basin Width (ft)	400	400
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	11	11
Freeboard (ft)	1	1
Effective Basin Width (ft)	370	340
Top Area (acres)	7.3	9.4
U/S-D/S Height Difference (ft)	10.0	10.0
Excess Area on Upstream (acres)	0.6	1.4

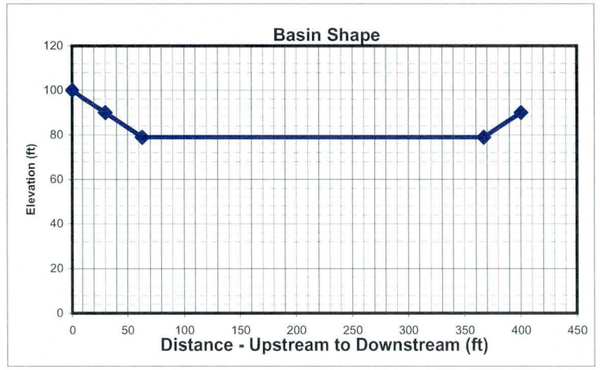
			Base	LC Enhanced
Bottom Length (ft)	734	Allocated Storage Volume (ac. ft)	58.6	58.6
Bottom Width (ft)	304	Total Available Volume (ac. ft) (incl. Freeboard)	65.4	66.4
		Total Excavation Volume (ac. ft)	102.1	113.2

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	5.00	ft
Invert Elevation	0.00	ft
Number of pipes	18	

Stage-Storage-Discharge

Elevation	0	2	4	6	8	9	10	11	12	13
Volume	0.00	10.53	21.65	33.37	45.70	52.09	58.65	65.36	72.24	79.28
Outflow	0.0	2406.6	3403.5	4168.4	4813.3	5105.3	5381.4	5644.1	5895.0	6135.8



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	658.0	806	806.0
Peak Inflow (cfs)	4159	5070	5070.0
Peak Outflow (cfs)	3976	4579	4579.0
Stage at Peak Outflow (ft)	5.5	7.3	7.3
Volume at Peak Outflow (ac. ft)	30.5	41.24	41.2

Volume Check

Total Volume needed	52.2	ac. ft
Total Volume Provided	58.6	ac. ft

Volume OK?	Yes

Stage Check

Depth Needed	8.3	ft
Depth Provided	11	ft

Depth OK?	Yes

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	240000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	800	ft
Base Total ROW Width	400	ft
LC Enh. Total ROW Length	1120	ft
LC Enh. Total ROW Length	500	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	164721	182629
Excavated Area (sq. Yd)	35556	62222

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	66	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	738	sq. Yd
Material Volume	369	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	550	ft
Unit Cost	160	per ft
Cost per outlet	$88,000	
Other Cost	$ -	
Total Cost	$88,000	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		164,721	cu. Yd	$ 4.00	$ 658,884	35,556	sq. Yd	$ 9.00	$ 320,004	35,556	sq. Yd	$ 8.33	$ 296,300
Basin - LC Enhancement		17,908	cu. Yd	$ 4.00	$ 71,632	26,666	sq. Yd	$ 9.00	$ 239,994	26,666	sq. Yd	$ 8.33	$ 222,217
Inlet	Riprap	369	sq. Yd	$ 75.00	$ 27,675	738	sq. Yd	$ -	$ -	738	sq. Yd	$ 33.33	$ 24,600
Inlet - LC Enhancement (20%Inlet)					$ 5,535				$ -				$ 4,920
Outlet	Pipe	1	EA	$ 88,000	$ 88,000	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 4,400				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 320,004	Base Maintenance Cost			$ 323,117
						LC Enh. Landscape Cost			$ 239,994	LC Enh. Maintenance Cost			$ 227,248
						Total Landscape Cost			$ 559,998	Total Maintenance Cost			$ 550,364

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 774,559	$ 71,632	$ 846,191
Contingency Cost (25% of Construction Cost)	$ 193,640	$ 17,908	$ 211,548
Engineering Design Cost (5% of Construction Cost)	$ 38,728	$ 3,582	$ 42,310
Total Construction Cost	$ 1,006,927	$ 93,122	$ 1,100,048

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	5.5	$100,000	$ 550,000
Basin	7.3	$100,000	$ 730,000
Other		$100,000	$ -
Total	12.8	$100,000	$ 1,280,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	7.3	$100,000	$ 730,000
LC Enhancement Cost	acre	5.5	$100,000	$ 550,000
Total Land Cost	acre	12.8	$100,000	$ 1,280,000

Total Cost

Base Total Cost	$ 2,380,047
Total LC Enhancement Cost	$ 1,110,363
Total Cost Including LC Enh.	$ 3,490,410

Open Channel

Structure ID	N110

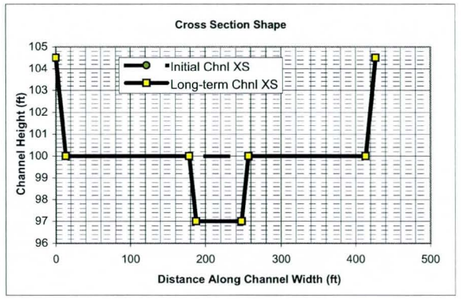
HEC1 ID	M1-N1

Longitudal Geometry

Length	5444.1	ft
U/S Elev	1565.0	ft
D/S Elev	1437.4	ft
Initial Channel Slope	0.0234	ft/ft
Long-term Channel Slope	0.0070	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	4



Initial Channel XS Geometry

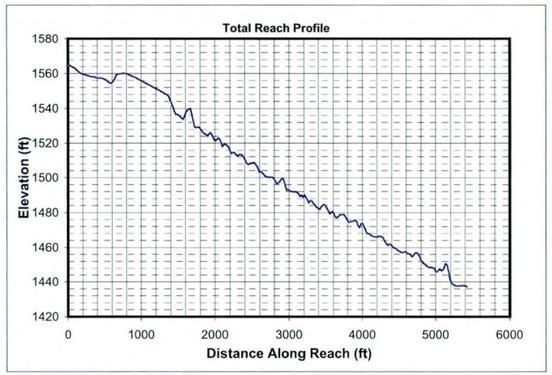
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	400	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	413.5	413.5	413.5	427
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	165	3	60	7.5	3	157	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	178.5	187.5	247.5	256.5	413.5	427
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RRCM1	N1							TOTAL
HEC1 Peak-Flow	4579	1253							5832
Weighting Factor	1.00	0.36							
Flow into Channel	4579	451							5030

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	11.45	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	5030	cfs	
Long-term Max. Chnl Capacity	16334	cfs	
Q2 Channel	503	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	427	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
503	402.7	173.9	0.4	100.0	100.4	2.9	0.4	402.6	0.4	0.19	0.78
1509	405.3	336.8	0.8	100.0	100.8	4.5	0.8	405.0	0.8	0.37	0.87
3773	409.2	585.9	1.4	100.0	101.4	6.4	1.4	408.7	1.4	0.63	0.95
5030	410.9	697.4	1.7	100.0	101.7	7.2	1.7	410.3	1.7	0.75	0.97

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
503	72.1	125.5	1.7	97.0	98.9	4.0	1.9	71.5	1.8	0.83	0.53
1509	405.3	484.0	1.2	97.0	100.7	3.1	3.7	404.1	1.2	1.61	0.50
3773	410.9	843.2	2.1	97.0	101.6	4.5	4.6	409.4	2.1	2.00	0.55
5030	413.4	1004.5	2.4	97.0	102.0	5.0	5.0	411.8	2.4	2.17	0.56

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
503										0
1509										0
3773										0
5030										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
503	1.74	1.1365	1.0797	Erosive	Erosive	Erosive	0.2	Erosive	7.5	Stable	Stable
1509	1.74	1.3386	1.2716	Erosive	Erosive	Erosive	0.3	Erosive	9.8	Stable	Stable
3773	1.74	1.5065	1.4312	Erosive	Erosive	Erosive	0.4	Erosive	12.0	Stable	Stable
5030	1.74	1.5590	1.4811	Erosive	Erosive	Erosive	0.4	Erosive	12.8	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	503	1509	3773	5030	503	1509	3773	5030	503	1509	3773	5030
Bray - Equation #1	63	113	183	212	2.1	3.0	4.1	4.5	3.8	4.4	5.0	5.2
Bray - Equation #2	83	148	240	279	2.3	3.3	4.5	5.0	2.6	3.0	3.4	3.6
Hey	20	36	60	70	6.9	10.4	14.7	16.4				
Ackers & Charlton/Lacey	49	78	114	129					2.3	2.7	3.2	3.3
Parker	154	267	422	487	1.8	2.9	4.2	4.8				
Chang	129	250	432	513	-0.2	-0.8	-1.7	-2.1				
Kellerhals	40	70	111	128	3.3	5.1	7.3	8.2	3.8	4.2	4.6	4.8
AMAFCA/Schumm	72	405	410	412								
Moody & Odem	31	31	31	31	1.4	1.4	1.4	1.4				
BUREC	25.7	38.8	54.7	60.9	7	10	15	16	4.5	5.9	7.4	8.0
Average	67	144	206	232	3.1	4.5	6.2	6.8	3.4	4.1	4.7	5.0
Values As Designed	71	404	409	412	1.9	3.7	4.6	5.0	4.0	3.1	4.5	5.0
Difference with Design	-5	-261	-204	-179	1.1	0.8	1.6	1.8	-0.6	0.9	0.3	0.0

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
503	10634	5295	11117	24166	10073	3925	2555	2050	33177	2883	11244	10647
1509	58180	18874	32536	155808	15120	18402	8166	10251	101211	13357	52452	44032
3773	238809	51693	81530	734989	20726	73819	20001	34770	254290	49566	174890	157735
5030	371796	70475	109767	1195202	22829	117824	26304	50360	339335	71352	252342	238871

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
503	7844	3906	8200	17824	7430	2895	1884	1512	24471	2127	8293	7853
1509	14304	4640	7999	38307	3717	4524	2008	2520	24883	3284	12896	10826
3773	23485	5084	8018	72281	2038	7260	1967	3419	25008	4874	17199	15512
5030	27423	5198	8096	88155	1684	8690	1940	3714	25028	5263	18612	17619

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
503	5073	1894	2837	11026	2023	1088	637	1118	5433	1071	5576	3434
1509	10863	4696	7894	21244	8928	2481	1778	2452	15975	2354	12541	8291
3773	44507	14374	20961	99939	12785	9177	4899	9481	40962	9225	47203	28501
5030	69222	20121	27155	162317	14230	13678	6593	14121	54844	10073	70431	42071

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
503	3742	1397	2092	8132	1492	803	470	824	4007	790	4113	2533
1509	2671	1154	1941	5223	2195	610	437	603	3928	579	3083	2039
3773	4377	1414	2061	9828	1257	902	482	932	4028	907	4642	2803
5030	5106	1484	2003	11972	1050	1009	486	1042	4045	743	5195	3103

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
503	0.0015	0.0028	187	0.57	0.050	0.0006	31	0.036	0.0004	0.0159	0.0006	0.0013	0.0044	0.0002	0.0015	0.0234	0.0073
1509	0.0006	0.0015	260	0.79	0.053	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0007	0.0044	0.0001	0.0007	0.0234	0.0072
3773	0.0003	0.0008	341	1.04	0.056	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0044	0.0001	0.0003	0.0234	0.0071
5030	0.0003	0.0007	371	1.13	0.057	0.0002	33	0.036	0.0001	0.0159	0.0002	0.0003	0.0044	0.0001	0.0003	0.0234	0.0070

Drop Structures

Design Slope	0.0070	ft/ft
Total Drop Needed	89.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	30	
Distance between structs.	181	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.54	sq. mi
Total Sediment Yield Volume	1.03	ac ft

Sedimentation Basins

Length	181 ft	Depth	3 ft
Width	427 ft	Side slope	3 ft/ft
Total Volume per Basin		4.97	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
503	1.1	-0.5	0.2	24.6	1.9	1.8	4.0	0.0070	0.2	1.5	3.0	6.3
1509	1.1	-1.1	0.1	24.6	3.7	1.2	3.1	0.0070	0.4	1.5	3.0	6.5
3773	1.1	-1.1	0.3	24.6	4.6	2.1	4.5	0.0070	0.5	1.5	3.0	6.7
5030	1.1	-1.1	0.3	24.6	5.0	2.4	5.0	0.0070	0.6	1.5	3.0	6.8

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	4462	cfs
Stage at Peak Flow	101.7	ft
Volume at Peak Flow	806.0	ac. ft

Freeboard

Max. Flow Depth	1.7	ft
Channel Depth as designed	4.5	ft
Available Freeboard	2.8	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.03	ac. ft
Outflowing Sediment Volume	0.94	ac. ft
Deposited(+)/Eroded(-) Volume	0.09	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5444	5444
Side Slope (?H:1V)	3	3
Channel Width (ft)	427	427
Channel XS Area (sq. ft)	2067.8	2067.8
Channel Perimeter (ft)	429	429

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5444	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	1815	sq. Yd
Volume	6049	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5444	5444
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	25405	52625
Left Levee Volume (cu. Yd)	25002	58876
Right Levee Length (ft)	5444	5444
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	25405	52625
Right Levee Volume (cu. Yd)	25002	58876
Total Levee Surface Area (sq. Yd)	50810	105250
Total Levee Volume (cu. Yd)	50004	117752

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5444	5444
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	8468	19961
Left Levee Lining Volume (cu. Yd)	4234	9981
Right Levee Length (ft)	5444	5444
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	8468	19961
Right Levee Lining Volume (cu. Yd)	4234	9981
Total Lining Area (sq. Yd)	16937	39923
Total Lining Volume (cu. Yd)	8468	19962

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	427	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	9.8	ft	
Structure Height	12.8	ft	
Number of Structures	30		
Volume per structure	609	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 45,675		
Area per structure	142	sq. Yd	
Total Area	4,270	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	8018	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 32,072	
Other Cost	$ -	
Total cost per basin	$ 32,072	
Area per basin	8,610	sq. Yd
Total Area	8,610	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost	
Levee	Fill	50,004	cu. Yd	$ 7.00	$ 350,028	50,810	sq. Yd	$ 9.00	$ 457,290	50,810	sq. Yd	$ 11.67	$ 592,783	
Levee - LC Enhancement	Fill	67,748	cu. Yd	$ 7.00	$ 474,236	54,440	sq. Yd	$ 9.00	$ 489,960	67,748	sq. Yd	$ 11.67	$ 790,393	
Levee Lining	Riprap	8,468	cu. Yd	$ 75.00	$ 635,100	16,937	sq. Yd	$ -	$ -	16,937	sq. Yd	$ 20.83	$ 352,852	
Levee Lining -LC Enhancement	Riprap	11,494	cu. Yd	$ 75.00	$ 862,050	22,986	sq. Yd	$ -	$ -	22,986	sq. Yd	$ 20.83	$ 478,870	
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -	
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	
Toe Protection	Riprap	6,049	cu. Yd	$ 75.00	$ 453,675	1,815	sq. Yd	$ -	$ -	1,815	sq. Yd	$ 25.00	$ 45,375	
Drop Structures	Riprap	30	EA	$ 45,675.00	$ 1,370,250	4,270	sq. Yd	$ -	$ -	4,270	sq. Yd	$ 33.33	$ 142,333	
Drop Str. - LC Enhancement	Riprap	30	EA	$ 4,567.50	$ 137,025	427	sq. Yd	$ -	$ -	427	sq. Yd	$ 33.33	$ 14,233	
Sedimentation Basins		1	EA	$ 32,072.00	$ 32,072	8,610	sq. Yd	$ -	$ -	8,610	sq. Yd	$ 8.33	$ 71,750	
Other					$ -				$ -				$ -	

Base Landscape Cost	$ 457,290	Base Maintenance Cost	$ 1,205,094
LC Enhancement Cost	$ 489,960	LC Enhancement Cost	$ 1,283,497
Total Landscape Cost	$ 947,250	Total Maintenance Cost	$ 2,488,591

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 2,841,125	$ 1,473,311	$ 4,314,436
Contingency Cost (25% of Construction Cost)	$ 710,281	$ 368,328	$ 1,078,609
Engineering Design Cost (5% of Construction Cost)	$ 142,056	$ 73,666	$ 215,722
Total Construction Cost	$ 3,693,463	$ 1,915,304	$ 5,608,767

Land Cost

Channel Length	5444 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	427	53.4	$100,000	$ 5,340,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	6.9	$100,000	$ 690,000
Levee LC Enhancement	51	6.4	$100,000	$ 640,000
Other	0	0	$100,000	$ -
Total	533	66.7		$ 6,670,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	60.3	$100,000	$ 6,030,000
LC Enhancement Cost	acre	6.4	$100,000	$ 640,000
Total Land Cost	acre	66.7	$100,000	$ 6,670,000

Total Cost

Base Total Cost	$ 11,385,846
Total Landscape Enhancement Cost	$ 4,328,761
Total Cost Including LC Enh.	$ 15,714,607

Open Channel

Structure ID	N120

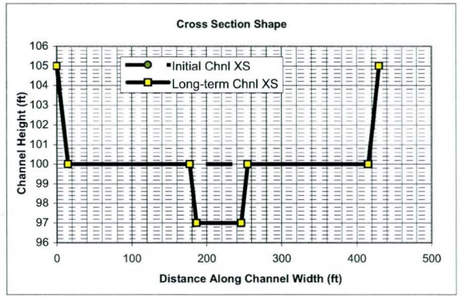
HEC1 ID	M1-N1

Longitudal Geometry

Length	4224.1	ft
U/S Elev	1437.4	ft
D/S Elev	1382.8	ft
Initial Channel Slope	0.0129	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	4



Initial Channel XS Geometry

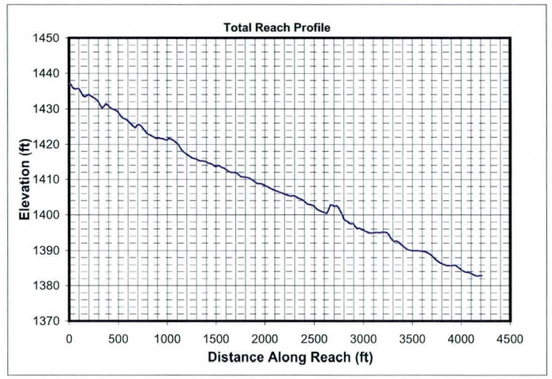
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	400	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	415	415	415	430
Y	105	100	100	100	100	100	100	105

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	162	3	60	8	3	160	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	177	186	246	255	415	430
Y	105	100	100	97	97	100	100	105



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	CN1								TOTAL
HEC1 Peak-Flow	4690								4690
Weighting Factor	1.00								
Flow into Channel	4690								4690

Reach Sediment Inflow Characteristics

U/S Contributing ID	M1-N1_N110								TOTAL
Flow Volume (ac. ft)	806.00								806
Sediment Conc. (ppm)	3103								
Sediment Volume (ac. ft)	0.94								0.94
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.94								0.94

Hydrology

Drainage Area	11.45	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	4690	cfs	
Long-term Max. Chnl Capacity	16191	cfs	
Q2 Channel	469	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	430	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
469	403.1	199.3	0.5	100.0	100.5	2.4	0.5	403.0	0.5	0.15	0.59
1407	406.1	386.3	1.0	100.0	101.0	3.6	1.0	405.8	1.0	0.30	0.66
3518	410.5	672.4	1.6	100.0	101.7	5.2	1.7	410.0	1.6	0.52	0.72
4690	412.5	800.6	1.9	100.0	102.0	5.9	2.0	411.8	1.9	0.62	0.74

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
469	72.8	133.6	1.8	97.0	99.0	3.5	2.0	72.1	1.9	0.63	0.45
1407	405.8	513.6	1.3	97.0	100.8	2.7	3.8	404.6	1.3	1.17	0.43
3518	411.7	895.1	2.2	97.0	101.7	3.9	4.7	410.2	2.2	1.47	0.47
4690	414.4	1066.6	2.6	97.0	102.1	4.4	5.1	412.7	2.6	1.60	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
	M1-N1_N110									
469	3434									3434
1407	8291									8291
3518	28501									28501
4690	42071									42071

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
469	1.74	1.1784	1.1195	Erosive	Erosive	Erosive	0.2	Stable	6.6	Stable	Stable
1407	1.74	1.3803	1.3113	Erosive	Erosive	Erosive	0.3	Stable	8.5	Stable	Stable
3518	1.74	1.5480	1.4706	Erosive	Erosive	Erosive	0.4	Stable	10.3	Stable	Stable
4690	1.74	1.6004	1.5204	Erosive	Erosive	Erosive	0.4	Stable	11.1	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	469	1407	3518	4690	469	1407	3518	4690	469	1407	3518	4690
Bray - Equation #1	61	109	176	205	2.1	3.0	4.0	4.4	3.7	4.4	5.0	5.2
Bray - Equation #2	80	143	231	269	2.3	3.3	4.4	4.8	2.6	3.0	3.4	3.5
Hey	19	35	58	68	6.7	10.1	14.3	16.0				
Ackers & Charlton/Lacey	48	76	111	125					2.2	2.7	3.1	3.3
Parker	149	258	407	470	1.8	2.8	4.1	4.6				
Chang	111	216	375	445	0.0	-0.4	-1.1	-1.5				
Kellerhals	39	68	107	123	3.2	4.9	7.1	8.0	3.8	4.2	4.6	4.7
AMAFCA/Schumm	72	405	411	413								
Moody & Odem	31	31	31	31	1.4	1.4	1.4	1.4				
BUREC	26.7	40.3	56.8	63.2	7	11	15	17	3.9	5.1	6.4	6.9
Average	64	138	196	221	3.1	4.5	6.2	6.8	3.2	3.9	4.5	4.7
Values As Designed	72	405	410	413	2.0	3.8	4.7	5.1	3.5	2.7	3.9	4.4
Difference with Design	-9	-267	-214	-191	1.0	0.7	1.5	1.7	-0.3	1.1	0.6	0.3

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
469	4185	2390	4875	8040	7371	1244	1014	790	12241	1091	4695	4358
1407	22874	9243	16358	51803	11498	6321	3697	4629	38243	5221	24203	17644
3518	93809	26353	37867	244142	16071	22613	9499	16793	96749	19929	85881	60882
4690	146009	36272	50180	396857	17782	33630	12613	24679	129254	27510	126090	90989

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
469	3310	1890	3857	6360	5831	984	802	625	9684	863	3714	3447
1407	6031	2437	4313	13659	3032	1667	975	1221	10084	1377	6382	4653
3518	9894	2780	3994	25750	1695	2385	1002	1771	10204	2102	9058	6421
4690	11550	2869	3969	31393	1407	2660	998	1952	10225	2176	9974	7198

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
469	2838	1197	1678	5581	1703	557	379	683	3010	582	3306	1956
1407	6111	2898	4807	10818	7359	1218	997	1438	8729	1279	7219	4807
3518	25023	9246	13117	50861	10772	4765	2979	5908	22789	5048	28468	16271
4690	38896	13059	18011	82582	12052	7148	4066	8907	30601	5579	42992	23990

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
469	2245	947	1328	4415	1347	441	300	541	2381	460	2615	1547
1407	1611	764	1267	2852	1940	321	263	379	2302	337	1904	1267
3518	2639	975	1383	5364	1136	503	314	623	2404	532	3003	1716
4690	3077	1033	1425	6533	953	565	322	705	2421	441	3401	1898

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
469	0.0016	0.0025	149	0.45	0.048	0.0005	30	0.036	0.0004	0.0159	0.0005	0.0012	0.0045	0.0002	0.0016	0.0129	0.0047
1407	0.0007	0.0013	206	0.63	0.051	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0045	0.0001	0.0007	0.0129	0.0045
3518	0.0003	0.0007	271	0.83	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0003	0.0045	0.0001	0.0004	0.0129	0.0045
4690	0.0003	0.0006	295	0.90	0.054	0.0002	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0045	0.0001	0.0003	0.0129	0.0044

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	33.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	12	
Distance between structs.	352	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.98	sq. mi
Total Sediment Yield Volume	1.87	ac ft

Sedimentation Basins

Length	352 ft	Depth	3 ft
Width	430 ft	Side slope	3 ft/ft
Total Volume per Basin		9.95	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
469	1.1	-0.6	0.2	24.6	2.0	1.9	3.5	0.0050	0.2	1.5	3.0	6.2
1407	1.1	-1.2	0.1	24.6	3.8	1.3	2.7	0.0050	0.4	1.5	3.0	6.4
3518	1.1	-1.2	0.2	24.6	4.7	2.2	3.9	0.0050	0.5	1.5	3.0	6.7
4690	1.1	-1.3	0.3	24.6	5.1	2.6	4.4	0.0050	0.6	1.5	3.0	6.8

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	4462	cfs
Stage at Peak Flow	101.7	ft
Volume at Peak Flow	806.0	ac. ft

Freeboard

Max. Flow Depth	2.0	ft
Channel Depth as designed	5.0	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	2.81	ac. ft
Outflowing Sediment Volume	0.58	ac. ft
Deposited(+)/Eroded(-) Volume	2.23	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	4224	4224
Side Slope (?H:1V)	3	3
Channel Width (ft)	430	430
Channel XS Area (sq. ft)	2282	2282
Channel Perimeter (ft)	433	433

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	4224	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	1408	sq. Yd
Volume	4693	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	4224	4224
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	5	6
Left Levee Surface Area (sq. Yd)	21589	43648
Left Levee Volume (cu. Yd)	22684	52565
Right Levee Length (ft)	4224	4224
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5	6
Right Levee Surface Area (sq. Yd)	21589	43648
Right Levee Volume (cu. Yd)	22684	52565
Total Levee Surface Area (sq. Yd)	43178	87296
Total Levee Volume (cu. Yd)	45368	105130

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	4224	4224
Left Levee Lining Width (ft)	16	36
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	7509	16896
Left Levee Lining Volume (cu. Yd)	3755	8448
Right Levee Length (ft)	4224	4224
Right Levee Lining Width (ft)	16	36
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	7509	16896
Right Levee Lining Volume (cu. Yd)	3755	8448
Total Lining Area (sq. Yd)	15019	33792
Total Lining Volume (cu. Yd)	7510	16896

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	430	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	9.4	ft	
Structure Height	12.4	ft	
Number of Structures	12		
Volume per structure	594	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 44,550		
Area per structure	143	sq. Yd	
Total Area	1,720	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	16053	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 64,212	
Other Cost	$ -	
Total cost per basin	$ 64,212	
Area per basin	16,818	sq. Yd
Total Area	16,818	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	45,368	cu. Yd	$ 7.00	$ 317,576	43,178	sq. Yd	$ 9.00	$ 388,602	43,178	sq. Yd	$ 11.67	$ 503,743
Levee - LC Enhancement	Fill	59,762	cu. Yd	$ 7.00	$ 418,334	44,118	sq. Yd	$ 9.00	$ 397,062	59,762	sq. Yd	$ 11.67	$ 697,223
Levee Lining	Riprap	7,510	cu. Yd	$ 75.00	$ 563,250	15,019	sq. Yd	$ -	$ -	15,019	sq. Yd	$ 20.83	$ 312,889
Levee Lining -LC Enhancement	Riprap	9,386	cu. Yd	$ 75.00	$ 703,950	18,773	sq. Yd	$ -	$ -	18,773	sq. Yd	$ 20.83	$ 391,111
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	4,693	cu. Yd	$ 75.00	$ 351,975	1,408	sq. Yd	$ -	$ -	1,408	sq. Yd	$ 25.00	$ 35,200
Drop Structures	Riprap	12	EA	$ 44,550.00	$ 534,600	1,720	sq. Yd	$ -	$ -	1,720	sq. Yd	$ 33.33	$ 57,333
Drop Str. - LC Enhancement	Riprap	12	EA	$ 4,455.00	$ 53,460	172	sq. Yd	$ -	$ -	172	sq. Yd	$ 33.33	$ 5,733
Sedimentation Basins		1	EA	$ 64,212.00	$ 64,212	16,818	sq. Yd	$ -	$ -	16,818	sq. Yd	$ 8.33	$ 140,150
Other					$ -				$ -				$ -

Base Landscape Cost	$ 388,602	Base Maintenance Cost	$ 1,049,316
LC Enhancement Cost	$ 397,062	LC Enhancement Cost	$ 1,094,068
Total Landscape Cost	$ 785,664	Total Maintenance Cost	$ 2,143,383

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 1,831,613	$ 1,175,744	$ 3,007,357
Contingency Cost (25% of Construction Cost)	$ 457,903	$ 293,936	$ 751,839
Engineering Design Cost (5% of Construction Cost)	$ 91,581	$ 58,787	$ 150,368
Total Construction Cost	$ 2,381,097	$ 1,528,467	$ 3,909,564

Land Cost

Channel Length	4224 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	430	41.7	$100,000	$ 4,170,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	58	5.6	$100,000	$ 560,000
Levee LC Enhancement	54	5.2	$100,000	$ 520,000
Other	0	0	$100,000	$ -
Total	542	52.5		$ 5,250,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	47.3	$100,000	$ 4,730,000
LC Enhancement Cost	acre	5.2	$100,000	$ 520,000
Total Land Cost	acre	52.5	$100,000	$ 5,250,000

Total Cost

Base Total Cost	$ 8,549,014
Total Landscape Enhancement Cost	$ 3,539,597
Total Cost Including LC Enh.	$ 12,088,611

Online Basin

HEC1 ID	RRCN1

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID	M1-N1						Total Volume (ac. ft)
Inflow Volume (ac. ft)	806						806
Volume Fraction	1						
Weighted Volume	806						806
Sediment Conc. (ppm)	1898						
Sediment Volume (ac. ft)	0.58						0.58
Weighting Factor	1						
Weighted Sed. Vol. (ac. ft)	0.58						0.58

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.5	sq. mi
Total Sediment Yield Volume	2.9	ac ft

Required Minimum Sediment Volume

Sediment Volume	3.5	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.021	0.021
Basin Length (ft)	900	1120
Basin Width (ft)	400	400
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	11	11
Freeboard (ft)	1	1
Effective Basin Width (ft)	375	350
Top Area (acres)	8.3	10.3
U/S-D/S Height Difference (ft)	8.4	8.4
Excess Area on Upstream (acres)	0.5	1.3

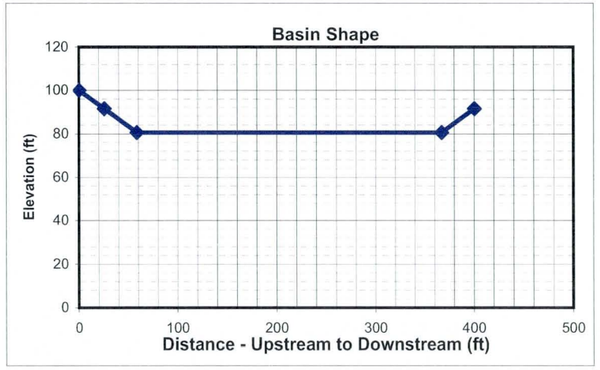
			Base	LC Enhanced
Bottom Length (ft)	834	Allocated Storage Volume (ac. ft)	67.3	67.2
Bottom Width (ft)	309	Total Available Volume (ac. ft) (incl. Freeboard)	75.0	76
		Total Excavation Volume (ac. ft)	109.7	119.2

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	5.00	ft
Invert Elevation	0.00	ft
Number of pipes	15	

Stage-Storage-Discharge

Elevation	0	2	4	6	8	9	10	11	14	16
Volume	0.00	12.15	24.94	38.39	52.51	59.82	67.31	74.97	99.01	115.94
Outflow	0.0	2005.5	2836.3	3473.7	4011.1	4254.4	4484.5	4703.4	5306.1	5672.5



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	719.0	898	898.0
Peak Inflow (cfs)	3998	4690	4690.0
Peak Outflow (cfs)	3757	4273	4273.0
Stage at Peak Outflow (ft)	7.1	9.1	9.1
Volume at Peak Outflow (ac. ft)	45.8	60.42	60.4

Volume Check

Total Volume needed	63.9	ac. ft
Total Volume Provided	67.3	ac. ft

Volume OK?	Yes

Stage Check

Depth Needed	10.1	ft
Depth Provided	11	ft

Depth OK?	Yes

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	250000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	900	ft
Base Total ROW Width	400	ft
LC Enh. Total ROW Length	1220	ft
LC Enh. Total ROW Length	500	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	176983	192309
Excavated Area (sq. Yd)	40000	67778

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	61	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	682	sq. Yd
Material Volume	341	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	688	ft
Unit Cost	160	per ft
Cost per outlet	$110,080	
Other Cost	$ -	
Total Cost	$110,080	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost	
Basin		176,983	cu. Yd	$ 4.00	$ 707,932	40,000	sq. Yd	$ 9.00	$ 360,000	40,000	sq. Yd	$ 8.33	$ 333,333	
Basin - LC Enhancement		15,326	cu. Yd	$ 4.00	$ 61,304	27,778	sq. Yd	$ 9.00	$ 250,002	27,778	sq. Yd	$ 8.33	$ 231,483	
Inlet	Riprap	341	sq. Yd	$ 75.00	$ 25,575	682	sq. Yd	$ -	$ -	682	sq. Yd	$ 33.33	$ 22,733	
Inlet - LC Enhancement (20%Inlet)					$ 5,115				$ -				$ 4,547	
Outlet	Pipe	1	EA	$ 110,080	$ 110,080	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217	
Outlet - LC Enhancement (5% Outlet)					$ 5,504				$ -				$ 111	
Other					$ -				$ -				$ -	
						Base Landscape Cost			$ 360,000	Base Maintenance Cost			$ 358,283	
						LC Enh. Landscape Cost			$ 250,002	LC Enh. Maintenance Cost			$ 236,141	
						Total Landscape Cost			$ 610,002	Total Maintenance Cost			$ 594,424	

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 843,587	$ 61,304	$ 904,891
Contingency Cost (25% of Construction Cost)	$ 210,897	$ 15,326	$ 226,223
Engineering Design Cost (5% of Construction Cost)	$ 42,179	$ 3,065	$ 45,245
Total Construction Cost	$ 1,096,663	$ 79,695	$ 1,176,358

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	5.7	$100,000	$ 570,000
Basin	8.3	$100,000	$ 830,000
Other		$100,000	$ -
Total	14.0	$100,000	$ 1,400,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	8.3	$100,000	$ 830,000
LC Enhancement Cost	acre	5.7	$100,000	$ 570,000
Total Land Cost	acre	14	$100,000	$ 1,400,000

Total Cost

Base Total Cost	$ 2,644,946
Total LC Enhancement Cost	$ 1,135,838
Total Cost Including LC Enh.	$ 3,780,784

Open Channel

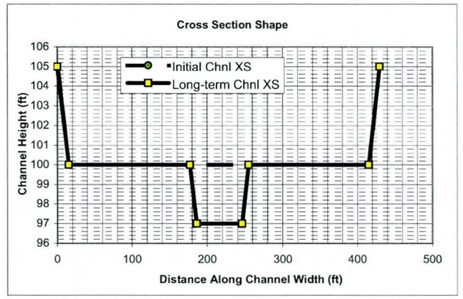
Structure ID	N125	HEC1 ID	N1-P1A

Longitudinal Geometry

Length	8101.2	ft
U/S Elev	1382.8	ft
D/S Elev	1276.4	ft
Initial Channel Slope	0.0131	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	4



Initial Channel XS Geometry

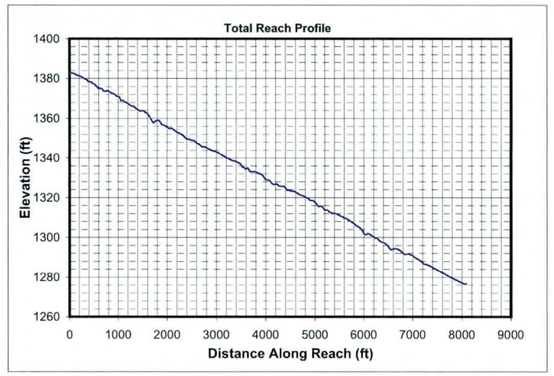
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	400	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	415	415	415	430
Y	105	100	100	100	100	100	100	105

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	162	3	60	8	3	160	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	177	186	246	255	415	430
Y	105	100	100	97	97	100	100	105



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	CN2AR									TOTAL
HEC1 Peak-Flow	4298									4298
Weighting Factor	1.00									
Flow into Channel	4298									4298

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	12.97	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	4298	cfs	
Long-term Max. Chnl Capacity	16191	cfs	
Q2 Channel	430	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	430	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
430	403.0	188.3	0.5	100.0	100.5	2.3	0.5	402.8	0.5	0.15	0.59
1289	405.7	364.8	0.9	100.0	100.9	3.5	0.9	405.4	0.9	0.28	0.66
3224	409.9	634.8	1.5	100.0	101.6	5.1	1.6	409.4	1.6	0.49	0.72
4298	411.8	755.7	1.8	100.0	101.9	5.7	1.9	411.2	1.8	0.58	0.74

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
430	72.2	126.4	1.8	97.0	98.9	3.4	1.9	71.5	1.8	0.60	0.45
1289	405.4	487.2	1.2	97.0	100.7	2.6	3.7	404.2	1.2	1.15	0.42
3224	411.0	848.9	2.1	97.0	101.6	3.8	4.6	409.5	2.1	1.43	0.46
4298	413.5	1011.2	2.4	97.0	102.0	4.3	5.0	411.9	2.5	1.55	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
430										0
1289										0
3224										0
4298										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
430	1.74	1.1609	1.1029	Erosive	Erosive	Erosive	0.2	Stable	6.4	Stable	Stable
1289	1.74	1.3629	1.2947	Erosive	Erosive	Erosive	0.3	Stable	8.3	Stable	Stable
3224	1.74	1.5307	1.4542	Erosive	Erosive	Erosive	0.4	Stable	10.1	Stable	Stable
4298	1.74	1.5831	1.5040	Erosive	Erosive	Erosive	0.4	Stable	10.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	430	1289	3224	4298	430	1289	3224	4298	430	1289	3224	4298
Bray - Equation #1	58	104	168	196	2.0	2.9	3.9	4.3	3.7	4.3	4.9	5.1
Bray - Equation #2	76	136	221	257	2.2	3.2	4.3	4.7	2.5	3.0	3.4	3.5
Hey	18	33	55	65	6.5	9.8	13.9	15.5				
Ackers & Charlton/Lacey	46	73	107	121					2.2	2.6	3.1	3.2
Parker	142	247	390	450	1.7	2.7	4.0	4.5				
Chang	105	205	356	422	0.0	-0.4	-1.1	-1.4				
Kellerhals	37	65	102	118	3.1	4.8	6.9	7.7	3.7	4.2	4.6	4.7
AMAFCA/Schumm	72	405	410	412								
Moody & Odem	32	32	32	32	1.4	1.4	1.4	1.4				
BUREC	25.8	39.0	54.9	61.2	7	10	15	16	3.8	5.0	6.3	6.8
Average	61	134	190	213	3.0	4.3	6.0	6.6	3.2	3.8	4.4	4.7
Values As Designed	72	404	410	412	1.9	3.7	4.6	5.0	3.4	2.6	3.8	4.3
Difference with Design	-10	-270	-220	-198	1.0	0.6	1.4	1.6	-0.2	1.2	0.6	0.4

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
430	3734	2173	4423	7108	7148	1113	925	690	11426	989	4175	3991
1289	20414	8479	15101	45811	11195	5729	3429	4142	35799	4702	21756	16051
3224	83760	24274	35431	215990	15675	20542	8862	15166	90644	17908	77620	55079
4298	130422	33447	46816	351165	17348	30560	11784	22336	121113	27312	114123	82402

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
430	3223	1876	3818	6136	6170	961	798	595	9863	854	3604	3445
1289	5874	2440	4345	13181	3221	1648	987	1192	10301	1353	6260	4618
3224	9640	2794	4078	24859	1804	2364	1020	1745	10432	2061	8933	6339
4298	11258	2887	4041	30312	1497	2638	1017	1928	10454	2358	9851	7113

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
430	2493	1078	1524	4840	1636	492	344	602	2750	512	2916	1744
1289	5342	2579	4256	9332	7079	1059	887	1243	7945	1124	6298	4286
3224	21883	8314	11885	43898	10405	4208	2704	5203	20830	4425	25082	14440
4298	34037	11772	16481	71297	11651	6326	3705	7876	27989	5467	37971	21325

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
430	2152	931	1316	4178	1413	425	297	519	2374	442	2517	1506
1289	1537	742	1224	2685	2037	305	255	358	2286	323	1812	1233
3224	2519	957	1368	5052	1198	484	311	599	2397	509	2887	1662
4298	2938	1016	1423	6154	1006	546	320	680	2416	472	3278	1841

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Sif (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
430	0.0017	0.0026	146	0.44	0.048	0.0006	30	0.036	0.0004	0.0159	0.0005	0.0013	0.0046	0.0002	0.0017	0.0131	0.0048
1289	0.0007	0.0013	202	0.62	0.051	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0046	0.0001	0.0008	0.0131	0.0046
3224	0.0004	0.0008	265	0.81	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0046	0.0001	0.0004	0.0131	0.0045
4298	0.0003	0.0007	289	0.88	0.054	0.0002	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0046	0.0001	0.0003	0.0131	0.0045

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	65.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	22	
Distance between structs.	368	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.48	sq. mi
Total Sediment Yield Volume	2.81	ac ft

Sedimentation Basins

Length	368 ft	Depth	3 ft
Width	430 ft	Side slope	3 ft/ft
Total Volume per Basin		10.42	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
430	1.1	-0.6	0.2	24.6	1.9	1.8	3.4	0.0050	0.2	1.5	3.0	6.2
1289	1.1	-1.2	0.1	24.6	3.7	1.2	2.6	0.0050	0.4	1.5	3.0	6.4
3224	1.1	-1.2	0.2	24.6	4.6	2.1	3.8	0.0050	0.5	1.5	3.0	6.6
4298	1.1	-1.3	0.2	24.6	5.0	2.5	4.3	0.0050	0.6	1.5	3.0	6.8

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	4230	cfs
Stage at Peak Flow	101.8	ft
Volume at Peak Flow	898.0	ac. ft

Freeboard

Max. Flow Depth	1.9	ft
Channel Depth as designed	5.0	ft
Available Freeboard	3.1	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	2.81	ac. ft
Outflowing Sediment Volume	0.62	ac. ft
Deposited(+)/Eroded(-) Volume	2.19	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	8101	8101
Side Slope (?H:1V)	3	3
Channel Width (ft)	430	430
Channel XS Area (sq. ft)	2282	2282
Channel Perimeter (ft)	433	433

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	8101	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	2700	sq. Yd
Volume	9001	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	8101	8101
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	5	6
Left Levee Surface Area (sq. Yd)	41405	83710
Left Levee Volume (cu. Yd)	43505	100812
Right Levee Length (ft)	8101	8101
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5	6
Right Levee Surface Area (sq. Yd)	41405	83710
Right Levee Volume (cu. Yd)	43505	100812
Total Levee Surface Area (sq. Yd)	82810	167420
Total Levee Volume (cu. Yd)	87010	201624

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	8101	8101
Left Levee Lining Width (ft)	16	36
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	14402	32404
Left Levee Lining Volume (cu. Yd)	7201	16202
Right Levee Length (ft)	8101	8101
Right Levee Lining Width (ft)	16	36
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	14402	32404
Right Levee Lining Volume (cu. Yd)	7201	16202
Total Lining Area (sq. Yd)	28804	64808
Total Lining Volume (cu. Yd)	14402	32404

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	430	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	9.0	ft
Structure Height	12.0	ft
Number of Structures	22	
Volume per structure	573	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 42,975	
Area per structure	143	sq. Yd
Total Area	3,153	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	16811	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 67,244	
Other Cost	$ -	
Total cost per basin	$ 67,244	
Area per basin	17,594	sq. Yd
Total Area	17,594	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	87,010	cu. Yd	$ 7.00	$ 609,070	82,810	sq. Yd	$ 9.00	$ 745,290	82,810	sq. Yd	$ 11.67	$ 966,117
Levee - LC Enhancement	Fill	114,614	cu. Yd	$ 7.00	$ 802,298	84,610	sq. Yd	$ 9.00	$ 761,490	114,614	sq. Yd	$ 11.67	$ 1,337,163
Levee Lining	Riprap	14,402	cu. Yd	$ 75.00	$ 1,080,150	28,804	sq. Yd	$ -	$ -	28,804	sq. Yd	$ 20.83	$ 600,074
Levee Lining -LC Enhancement	Riprap	18,002	cu. Yd	$ 75.00	$ 1,350,150	36,004	sq. Yd	$ -	$ -	36,004	sq. Yd	$ 20.83	$ 750,093
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	9,001	cu. Yd	$ 75.00	$ 675,075	2,700	sq. Yd	$ -	$ -	2,700	sq. Yd	$ 25.00	$ 67,500
Drop Structures	Riprap	22	EA	$ 42,975.00	$ 945,450	3,153	sq. Yd	$ -	$ -	3,153	sq. Yd	$ 33.33	$ 105,100
Drop Str. - LC Enhancement	Riprap	22	EA	$ 4,297.50	$ 94,545	315	sq. Yd	$ -	$ -	315	sq. Yd	$ 33.33	$ 10,510
Sedimentation Basins		1	EA	$ 67,244.00	$ 67,244	17,594	sq. Yd	$ -	$ -	17,594	sq. Yd	$ 8.33	$ 146,617
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 745,290	Base Maintenance Cost			$ 1,885,407
						LC Enhancement Cost			$ 761,490	LC Enhancement Cost			$ 2,097,766
						Total Landscape Cost			$ 1,506,780	Total Maintenance Cost			$ 3,983,173

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,376,989	$ 2,246,993	$ 5,623,982
Contingency Cost (25% of Construction Cost)	$ 844,247	$ 561,748	$ 1,405,996
Engineering Design Cost (5% of Construction Cost)	$ 168,849	$ 112,350	$ 281,199
Total Construction Cost	$ 4,390,086	$ 2,921,091	$ 7,311,177

Land Cost

Channel Length	8101 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	430	80	$100,000	$ 8,000,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	58	10.8	$100,000	$ 1,080,000
Levee LC Enhancement	54	10	$100,000	$ 1,000,000
Other	0	0	$100,000	$ -
Total	542	100.8		$ 10,080,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	90.8	$100,000	$ 9,080,000
LC Enhancement Cost	acre	10	$100,000	$ 1,000,000
Total Land Cost	acre	100.8	$100,000	$ 10,080,000

Total Cost

Base Total Cost	$ 16,100,783
Total Landscape Enhancement Cost	$ 6,780,347
Total Cost Including LC Enh.	$ 22,881,130

Online Basin

HEC1 ID	RRP1A

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.5	sq. mi
Total Sediment Yield Volume	1.0	ac ft

Required Minimum Sediment Volume

Sediment Volume	1.0	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.0222	0.0222
Basin Length (ft)	350	450
Basin Width (ft)	200	200
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	5	5
Freeboard (ft)	1	1
Effective Basin Width (ft)	187	173
Top Area (acres)	1.6	2.1
U/S-D/S Height Difference (ft)	4.4	4.4
Excess Area on Upstream (acres)	0.1	0.3

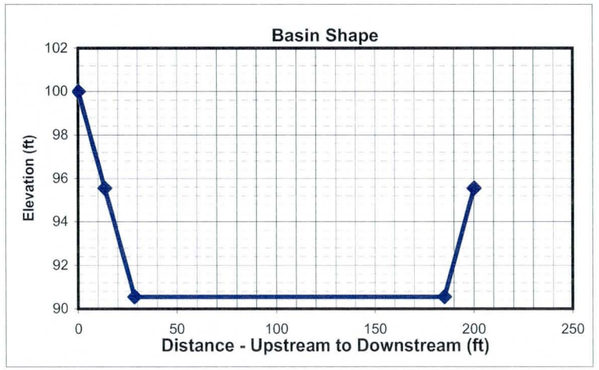
			Base	LC Enhanced
Bottom Length (ft)	320	Allocated Storage Volume (ac. ft)	5.2	5.2
Bottom Width (ft)	157	Total Available Volume (ac. ft) (incl. Freeboard)	6.6	6.9
		Total Excavation Volume (ac. ft)	10.2	11.5

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	4.00	ft
Invert Elevation	0.00	ft
Number of pipes	5	

Stage-Storage-Discharge

Elevation	0	0.5	1	1.5	2	3	4	5	6	7
Volume	0.00	0.58	1.19	1.80	2.44	3.76	5.16	6.62	8.16	9.78
Outflow	0.0	213.9	302.5	370.5	427.8	524.0	605.1	676.5	741.1	800.4



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	44.0	41	44.0
Peak Inflow (cfs)	575	441	575.0
Peak Outflow (cfs)	516	410	516.0
Stage at Peak Outflow (ft)	2.9	1.8	2.9
Volume at Peak Outflow (ac. ft)	3.7	2.21	3.7

Volume Check

Total Volume needed	4.7	ac. ft
Total Volume Provided	5.2	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	3.9	ft
Depth Provided	5	ft
Depth OK?	Yes	

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	95000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	350	ft
Base Total ROW Width	200	ft
LC Enh. Total ROW Length	550	ft
LC Enh. Total ROW Length	300	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	16456	18553
Excavated Area (sq. Yd)	7778	18333

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	30	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	330	sq. Yd
Material Volume	165	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	291	ft
Unit Cost	160	per ft
Cost per outlet	$46,560	
Other Cost	$ -	
Total Cost	$46,560	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		16,456	cu. Yd	$ 4.00	$ 65,824	7,778	sq. Yd	$ 9.00	$ 70,002	7,778	sq. Yd	$ 8.33	$ 64,817
Basin - LC Enhancement		2,097	cu. Yd	$ 4.00	$ 8,388	10,555	sq. Yd	$ 9.00	$ 94,995	10,555	sq. Yd	$ 8.33	$ 87,958
Inlet	Riprap	165	sq. Yd	$ 75.00	$ 12,375	330	sq. Yd	$ -	$ -	330	sq. Yd	$ 33.33	$ 11,000
Inlet - LC Enhancement (20%Inlet)					$ 2,475				$ -				$ 2,200
Outlet	Pipe	1	EA	$ 46,560	$ 46,560	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 2,328				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 70,002	Base Maintenance Cost			$ 78,033
						LC Enh. Landscape Cost			$ 94,995	LC Enh. Maintenance Cost			$ 90,269
						Total Landscape Cost			$ 164,997	Total Maintenance Cost			$ 168,303

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 124,759	$ 8,388	$ 133,147
Contingency Cost (25% of Construction Cost)	$ 31,190	$ 2,097	$ 33,287
Engineering Design Cost (5% of Construction Cost)	$ 6,238	$ 419	$ 6,657
Total Construction Cost	$ 162,187	$ 10,904	$ 173,091

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	2.2	$100,000	$ 220,000
Basin	1.6	$100,000	$ 160,000
Other		$100,000	$ -
Total	3.8	$100,000	$ 380,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	1.6	$100,000	$ 160,000
LC Enhancement Cost	acre	2.2	$100,000	$ 220,000
Total Land Cost	acre	3.8	$100,000	$ 380,000

Total Cost

Base Total Cost	$ 470,222
Total LC Enhancement Cost	$ 416,169
Total Cost Including LC Enh.	$ 886,391

Open Channel

Structure ID	N130

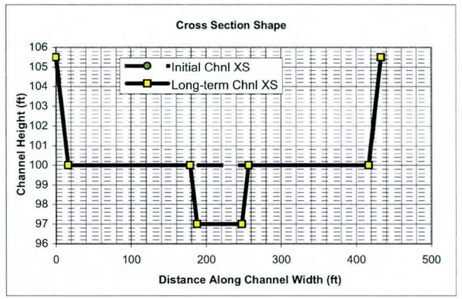
HEC1 ID	P1A-1B

Longitundal Geometry

Length	10853.3	ft
U/S Elev	1276.4	ft
D/S Elev	1133.0	ft
Initial Channel Slope	0.0132	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	11



Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5.5	0	3	400	5.5	3	0	5.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	16.5	16.5	16.5	416.5	416.5	416.5	433
Y	105.5	100	100	100	100	100	100	105.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5.5	162	3	60	8.5	3	160	5.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	16.5	178.5	187.5	247.5	256.5	416.5	433
Y	105.5	100	100	97	97	100	100	105.5

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	P1A-1B	P1B							TOTAL
HEC1 Peak-Flow	4260	852							5112
Weighting Factor	1.00	0.64							
Flow into Channel	4260	545							4805

Reach Sediment Inflow Characteristics

U/S Contributing ID	N1-P1A_N125	P1A-1B_RRP1A10							TOTAL
Flow Volume (ac. ft)	898.00	1026.00							1924
Sediment Conc. (ppm)	1841	2664							
Sediment Volume (ac. ft)	0.62	1.03							1.66
Weighting Factor	1	1							
Weighted Sed. Vol. (ac. ft)	0.62	1.03							1.66

Hydrology

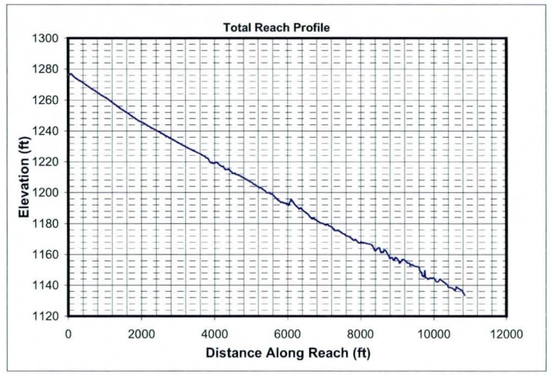
Drainage Area	15.41	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	4805	cfs	
Long-term Max. Chnl Capacity	18730	cfs	
Q2 Channel	481	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	433	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

5



Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
481	403.2	200.8	0.5	100.0	100.5	2.4	0.5	403.0	0.5	0.16	0.60
1442	406.1	389.4	1.0	100.0	101.0	3.7	1.0	405.8	1.0	0.30	0.67
3604	410.6	677.8	1.7	100.0	101.7	5.3	1.7	410.0	1.7	0.52	0.73
4805	412.6	807.0	2.0	100.0	102.0	6.0	2.0	411.9	2.0	0.62	0.75

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
481	73.0	135.7	1.9	97.0	99.1	3.5	2.1	72.3	1.9	0.64	0.46
1442	405.9	521.2	1.3	97.0	100.8	2.8	3.8	404.7	1.3	1.18	0.43
3604	411.9	908.4	2.2	97.0	101.7	4.0	4.7	410.4	2.2	1.48	0.47
4805	414.6	1082.5	2.6	97.0	102.2	4.4	5.2	412.9	2.6	1.61	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
	N1-P1A_N125	P1A-1B_RRP1A10								
481	1744	285								2030
1442	4286	791								5077
3604	14440	2537								16977
4805	21325	3705								25030

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
481	1.74	1.1806	1.1216	Erosive	Erosive	Erosive	0.2	Stable	6.7	Stable	Stable
1442	1.74	1.3827	1.3136	Erosive	Erosive	Erosive	0.3	Stable	8.5	Stable	Stable
3604	1.74	1.5504	1.4729	Erosive	Erosive	Erosive	0.4	Stable	10.4	Stable	Stable
4805	1.74	1.6028	1.5227	Erosive	Erosive	Erosive	0.4	Stable	11.2	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	481	1442	3604	4805	481	1442	3604	4805	481	1442	3604	4805
Bray - Equation #1	62	110	178	207	2.1	3.0	4.1	4.5	3.8	4.4	5.0	5.2
Bray - Equation #2	81	144	234	273	2.3	3.3	4.4	4.9	2.6	3.0	3.4	3.6
Hey	19	36	59	69	6.7	10.2	14.5	16.2				
Ackers & Charlton/Lacey	48	76	112	127					2.2	2.7	3.1	3.3
Parker	151	261	412	476	1.8	2.8	4.1	4.7				
Chang	112	219	380	451	0.0	-0.5	-1.2	-1.5				
Kellerhals	39	68	108	125	3.2	5.0	7.2	8.1	3.8	4.2	4.6	4.8
AMAFCA/Schumm	72	405	411	413								
Moody & Odem	34	34	34	34	1.4	1.4	1.4	1.4				
BUREC	26.9	40.6	57.3	63.8	7	11	15	17	3.9	5.1	6.5	6.9
Average	65	139	199	224	3.1	4.5	6.2	6.9	3.3	3.9	4.5	4.8
Values As Designed	72	405	410	413	2.1	3.8	4.7	5.2	3.5	2.8	4.0	4.4
Difference with Design	-8	-265	-212	-189	1.0	0.7	1.5	1.7	-0.3	1.1	0.6	0.3

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
481	4495	2541	5164	8690	7527	1351	1087	855	13003	1167	5031	4628
1442	24477	9739	17250	55963	11714	6782	3900	4924	40532	5582	25711	18779
3604	100385	27688	39714	263738	16351	24227	9980	17766	102477	21291	90858	64952
4805	156239	38083	52742	428699	18086	36031	13242	26080	136892	28638	133252	97090

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
481	3471	1962	3987	6709	5811	1043	839	660	10039	901	3884	3573
1442	6300	2507	4440	14403	3015	1745	1004	1267	10432	1437	6617	4833
3604	10334	2850	4088	27151	1683	2494	1027	1829	10550	2192	9354	6687
4805	12063	2940	4072	33100	1396	2782	1022	2014	10570	2211	10289	7496

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
481	2942	1232	1724	5806	1722	576	390	708	3087	603	3422	2019
1442	6343	2993	4972	11270	7438	1266	1029	1497	8959	1326	7496	4963
3604	25971	9522	13482	52981	10875	4932	3059	6119	23364	5236	29482	16820
4805	40365	13439	18395	86020	12165	7394	4172	9215	31367	5611	44495	24785

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
481	2272	952	1331	4483	1330	445	301	546	2383	466	2642	1559
1442	1633	770	1280	2901	1914	326	265	385	2306	341	1929	1277
3604	2674	980	1388	5454	1120	508	315	630	2405	539	3035	1732
4805	3117	1038	1420	6642	939	571	322	711	2422	433	3436	1914

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
481	0.0015	0.0024	151	0.46	0.048	0.0005	30	0.036	0.0004	0.0159	0.0005	0.0012	0.0044	0.0002	0.0016	0.0132	0.0048
1442	0.0007	0.0013	210	0.64	0.051	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0044	0.0001	0.0007	0.0132	0.0046
3604	0.0003	0.0007	275	0.84	0.054	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0003	0.0044	0.0001	0.0004	0.0132	0.0045
4805	0.0003	0.0006	299	0.91	0.054	0.0002	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0044	0.0001	0.0003	0.0132	0.0045

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	89.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	30	
Distance between structs.	362	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.83	sq. mi
Total Sediment Yield Volume	3.47	ac ft

Sedimentation Basins

Length	362 ft	Depth	3 ft
Width	433 ft	Side slope	3 ft/ft
Total Volume per Basin		10.30	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
481	1.1	-0.6	0.2	24.6	2.1	1.9	3.5	0.0050	0.2	1.5	3.0	6.3
1442	1.1	-1.2	0.1	24.6	3.8	1.3	2.8	0.0050	0.4	1.5	3.0	6.4
3604	1.1	-1.3	0.2	24.6	4.7	2.2	4.0	0.0050	0.5	1.5	3.0	6.7
4805	1.1	-1.3	0.3	24.6	5.2	2.6	4.4	0.0050	0.6	1.5	3.0	6.8

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	4260	cfs
Stage at Peak Flow	101.9	ft
Volume at Peak Flow	1026.0	ac. ft

Freeboard

Max. Flow Depth	2.0	ft
Channel Depth as designed	5.5	ft
Available Freeboard	3.5	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	5.12	ac. ft
Outflowing Sediment Volume	0.74	ac. ft
Deposited(+)/Eroded(-) Volume	4.38	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	10853	10853
Side Slope (?H:1V)	3	3
Channel Width (ft)	433	433
Channel XS Area (sq. ft)	2497.8	2497.8
Channel Perimeter (ft)	436	436

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	10853	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	3618	sq. Yd
Volume	12059	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	10853	10853
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	5.5	6.5
Left Levee Surface Area (sq. Yd)	59089	119383
Left Levee Volume (cu. Yd)	67530	154354
Right Levee Length (ft)	10853	10853
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5.5	6.5
Right Levee Surface Area (sq. Yd)	59089	119383
Right Levee Volume (cu. Yd)	67530	154354
Total Levee Surface Area (sq. Yd)	118178	238766
Total Levee Volume (cu. Yd)	135060	308708

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	10853	10853
Left Levee Lining Width (ft)	17	40
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	20500	48236
Left Levee Lining Volume (cu. Yd)	10250	24118
Right Levee Length (ft)	10853	10853
Right Levee Lining Width (ft)	17	40
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	20500	48236
Right Levee Lining Volume (cu. Yd)	10250	24118
Total Lining Area (sq. Yd)	41000	96471
Total Lining Volume (cu. Yd)	20500	48236

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	433	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	9.6	ft
Structure Height	12.6	ft
Number of Structures	30	
Volume per structure	604	cu. Yd
Other Cost	$ -	
Cost per structure	$ 45,300	
Area per structure	144	sq. Yd
Total Area	4,330	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	16617	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 66,468	
Other Cost	$ -	
Total cost per basin	$ 66,468	
Area per basin	17,405	sq. Yd
Total Area	34,810	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	135,060	cu. Yd	$ 7.00	$ 945,420	118,178	sq. Yd	$ 9.00	$ 1,063,602	118,178	sq. Yd	$ 11.67	$ 1,378,743
Levee - LC Enhancement	Fill	173,648	cu. Yd	$ 7.00	$ 1,215,536	120,588	sq. Yd	$ 9.00	$ 1,085,292	173,648	sq. Yd	$ 11.67	$ 2,025,893
Levee Lining	Riprap	20,500	cu. Yd	$ 75.00	$ 1,537,500	41,000	sq. Yd	$ -	$ -	41,000	sq. Yd	$ 20.83	$ 854,171
Levee Lining -LC Enhancement	Riprap	27,736	cu. Yd	$ 75.00	$ 2,080,200	55,471	sq. Yd	$ -	$ -	55,471	sq. Yd	$ 20.83	$ 1,155,644
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	12,059	cu. Yd	$ 75.00	$ 904,425	3,618	sq. Yd	$ -	$ -	3,618	sq. Yd	$ 25.00	$ 90,450
Drop Structures	Riprap	30	EA	$ 45,300.00	$ 1,359,000	4,330	sq. Yd	$ -	$ -	4,330	sq. Yd	$ 33.33	$ 144,333
Drop Str. - LC Enhancement	Riprap	30	EA	$ 4,530.00	$ 135,900	433	sq. Yd	$ -	$ -	433	sq. Yd	$ 33.33	$ 14,433
Sedimentation Basins		2	EA	$ 66,468.00	$ 132,936	34,810	sq. Yd	$ -	$ -	34,810	sq. Yd	$ 8.33	$ 290,083
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,063,602	Base Maintenance Cost			$ 2,757,781
						LC Enhancement Cost			$ 1,085,292	LC Enhancement Cost			$ 3,195,970
						Total Landscape Cost			$ 2,148,894	Total Maintenance Cost			$ 5,953,751

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 4,879,281	$ 3,431,636	$ 8,310,917
Contingency Cost (25% of Construction Cost)	$ 1,219,820	$ 857,909	$ 2,077,729
Engineering Design Cost (5% of Construction Cost)	$ 243,964	$ 171,582	$ 415,546
Total Construction Cost	$ 6,343,065	$ 4,461,127	$ 10,804,192

Land Cost

Channel Length	10853	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	433	107.9	$100,000	$ 10,790,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	61	15.2	$100,000	$ 1,520,000
Levee LC Enhancement	57	14.2	$100,000	$ 1,420,000
Other	0	0	$100,000	$ -
Total	551	137.3		$ 13,730,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	123.1	$100,000	$ 12,310,000
LC Enhancement Cost	acre	14.2	$100,000	$ 1,420,000
Total Land Cost	acre	137.3	$100,000	$ 13,730,000

Total Cost

Base Total Cost	$	22,474,449
Total Landscape Enhancement Cost	$	10,162,389
Total Cost Including LC Enh.	$	32,636,838

Open Channel

Structure ID	N140

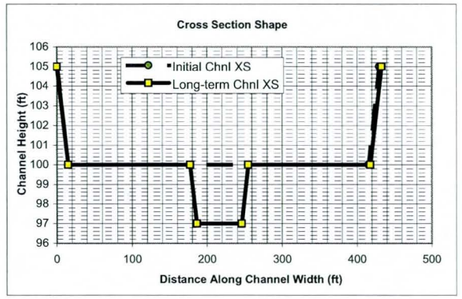
HEC1 ID	P1A-1B

Longitudal Geometry

Length	5668.0	ft
U/S Elev	1133.0	ft
D/S Elev	1092.0	ft
Initial Channel Slope	0.0072	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	11



Initial Channel XS Geometry

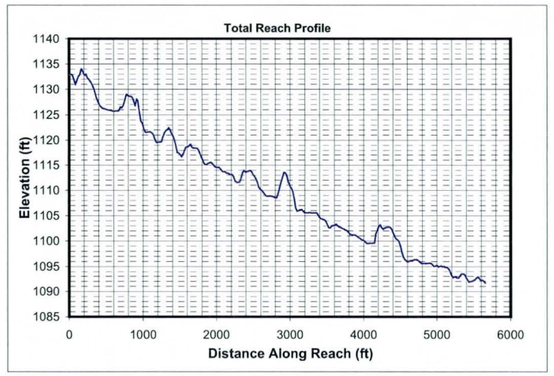
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	400	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	415	415	415	430
Y	105	100	100	100	100	100	100	105

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	162	3	60	8	3	163	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	177	186	246	255	418	433
Y	105	100	100	97	97	100	100	105



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	P									TOTAL
HEC1 Peak-Flow	4581									4581
Weighting Factor	1.00									
Flow into Channel	4581									4581

Reach Sediment Inflow Characteristics

U/S Contributing ID	P1A-1B_N130	Q1A-P_P1B10								TOTAL
Flow Volume (ac. ft)	1026.00	97.00								1123
Sediment Conc. (ppm)	1914	1551								
Sediment Volume (ac. ft)	0.74	0.06								0.80
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.74	0.06								0.80

Hydrology

Drainage Area	16.71	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	4581	cfs	
Long-term Max. Chnl Capacity	12621	cfs	
Q2 Channel	458	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	433	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
458	403.7	234.0	0.6	100.0	100.6	2.0	0.6	403.5	0.6	0.11	0.45
1374	407.1	454.1	1.1	100.0	101.1	3.0	1.1	406.8	1.1	0.21	0.50
3436	412.3	790.9	1.9	100.0	101.9	4.3	1.9	411.7	1.9	0.36	0.55
4581	414.6	942.1	2.3	100.0	102.3	4.9	2.3	413.9	2.3	0.43	0.57

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
458	74.7	155.1	2.1	97.0	99.3	3.0	2.3	73.9	2.1	0.43	0.36
1374	410.0	592.7	1.4	97.0	101.0	2.3	4.0	408.7	1.5	0.74	0.34
3436	416.8	1033.7	2.5	97.0	102.0	3.3	5.0	415.1	2.5	0.94	0.37
4581	419.8	1232.1	2.9	97.0	102.5	3.7	5.5	418.0	2.9	1.03	0.38

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
	P1A-1B_N130	Q1A-P_P1B10								
458	2019	369								2389
1374	4963	966								5928
3436	16820	3154								19974
4581	24785	4619								29404

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuosity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
458	1.74	1.2275	1.1661	Erosive	Erosive	Erosive	0.3	Stable	5.6	Stable	Stable
1374	1.74	1.4294	1.3579	Erosive	Erosive	Erosive	0.3	Stable	6.9	Stable	Stable
3436	1.74	1.5968	1.5169	Erosive	Erosive	Erosive	0.4	Stable	8.5	Stable	Stable
4581	1.74	1.6491	1.5666	Erosive	Erosive	Erosive	0.4	Stable	9.1	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	458	1374	3436	4581	458	1374	3436	4581	458	1374	3436	4581
Bray - Equation #1	60	107	174	202	2.0	3.0	4.0	4.4	3.7	4.3	4.9	5.1
Bray - Equation #2	79	141	229	266	2.2	3.2	4.4	4.8	2.6	3.0	3.4	3.5
Hey	19	35	57	67	6.6	10.0	14.2	15.9				
Ackers & Charlton/Lacey	47	75	110	124					2.2	2.7	3.1	3.3
Parker	147	255	403	465	1.8	2.8	4.1	4.6				
Chang	92	180	314	374	0.3	0.0	-0.5	-0.7				
Kellerhals	39	67	106	122	3.2	4.9	7.1	7.9	3.8	4.2	4.6	4.7
AMAFCA/Schumm	74	409	416	419								
Moody & Odem	35	35	35	35	1.4	1.4	1.4	1.4				
BUREC	29.1	43.9	61.9	69.0	8	12	17	18	3.2	4.2	5.3	5.7
Average	62	135	191	214	3.2	4.6	6.4	7.1	3.1	3.7	4.3	4.5
Values As Designed	74	409	415	418	2.3	4.0	5.0	5.5	3.0	2.3	3.3	3.7
Difference with Design	-12	-274	-225	-204	0.8	0.7	1.4	1.6	0.1	1.4	0.9	0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	**Zeller Fullerton**	**Ackers White**	**Einstein**	**Engelund/Hansen**	**Kalinske**	**Laursen**	**MPM**	**Rottner**	**Schoklitsch**	**Toffaleti**	**Yang**	**Average**
458	1805	1074	1829	2953	5329	359	356	309	4610	439	1968	1912
1374	9822	4651	7430	19003	8751	2279	1666	2198	15208	2142	11341	7681
3436	40239	13971	19978	89450	12559	8475	4628	8601	39055	8371	42930	26205
4581	62578	19455	25831	145318	13984	12638	6236	12839	52305	10451	64138	38707

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	**Zeller Fullerton**	**Ackers White**	**Einstein**	**Engelund/Hansen**	**Kalinske**	**Laursen**	**MPM**	**Rottner**	**Schoklitsch**	**Toffaleti**	**Yang**	**Average**
458	1462	870	1482	2392	4316	291	288	251	3734	356	1593	1549
1374	2652	1256	2006	5130	2362	615	450	593	4105	578	3061	2073
3436	4345	1509	2157	9659	1356	915	500	929	4217	904	4636	2830
4581	5068	1576	2092	11769	1132	1023	505	1040	4236	846	5194	3135

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	**Zeller Fullerton**	**Ackers White**	**Einstein**	**Engelund/Hansen**	**Kalinske**	**Laursen**	**MPM**	**Rottner**	**Schoklitsch**	**Toffaleti**	**Yang**	**Average**
458	1328	635	848	2269	1336	213	175	356	1310	214	1605	935
1374	2886	1472	2024	4442	5568	408	396	703	3655	373	3356	2298
3436	11809	5073	6610	20861	8475	1905	1444	3179	10033	1730	14227	7759
4581	18347	7283	9012	33853	9571	2918	2036	4884	13577	2281	21881	11422

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	**Zeller Fullerton**	**Ackers White**	**Einstein**	**Engelund/Hansen**	**Kalinske**	**Laursen**	**MPM**	**Rottner**	**Schoklitsch**	**Toffaleti**	**Yang**	**Average**
458	1075	514	687	1838	1082	173	142	288	1061	173	1300	758
1374	779	397	546	1199	1503	110	107	190	987	101	906	620
3436	1275	548	714	2253	915	206	156	343	1083	187	1536	838
4581	1486	590	730	2742	775	236	165	396	1100	185	1772	925

Equilibrium Slope Calculations

Discharge	**Schoklitsch**	**MPM**	**Shields**							**Lane's Tractive Force**		**Average BUREC**	**Bray**	**Henderson**	**BUREC**	**Simplified AMAFCA**	**Average**
Q (cfs)	**SL (ft/ft)**	**SL (ft/ft)**	**R*o**	**U***	**T*o**	**Slo (ft/ft)**	**R*f**	**T*f**	**Slf (ft/ft)**	**Tc (Fig. 4)**	**SL (ft/ft)**	**SL (ft/ft)**	**SL (ft/ft)**	**SL (ft/ft)**	**SL (ft/ft)**	**Ss (ft/ft)**	**SL (ft/ft)**
458	0.0016	0.0021	120	0.37	0.046	0.0004	29	0.035	0.0003	0.0159	0.0004	0.0011	0.0045	0.0002	0.0017	0.0072	0.0033
1374	0.0007	0.0011	167	0.51	0.049	0.0002	30	0.036	0.0002	0.0159	0.0002	0.0005	0.0045	0.0001	0.0007	0.0072	0.0031
3436	0.0004	0.0006	219	0.67	0.051	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0003	0.0045	0.0001	0.0004	0.0072	0.0030
4581	0.0003	0.0005	238	0.73	0.052	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0003	0.0045	0.0001	0.0003	0.0072	0.0030

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	23.9	ft
Height of Drop Structure	3	ft
No . of Drop Structures	8	
Distance between structs.	708	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.70	sq. mi
Total Sediment Yield Volume	1.34	ac ft

Sedimentation Basins

Length	708 ft	Depth	3 ft
Width	430 ft	Side slope	3 ft/ft
Total Volume per Basin		20.28	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations										
Discharge	**COT/PC**	**General**	**Antidune**	**Bend**	**Max. Depth**	**Hyd. Depth**	**Avg Vel**	**Se**	**Bend Scour**	**LongTerm Scour**	**Thalweg channel**	**Total**
Q (cfs)	**Sinuosity**	**Zgs (ft)**	**Za (ft)**	**Angle (deg)**	**Ymax (ft)**	**Yh (ft)**	**Vm (ft/s)**		**Zbs (ft)**	**Zls (ft)**	**Zlft (ft)**	**Zt (ft)**
458	1.1	-0.7	0.1	24.6	2.3	2.1	3.0	0.0030	0.2	1.5	3.0	6.2
1374	1.1	-1.3	0.1	24.6	4.0	1.5	2.3	0.0030	0.4	1.5	3.0	6.4
3436	1.1	-1.5	0.2	24.6	5.0	2.5	3.3	0.0030	0.5	1.5	3.0	6.7
4581	1.1	-1.5	0.2	24.6	5.5	2.9	3.7	0.0030	0.6	1.5	3.0	6.8

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	4260	cfs
Stage at Peak Flow	101.9	ft
Volume at Peak Flow	1026.0	ac. ft

Freeboard

Max. Flow Depth	2.3	ft
Channel Depth as designed	5.0	ft
Available Freeboard	2.7	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	2.14	ac. ft
Outflowing Sediment Volume	0.36	ac. ft
Deposited(+)/Eroded(-) Volume	1.78	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5668	5668
Side Slope (?H:1V)	3	3
Channel Width (ft)	433	433
Channel XS Area (sq. ft)	2297	2297
Channel Perimeter (ft)	436	436

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5668	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	1889	sq. Yd
Volume	6298	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5668	5668
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	5	6
Left Levee Surface Area (sq. Yd)	28970	58569
Left Levee Volume (cu. Yd)	30439	70535
Right Levee Length (ft)	5668	5668
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5	6
Right Levee Surface Area (sq. Yd)	28970	58569
Right Levee Volume (cu. Yd)	30439	70535
Total Levee Surface Area (sq. Yd)	57940	117138
Total Levee Volume (cu. Yd)	60878	141070

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5668	5668
Left Levee Lining Width (ft)	16	36
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	10076	22672
Left Levee Lining Volume (cu. Yd)	5038	11336
Right Levee Length (ft)	5668	5668
Right Levee Lining Width (ft)	16	36
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	10076	22672
Right Levee Lining Volume (cu. Yd)	5038	11336
Total Lining Area (sq. Yd)	20153	45344
Total Lining Volume (cu. Yd)	10076	22672

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	433	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	9.2	ft	
Structure Height	12.2	ft	
Number of Structures	8		
Volume per structure	589	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 44,175		
Area per structure	144	sq. Yd	
Total Area	1,155	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	32718	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 130,872	
Other Cost	$ -	
Total cost per basin	$ 130,872	
Area per basin	33,850	sq. Yd
Total Area	33,850	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	60,878	cu. Yd	$ 7.00	$ 426,146	57,940	sq. Yd	$ 9.00	$ 521,460	57,940	sq. Yd	$ 11.67	$ 675,967
Levee - LC Enhancement	Fill	80,192	cu. Yd	$ 7.00	$ 561,344	59,198	sq. Yd	$ 9.00	$ 532,782	80,192	sq. Yd	$ 11.67	$ 935,573
Levee Lining	Riprap	10,076	cu. Yd	$ 75.00	$ 755,700	20,153	sq. Yd	$ -	$ -	20,153	sq. Yd	$ 20.83	$ 419,852
Levee Lining -LC Enhancement	Riprap	12,596	cu. Yd	$ 75.00	$ 944,700	25,191	sq. Yd	$ -	$ -	25,191	sq. Yd	$ 20.83	$ 524,815
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	6,298	cu. Yd	$ 75.00	$ 472,350	1,889	sq. Yd	$ -	$ -	1,889	sq. Yd	$ 25.00	$ 47,225
Drop Structures	Riprap	8	EA	$ 44,175.00	$ 353,400	1,155	sq. Yd	$ -	$ -	1,155	sq. Yd	$ 33.33	$ 38,500
Drop Str. - LC Enhancement	Riprap	8	EA	$ 4,417.50	$ 35,340	116	sq. Yd	$ -	$ -	116	sq. Yd	$ 33.33	$ 3,850
Sedimentation Basins		1	EA	$ 130,872.00	$ 130,872	33,850	sq. Yd	$ -	$ -	33,850	sq. Yd	$ 8.33	$ 282,083
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 521,460	Base Maintenance Cost			$ 1,463,627
						LC Enhancement Cost			$ 532,782	LC Enhancement Cost			$ 1,464,238
						Total Landscape Cost			$ 1,054,242	Total Maintenance Cost			$ 2,927,865

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,138,468	$ 1,541,384	$ 3,679,852
Contingency Cost (25% of Construction Cost)	$ 534,617	$ 385,346	$ 919,963
Engineering Design Cost (5% of Construction Cost)	$ 106,923	$ 77,069	$ 183,993
Total Construction Cost	$ 2,780,008	$ 2,003,799	$ 4,783,808

Land Cost

Channel Length	5668	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	433	56.3	$100,000	$ 5,630,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	58	7.5	$100,000	$ 750,000
Levee LC Enhancement	54	7	$100,000	$ 700,000
Other	0	0	$100,000	$ -
Total	545	70.8		$ 7,080,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	63.8	$100,000	$ 6,380,000
LC Enhancement Cost	acre	7	$100,000	$ 700,000
Total Land Cost	acre	70.8	$100,000	$ 7,080,000

Total Cost

Base Total Cost	$	11,145,095
Total Landscape Enhancement Cost	$	4,700,819
Total Cost Including LC Enh.	$	15,845,915

Online Basin

HEC1 ID	RRQ1A

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.0	sq. mi
Total Sediment Yield Volume	1.9	ac ft

Required Minimum Sediment Volume

Sediment Volume	1.9	ac. ft

Geometry

	Base	LC Enhanced
Topography slope (ft/ft)	0.03	0.03
Basin Length (ft)	450	600
Basin Width (ft)	220	220
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	6	6
Freeboard (ft)	1	1
Effective Basin Width (ft)	200	180
Top Area (acres)	2.3	3.0
U/S-D/S Height Difference (ft)	6.6	6.6
Excess Area on Upstream (acres)	0.2	0.6

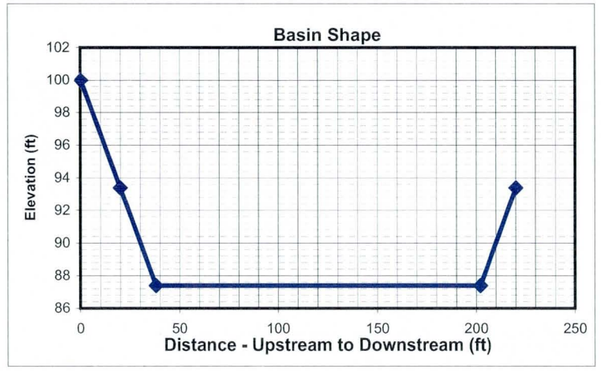
			Base	LC Enhanced
Bottom Length (ft)	414	Allocated Storage Volume (ac. ft)	8.8	8.9
Bottom Width (ft)	164	Total Available Volume (ac. ft) (incl. Freeboard)	10.8	11.2
		Total Excavation Volume (ac. ft)	18.4	21.3

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	5.00	ft
Invert Elevation	0.00	ft
Number of pipes	5	

Stage-Storage-Discharge

Elevation	0	1	1.5	2	2.5	3	4	5	6	7
Volume	0.00	1.60	2.43	3.28	4.15	5.04	6.89	8.82	10.84	12.96
Outflow	0.0	472.7	578.9	668.5	747.4	818.8	945.4	1057.0	1157.9	1250.7



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	97.0	95	97.0
Peak Inflow (cfs)	990	915	990.0
Peak Outflow (cfs)	908	836	908.0
Stage at Peak Outflow (ft)	3.7	3.1	3.7
Volume at Peak Outflow (ac. ft)	6.3	5.26	6.3

Volume Check

Total Volume needed	8.2	ac. ft
Total Volume Provided	8.8	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	4.7	ft
Depth Provided	6	ft
Depth OK?	Yes	

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	125000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	450	ft
Base Total ROW Width	220	ft
LC Enh. Total ROW Length	700	ft
LC Enh. Total ROW Length	320	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	29685	34364
Excavated Area (sq. Yd)	11000	24889

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	40	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	443	sq. Yd
Material Volume	222	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	240	ft
Unit Cost	160	per ft
Cost per outlet	$38,400	
Other Cost	$ -	
Total Cost	$38,400	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		29,685	cu. Yd	$ 4.00	$ 118,740	11,000	sq. Yd	$ 9.00	$ 99,000	11,000	sq. Yd	$ 8.33	$ 91,667
Basin - LC Enhancement		4,679	cu. Yd	$ 4.00	$ 18,716	13,889	sq. Yd	$ 9.00	$ 125,001	13,889	sq. Yd	$ 8.33	$ 115,742
Inlet	Riprap	222	sq. Yd	$ 75.00	$ 16,650	443	sq. Yd	$ -	$ -	443	sq. Yd	$ 33.33	$ 14,767
Inlet - LC Enhancement (20%Inlet)					$ 3,330				$ -				$ 2,953
Outlet	Pipe	1	EA	$ 38,400	$ 38,400	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 1,920				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 99,000	Base Maintenance Cost			$ 108,650
						LC Enh. Landscape Cost			$ 125,001	LC Enh. Maintenance Cost			$ 118,806
						Total Landscape Cost			$ 224,001	Total Maintenance Cost			$ 227,456

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 173,790	$ 18,716	$ 192,506
Contingency Cost (25% of Construction Cost)	$ 43,448	$ 4,679	$ 48,127
Engineering Design Cost (5% of Construction Cost)	$ 8,690	$ 936	$ 9,625
Total Construction Cost	$ 225,927	$ 24,331	$ 250,258

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	2.9	$100,000	$ 290,000
Basin	2.3	$100,000	$ 230,000
Other		$100,000	$ -
Total	5.2	$100,000	$ 520,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	2.3	$100,000	$ 230,000
LC Enhancement Cost	acre	2.9	$100,000	$ 290,000
Total Land Cost	acre	5.2	$100,000	$ 520,000

Total Cost

Base Total Cost	$ 663,577
Total LC Enhancement Cost	$ 558,138
Total Cost Including LC Enh.	$ 1,221,715

Open Channel

Structure ID	P1B10

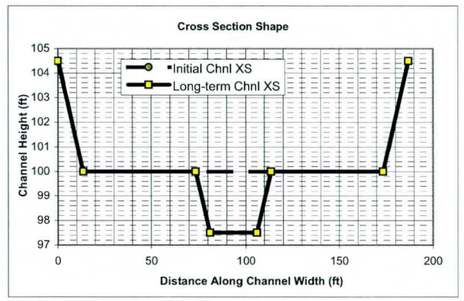
HEC1 ID	Q1A-P

Longitudal Geometry

Length	5122.9	ft
U/S Elev	1190.4	ft
D/S Elev	1133.0	ft
Initial Channel Slope	0.0112	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	7



Initial Channel XS Geometry

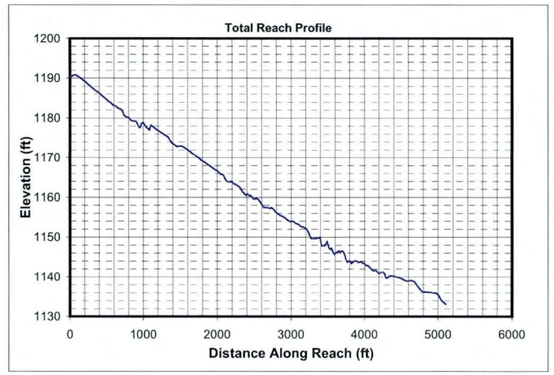
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	160	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	173.5	173.5	173.5	187
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	60	3	25	7	3	60	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	73.5	81	106	113.5	173.5	187
Y	104.5	100	100	97.5	97.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RRQ1A	P1B							TOTAL
HEC1 Peak-Flow	908	852							1760
Weighting Factor	1.00	0.23							
Flow into Channel	908	197							1105

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	1.384	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	1105	cfs	
Long-term Max. Chnl Capacity	5545	cfs	
Q2 Channel	111	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	187	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
111	162.4	60.8	0.4	100.0	100.4	1.8	0.4	162.3	0.4	0.12	0.52
332	164.6	118.0	0.7	100.0	100.7	2.8	0.7	164.4	0.7	0.23	0.58
829	168.0	206.2	1.2	100.0	101.3	4.0	1.3	167.6	1.2	0.39	0.64
1105	169.5	245.9	1.5	100.0	101.5	4.5	1.5	169.0	1.5	0.47	0.66

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
111	33.9	41.4	1.2	97.5	98.9	2.7	1.4	33.5	1.2	0.44	0.42
332	163.5	150.0	0.9	97.5	100.4	2.2	2.9	162.6	0.9	0.91	0.41
829	167.8	262.6	1.6	97.5	101.1	3.2	3.6	166.7	1.6	1.13	0.44
1105	169.8	313.5	1.8	97.5	101.4	3.5	3.9	168.5	1.9	1.22	0.46

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
111										0
332										0
829										0
1105										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
111	1.74	1.0926	1.0379	Erosive	Erosive	Erosive	0.2	Stable	5.2	Stable	Stable
332	1.74	1.2933	1.2286	Erosive	Erosive	Erosive	0.3	Stable	7.1	Stable	Stable
829	1.74	1.4595	1.3865	Erosive	Erosive	Erosive	0.3	Stable	8.6	Stable	Stable
1105	1.74	1.5112	1.4356	Erosive	Erosive	Erosive	0.4	Stable	9.2	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	111	332	829	1105	111	332	829	1105	111	332	829	1105
Bray - Equation #1	28	51	82	96	1.3	1.8	2.5	2.7	3.1	3.6	4.0	4.2
Bray - Equation #2	37	66	108	126	1.4	2.0	2.7	3.0	2.1	2.4	2.8	2.9
Hey	8	16	26	31	3.9	5.8	8.3	9.2				
Ackers & Charlton/Lacey	26	41	61	68					1.8	2.1	2.5	2.6
Parker	72	125	198	228	1.0	1.5	2.3	2.5				
Chang	46	90	157	187	0.2	0.1	-0.2	-0.3				
Kellerhals	19	33	52	60	1.8	2.8	4.0	4.5	3.3	3.6	4.0	4.1
AMAFCA/Schumm	34	163	167	169								
Moody & Odem	14	14	14	14	1.0	1.0	1.0	1.0				
BUREC	15.5	23.4	33.0	36.8	4	6	9	10	2.7	3.6	4.5	4.8
Average	30	62	90	101	1.8	2.7	3.7	4.1	2.6	3.1	3.6	3.7
Values As Designed	33	163	167	168	1.4	2.9	3.6	3.9	2.7	2.2	3.2	3.5
Difference with Design	-4	-100	-77	-67	0.4	-0.3	0.1	0.1	-0.1	0.8	0.4	0.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
111	602	382	733	1028	2146	144	142	88	2172	170	633	749
332	3282	1650	2986	6595	3531	916	670	676	7112	783	3703	2900
829	13377	4936	8032	30884	5093	3395	1860	2709	18229	2950	13945	9583
1105	20768	6866	10382	50064	5682	5057	2507	4060	24406	4492	20774	14096

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
111	2022	1282	2461	3451	7207	484	478	294	7294	572	2127	2515
332	3673	1847	3341	7381	3952	1025	750	757	7959	876	4144	3246
829	5988	2210	3596	13825	2280	1520	833	1213	8160	1321	6243	4290
1105	6973	2305	3486	16809	1908	1698	842	1363	8194	1508	6975	4733

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
111	458	233	364	817	597	91	75	107	683	97	541	369
332	1070	558	915	1753	2321	194	183	224	1948	234	1224	966
829	4347	1905	2894	8177	3530	867	641	1049	5257	898	5124	3154
1105	6739	2730	3965	13233	3990	1321	898	1621	7095	1378	7840	4619

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
111	1536	781	1223	2744	2005	305	253	360	2292	327	1817	1240
332	1197	625	1024	1962	2597	217	205	251	2181	262	1369	1081
829	1946	853	1296	3661	1580	388	287	469	2353	402	2294	1412
1105	2263	917	1331	4443	1340	443	301	544	2382	463	2632	1551

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
111	0.0023	0.0032	121	0.37	0.046	0.0007	29	0.035	0.0005	0.0159	0.0007	0.0017	0.0073	0.0004	0.0026	0.0112	0.0051
332	0.0010	0.0017	167	0.51	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0008	0.0073	0.0003	0.0011	0.0112	0.0049
829	0.0005	0.0010	218	0.67	0.051	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0073	0.0002	0.0006	0.0112	0.0048
1105	0.0004	0.0008	237	0.72	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0073	0.0002	0.0005	0.0112	0.0047

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	31.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	11	
Distance between structs.	466	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.45	sq. mi
Total Sediment Yield Volume	0.85	ac ft

Sedimentation Basins

Length	466 ft	Depth	3 ft
Width	187 ft	Side slope	3 ft/ft
Total Volume per Basin		5.60	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
111	1.1	-0.5	0.1	24.6	1.4	1.2	2.7	0.0050	0.1	1.5	2.5	5.5
332	1.1	-1.0	0.1	24.6	2.9	0.9	2.2	0.0050	0.3	1.5	2.5	5.6
829	1.1	-1.1	0.1	24.6	3.6	1.6	3.2	0.0050	0.4	1.5	2.5	5.8
1105	1.1	-1.1	0.2	24.6	3.9	1.9	3.5	0.0050	0.4	1.5	2.5	5.9

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	883	cfs
Stage at Peak Flow	101.3	ft
Volume at Peak Flow	97.0	ac. ft

Freeboard

Max. Flow Depth	1.5	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.85	ac. ft
Outflowing Sediment Volume	0.06	ac. ft
Deposited(+)/Eroded(-) Volume	0.79	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5123	5123
Side Slope (?H:1V)	3	3
Channel Width (ft)	187	187
Channel XS Area (sq. ft)	862	862
Channel Perimeter (ft)	189	189

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5123	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1708	sq. Yd
Volume	5123	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5123	5123
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	23907	49522
Left Levee Volume (cu. Yd)	23528	55404
Right Levee Length (ft)	5123	5123
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	23907	49522
Right Levee Volume (cu. Yd)	23528	55404
Total Levee Surface Area (sq. Yd)	47814	99044
Total Levee Volume (cu. Yd)	47056	110808

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5123	5123
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	7969	18784
Left Levee Lining Volume (cu. Yd)	3985	9392
Right Levee Length (ft)	5123	5123
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	7969	18784
Right Levee Lining Volume (cu. Yd)	3985	9392
Total Lining Area (sq. Yd)	15938	37569
Total Lining Volume (cu. Yd)	7970	18784

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	187	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	6.9	ft	
Structure Height	9.9	ft	
Number of Structures	11		
Volume per structure	206	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 15,450		
Area per structure	62	sq. Yd	
Total Area	686	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	9035	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 36,140	
Other Cost	$ -	
Total cost per basin	$ 36,140	
Area per basin	9,677	sq. Yd
Total Area	9,677	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	47,056	cu. Yd	$ 7.00	$ 329,392	47,814	sq. Yd	$ 9.00	$ 430,326	47,814	sq. Yd	$ 11.67	$ 557,830
Levee - LC Enhancement	Fill	63,752	cu. Yd	$ 7.00	$ 446,264	51,230	sq. Yd	$ 9.00	$ 461,070	63,752	sq. Yd	$ 11.67	$ 743,773
Levee Lining	Riprap	7,970	cu. Yd	$ 75.00	$ 597,750	15,938	sq. Yd	$ -	$ -	15,938	sq. Yd	$ 20.83	$ 332,046
Levee Lining -LC Enhancement	Riprap	10,814	cu. Yd	$ 75.00	$ 811,050	21,630	sq. Yd	$ -	$ -	21,630	sq. Yd	$ 20.83	$ 450,634
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	5,123	cu. Yd	$ 75.00	$ 384,225	1,708	sq. Yd	$ -	$ -	1,708	sq. Yd	$ 25.00	$ 42,700
Drop Structures	Riprap	11	EA	$ 15,450.00	$ 169,950	686	sq. Yd	$ -	$ -	686	sq. Yd	$ 33.33	$ 22,867
Drop Str. - LC Enhancement	Riprap	11	EA	$ 1,545.00	$ 16,995	69	sq. Yd	$ -	$ -	69	sq. Yd	$ 33.33	$ 2,287
Sedimentation Basins		1	EA	$ 36,140.00	$ 36,140	9,677	sq. Yd	$ -	$ -	9,677	sq. Yd	$ 8.33	$ 80,642
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 430,326	Base Maintenance Cost			$ 1,036,085
						LC Enhancement Cost			$ 461,070	LC Enhancement Cost			$ 1,196,694
						Total Landscape Cost			$ 891,396	Total Maintenance Cost			$ 2,232,779

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,517,457	$ 1,274,309	$ 2,791,766
Contingency Cost (25% of Construction Cost)	$ 379,364	$ 318,577	$ 697,942
Engineering Design Cost (5% of Construction Cost)	$ 75,873	$ 63,715	$ 139,588
Total Construction Cost	$ 1,972,694	$ 1,656,602	$ 3,629,296

Land Cost

Channel Length	5123 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	187	22	$100,000	$ 2,200,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	6.5	$100,000	$ 650,000
Levee LC Enhancement	51	6	$100,000	$ 600,000
Other	0	0	$100,000	$ -
Total	293	34.5		$ 3,450,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	28.5	$100,000	$ 2,850,000
LC Enhancement Cost	acre	6	$100,000	$ 600,000
Total Land Cost	acre	34.5	$100,000	$ 3,450,000

Total Cost

Base Total Cost	$ 6,289,105
Total Landscape Enhancement Cost	$ 3,914,366
Total Cost Including LC Enh.	$ 10,203,471

Open Channel

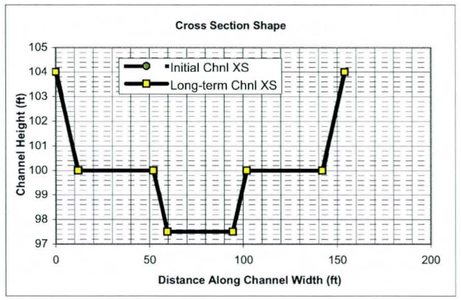
Structure ID	L30	HEC1 ID	L30

Longitudal Geometry

Length	6103.1	ft
U/S Elev	1119.1	ft
D/S Elev	1148.6	ft
Initial Channel Slope	0.0048	ft/ft
Long-term Channel Slope	0.0048	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	



Initial Channel XS Geometry

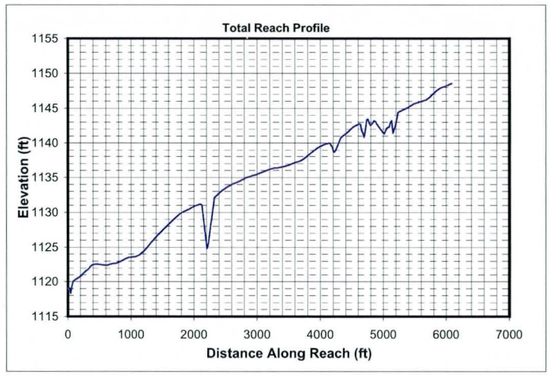
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	40	3	35	6.5	3	40	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	52	59.5	94.5	102	142	154
Y	104	100	100	97.5	97.5	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	40	3	35	6.5	3	40	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	52	59.5	94.5	102	142	154
Y	104	100	100	97.5	97.5	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	L								TOTAL
HEC1 Peak-Flow	2162								2162
Weighting Factor	1.00								
Flow into Channel	2162								2162

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	12.5	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	2162	cfs	
Long-term Max. Chnl Capacity	4102	cfs	
Q2 Channel	216	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	154	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
216	46.1	70.8	1.5	97.5	99.3	3.1	1.8	45.5	1.6	0.53	0.43
649	135.8	210.9	1.6	97.5	100.8	3.1	3.3	134.7	1.6	0.99	0.43
1622	143.2	373.3	2.6	97.5	102.0	4.3	4.5	141.8	2.6	1.34	0.47
2162	146.5	447.6	3.1	97.5	102.5	4.8	5.0	144.9	3.1	1.49	0.48

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
216	46.1	70.8	1.5	97.5	99.3	3.1	1.8	45.5	1.6	0.53	0.43
649	135.8	210.9	1.6	97.5	100.8	3.1	3.3	134.7	1.6	0.99	0.43
1622	143.2	373.3	2.6	97.5	102.0	4.3	4.5	141.8	2.6	1.34	0.47
2162	146.5	447.6	3.1	97.5	102.5	4.8	5.0	144.9	3.1	1.49	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)								TOTAL
216									0
649									0
1622									0
2162									0

Allowable Velocity

Channel Lining

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
216	1.74	1.5315	1.4549	Erosive	Erosive	Erosive	0.4	Stable	5.9	Stable	Stable
649	1.74	1.5335	1.4569	Erosive	Erosive	Erosive	0.4	Stable	8.0	Stable	Stable
1622	1.74	1.6939	1.6092	Erosive	Erosive	Erosive	0.4	Stable	10.2	Stable	Stable
2162	1.74	1.7432	1.6561	Erosive	Erosive	Erosive	0.5	Stable	11.1	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	6

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	216	649	1622	2162	216	649	1622	2162	216	649	1622	2162
Bray - Equation #1	40	72	117	136	1.6	2.3	3.1	3.4	3.4	3.9	4.4	4.6
Bray - Equation #2	53	95	154	179	1.8	2.5	3.4	3.8	2.3	2.7	3.1	3.2
Hey	12	23	38	44	5.0	7.5	10.7	11.9				
Ackers & Charlton/Lacey	34	55	80	91					2.0	2.4	2.7	2.9
Parker	101	175	277	319	1.3	2.0	3.0	3.4				
Chang	68	133	232	276	0.1	-0.1	-0.5	-0.7				
Kellerhals	26	46	72	84	2.3	3.6	5.2	5.9	3.5	3.9	4.3	4.4
AMAFCA/Schumm	46	135	142	145								
Moody & Odem	32	32	32	32	1.4	1.4	1.4	1.4				
BUREC	20.1	30.3	42.8	47.7	5	8	11	13	3.1	4.1	5.2	5.6
Average	43	80	119	135	2.4	3.4	4.7	5.2	2.9	3.4	4.0	4.1
Values As Designed	46	135	142	145	1.8	3.3	4.5	5.0	3.1	3.1	4.3	4.8
Difference with Design	-2	-55	-23	-10	0.6	0.1	0.3	0.2	-0.2	0.3	-0.4	-0.7

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	1035	484	715	1953	935	205	154	251	1300	217	1236	771
649	3153	1416	2157	5922	2777	623	469	766	3903	657	3762	2328
1622	12611	4333	5950	27117	4105	2309	1323	2928	10069	1834	14170	7886
2162	19419	6058	7681	43546	4626	3427	1789	4343	13497	1982	21125	11590

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	1775	831	1227	3351	1604	351	265	431	2231	372	2122	1324
649	1803	810	1234	3387	1589	356	268	438	2233	376	2152	1331
1622	2885	991	1361	6204	939	528	303	670	2304	420	3242	1804
2162	3332	1040	1318	7473	794	588	307	745	2316	340	3625	1989

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	1035	484	713	1928	929	204	154	251	1283	215	1227	766
649	3153	1414	2149	5847	2761	620	469	766	3852	650	3733	2310
1622	12611	4328	5926	26777	4084	2297	1323	2928	9941	1797	14066	7825
2162	19419	6052	7658	43001	4602	3409	1789	4343	13325	1943	20974	11501

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	1775	830	1223	3309	1594	350	265	431	2201	369	2105	1314
649	1803	809	1229	3345	1579	355	268	438	2203	372	2135	1321
1622	2885	990	1356	6127	934	526	303	670	2274	411	3218	1790
2162	3332	1038	1314	7379	790	585	307	745	2287	333	3599	1974

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
216	0.0005	0.0008	160	0.49	0.049	0.0002	30	0.036	0.0001	0.0159	0.0002	0.0004	0.0058	0.0003	0.0014	0.0047	0.0028
649	0.0005	0.0008	161	0.49	0.049	0.0002	30	0.036	0.0001	0.0159	0.0002	0.0004	0.0058	0.0002	0.0006	0.0048	0.0028
1622	0.0003	0.0005	209	0.64	0.051	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0002	0.0058	0.0001	0.0003	0.0047	0.0027
2162	0.0002	0.0004	226	0.69	0.052	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0002	0.0058	0.0001	0.0002	0.0047	0.0027

Drop Structures

Design Slope	0.0048	ft/ft
Total Drop Needed	0.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	1	
Distance between structs.	6103	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	5.85	sq. mi
Total Sediment Yield Volume	11.12	ac ft

Sedimentation Basins

Length	6103 ft	Depth	3 ft
Width	154 ft	Side slope	3 ft/ft
Total Volume per Basin		60.86	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
216	1.1	-0.5	0.1	24.6	1.8	1.6	3.1	0.0048	0.2	0.0	2.5	3.6
649	1.1	-1.0	0.1	24.6	3.3	1.6	3.1	0.0048	0.4	0.0	2.5	3.8
1622	1.1	-1.1	0.3	24.6	4.5	2.6	4.3	0.0048	0.5	0.0	2.5	4.1
2162	1.1	-1.2	0.3	24.6	5.0	3.1	4.8	0.0048	0.6	0.0	2.5	4.2

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	226	cfs
Stage at Peak Flow	100.3	ft
Volume at Peak Flow	342.0	ac. ft

Freeboard

Max. Flow Depth	5.0	ft
Channel Depth as designed	6.5	ft
Available Freeboard	1.5	ft
Required Freeboard	1.3	ft

Sediment Volume

Inflowing Sediment Volume	11.12	ac. ft
Outflowing Sediment Volume	0.25	ac. ft
Deposited(+)/Eroded(-) Volume	10.86	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	6103	6103
Side Slope (?H:1V)	3	6
Channel Width (ft)	154	193
Channel XS Area (sq. ft)	674.2	800.95
Channel Perimeter (ft)	156	194

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	156694	186433
Excavated Area (sq. Yd)	104429	130875

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	6103	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	1017	sq. Yd
Volume	2712	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	6103	6103
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	6103	6103
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	154	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	11.0	ft	
Structure Height	14.0	ft	
Number of Structures	1		
Volume per structure	240	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 18,000		
Area per structure	51	sq. Yd	
Total Area	51	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	98187	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 392,748	
Other Cost	$ -	
Total cost per basin	$ 392,748	
Area per basin	104,430	sq. Yd
Total Area	104,430	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	156,694	cu. Yd	$ 10.00	$ 1,566,940	104,429	sq. Yd	$ 9.00	$ 939,861	104,429	sq. Yd	$ 8.33	$ 870,242
Exc. Chl - LC Enhancement	Excavated	29,739	cu. Yd	$ 10.00	$ 297,390	26,446	sq. Yd	$ 9.00	$ 238,014	26,446	sq. Yd	$ 8.33	$ 220,383
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	2,712	cu. Yd	$ 75.00	$ 203,400	1,017	sq. Yd	$ -	$ -	1,017	sq. Yd	$ 25.00	$ 25,425
Drop Structures	Riprap	1	EA	$ 18,000.00	$ 18,000	51	sq. Yd	$ -	$ -	51	sq. Yd	$ 33.33	$ 1,700
Drop Str. - LC Enhancement	Riprap	1	EA	$ 1,800.00	$ 1,800	5	sq. Yd	$ -	$ -	5	sq. Yd	$ 33.33	$ 170
Sedimentation Basins		1	EA	$ 392,748.00	$ 392,748	104,430	sq. Yd	$ -	$ -	104,430	sq. Yd	$ 8.33	$ 870,250
Other					$ -				$ -				$ -

Base Landscape Cost	$ 939,861	Base Maintenance Cost	$ 1,767,617
LC Enhancement Cost	$ 238,014	LC Enhancement Cost	$ 220,553
Total Landscape Cost	$ 1,177,875	Total Maintenance Cost	$ 1,988,170

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 2,181,088	$ 299,190	$ 2,480,278
Contingency Cost (25% of Construction Cost)	$ 545,272	$ 74,798	$ 620,070
Engineering Design Cost (5% of Construction Cost)	$ 109,054	$ 14,960	$ 124,014
Total Construction Cost	$ 2,835,414	$ 388,947	$ 3,224,361

Land Cost

Channel Length	6103 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	14	2	$100,000	$ 200,000
LC Enhancement Buffer	50	7	$100,000	$ 700,000
Channel	154	21.6	$100,000	$ 2,160,000
Channel LC Enhancement	39	5.5	$100,000	$ 550,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	257	36.1		$ 3,610,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	23.6	$100,000	$ 2,360,000
LC Enhancement Cost	acre	12.5	$100,000	$ 1,250,000
Total Land Cost	acre	36.1	$100,000	$ 3,610,000

Total Cost

Base Total Cost	$ 7,902,892
Total Landscape Enhancement Cost	$ 2,097,514
Total Cost Including LC Enh.	$ 10,000,406

Open Channel

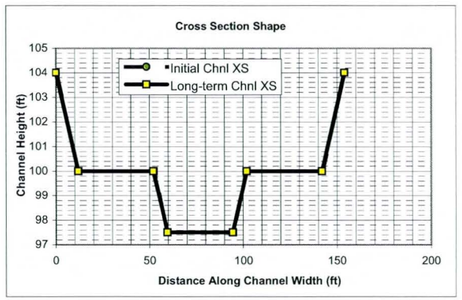
Structure ID	L40	HEC1 ID	L40

Longitundal Geometry

Length	8055.0	ft
U/S Elev	1119.1	ft
D/S Elev	1087.1	ft
Initial Channel Slope	0.0040	ft/ft
Long-term Channel Slope	0.0040	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	



Initial Channel XS Geometry

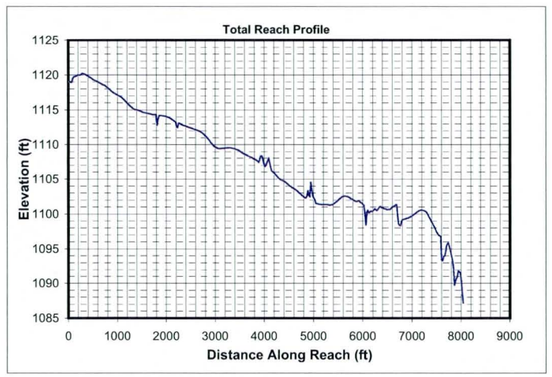
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	40	3	35	6.5	3	40	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	52	59.5	94.5	102	142	154
Y	104	100	100	97.5	97.5	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	40	3	35	6.5	3	40	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	52	59.5	94.5	102	142	154
Y	104	100	100	97.5	97.5	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	L									TOTAL
HEC1 Peak-Flow	2162									2162
Weighting Factor	1.00									
Flow into Channel	2162									2162

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	12.5	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	2162	cfs	
Long-term Max. Chnl Capacity	3745	cfs	
Q2 Channel	216	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	154	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
216	46.7	75.2	1.6	97.5	99.4	2.9	1.9	46.1	1.6	0.46	0.40
649	136.4	223.1	1.6	97.5	100.9	2.9	3.4	135.3	1.6	0.84	0.40
1622	144.2	395.3	2.7	97.5	102.1	4.1	4.6	142.7	2.8	1.15	0.43
2162	147.7	474.3	3.2	97.5	102.7	4.6	5.2	146.0	3.2	1.29	0.45

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
216	46.7	75.2	1.6	97.5	99.4	2.9	1.9	46.1	1.6	0.46	0.40
649	136.4	223.1	1.6	97.5	100.9	2.9	3.4	135.3	1.6	0.84	0.40
1622	144.2	395.3	2.7	97.5	102.1	4.1	4.6	142.7	2.8	1.15	0.43
2162	147.7	474.3	3.2	97.5	102.7	4.6	5.2	146.0	3.2	1.29	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
216										0
649										0
1622										0
2162										0

Allowable Velocity

Channel Lining

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
216	1.74	1.5461	1.4688	Erosive	Erosive	Erosive	0.4	Stable	5.5	Stable	Stable
649	1.74	1.5497	1.4722	Erosive	Erosive	Erosive	0.4	Stable	7.5	Stable	Stable
1622	1.74	1.7096	1.6241	Erosive	Erosive	Erosive	0.4	Stable	9.5	Stable	Stable
2162	1.74	1.7518	1.6642	Erosive	Erosive	Erosive	0.5	Stable	10.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	6

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	216	649	1622	2162	216	649	1622	2162	216	649	1622	2162
Bray - Equation #1	40	72	117	136	1.6	2.3	3.1	3.4	3.4	3.9	4.4	4.6
Bray - Equation #2	53	95	154	179	1.8	2.5	3.4	3.8	2.3	2.7	3.1	3.2
Hey	12	23	38	44	5.0	7.5	10.7	11.9				
Ackers & Charlton/Lacey	34	55	80	91					2.0	2.4	2.7	2.9
Parker	101	175	277	319	1.3	2.0	3.0	3.4				
Chang	64	125	219	261	0.2	0.0	-0.3	-0.5				
Kellerhals	26	46	72	84	2.3	3.6	5.2	5.9	3.5	3.9	4.3	4.4
AMAFCA/Schumm	46	135	143	146								
Moody & Odem	32	32	32	32	1.4	1.4	1.4	1.4				
BUREC	20.8	31.4	44.3	49.3	6	8	12	13	2.9	3.9	4.9	5.2
Average	43	79	118	134	2.4	3.5	4.8	5.3	2.8	3.3	3.9	4.1
Values As Designed	46	135	143	146	1.9	3.4	4.6	5.2	2.9	2.9	4.1	4.6
Difference with Design	-3	-56	-25	-12	0.5	0.1	0.2	0.1	-0.1	0.4	-0.2	-0.5

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	797	387	568	1400	851	145	117	200	949	161	948	593
649	2442	1139	1714	4271	2517	443	357	612	2852	488	2900	1794
1622	9754	3551	4625	19522	3768	1685	1048	2392	7433	1291	11150	6020
2162	15011	4986	6343	31327	4260	2508	1428	3565	9979	1398	16713	8865

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	1368	664	975	2402	1460	248	201	342	1629	276	1626	1017
649	1397	651	981	2443	1440	253	204	350	1631	279	1659	1026
1622	2232	813	1058	4467	862	386	240	547	1701	295	2551	1377
2162	2576	856	1088	5376	731	430	245	612	1712	240	2868	1521

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	797	387	570	1415	855	145	117	200	960	162	954	597
649	2442	1140	1720	4316	2530	445	357	612	2884	493	2920	1805
1622	9754	3555	4641	19729	3785	1692	1048	2392	7514	1313	11221	6059
2162	15011	4990	6359	31659	4278	2519	1428	3565	10087	1422	16817	8921

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	1368	664	978	2428	1468	249	201	342	1647	278	1637	1024
649	1397	652	984	2469	1447	254	204	350	1650	282	1670	1033
1622	2232	813	1062	4514	866	387	240	547	1719	300	2567	1386
2162	2576	856	1091	5433	734	432	245	612	1731	244	2886	1531

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Sif (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
216	0.0005	0.0007	149	0.45	0.048	0.0002	30	0.036	0.0001	0.0159	0.0002	0.0004	0.0058	0.0003	0.0014	0.0039	0.0026
649	0.0005	0.0007	150	0.46	0.048	0.0002	30	0.036	0.0001	0.0159	0.0002	0.0004	0.0058	0.0002	0.0006	0.0040	0.0026
1622	0.0003	0.0004	194	0.59	0.050	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0002	0.0058	0.0001	0.0003	0.0040	0.0025
2162	0.0002	0.0004	210	0.64	0.051	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0002	0.0058	0.0001	0.0002	0.0039	0.0025

Drop Structures

Design Slope	0.0040	ft/ft
Total Drop Needed	0.0	ft
Height of Drop Structure	3	ft
No . of Drop Structures	0	
Distance between structs.	N/A	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	5.85	sq. mi
Total Sediment Yield Volume	11.12	ac ft

Sedimentation Basins

Length	0 ft	Depth	3 ft
Width	154 ft	Side slope	3 ft/ft
Total Volume per Basin		0.00	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		0	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
216	1.1	-0.6	0.1	24.6	1.9	1.6	2.9	0.0040	0.2	0.0	2.5	3.6
649	1.1	-1.0	0.1	24.6	3.4	1.6	2.9	0.0040	0.4	0.0	2.5	3.8
1622	1.1	-1.2	0.2	24.6	4.6	2.8	4.1	0.0040	0.5	0.0	2.5	4.1
2162	1.1	-1.3	0.3	24.6	5.2	3.2	4.6	0.0040	0.6	0.0	2.5	4.2

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	226	cfs
Stage at Peak Flow	100.3	ft
Volume at Peak Flow	342.0	ac. ft

Freeboard

Max. Flow Depth	5.2	ft
Channel Depth as designed	6.5	ft
Available Freeboard	1.3	ft
Required Freeboard	1.4	ft

Sediment Volume

Inflowing Sediment Volume	11.12	ac. ft
Outflowing Sediment Volume	0.20	ac. ft
Deposited(+)/Eroded(-) Volume	10.92	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	8055	8055
Side Slope (?H:1V)	3	6
Channel Width (ft)	154	193
Channel XS Area (sq. ft)	674.2	800.95
Channel Perimeter (ft)	156	194

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	195952	232453
Excavated Area (sq. Yd)	137830	172735

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	8055	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	1343	sq. Yd
Volume	3580	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	8055	8055
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	8055	8055
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	154	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	11.0	ft	
Structure Height	14.0	ft	
Number of Structures	0		
Volume per structure	239	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 17,925		
Area per structure	51	sq. Yd	
Total Area	0	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	0	
Total Volume per Basin	0	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ -	
Other Cost	$ -	
Total cost per basin	$ -	
Area per basin	0	sq. Yd
Total Area	0	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	195,952	cu. Yd	$ 10.00	$ 1,959,520	137,830	sq. Yd	$ 9.00	$ 1,240,470	137,830	sq. Yd	$ 8.33	$ 1,148,583
Exc. Chl - LC Enhancement	Excavated	36,501	cu. Yd	$ 10.00	$ 365,010	34,905	sq. Yd	$ 9.00	$ 314,145	34,905	sq. Yd	$ 8.33	$ 290,875
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	3,580	cu. Yd	$ 75.00	$ 268,500	1,343	sq. Yd	$ -	$ -	1,343	sq. Yd	$ 25.00	$ 33,575
Drop Structures	Riprap	0	EA	$ 17,925.00	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 33.33	$ -
Drop Str. - LC Enhancement	Riprap	0	EA	$ 1,792.50	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 33.33	$ -
Sedimentation Basins		0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 8.33	$ -
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,240,470	Base Maintenance Cost			$ 1,182,158
						LC Enhancement Cost			$ 314,145	LC Enhancement Cost			$ 290,875
						Total Landscape Cost			$ 1,554,615	Total Maintenance Cost			$ 1,473,033

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,228,020	$ 365,010	$ 2,593,030
Contingency Cost (25% of Construction Cost)	$ 557,005	$ 91,253	$ 648,258
Engineering Design Cost (5% of Construction Cost)	$ 111,401	$ 18,251	$ 129,652
Total Construction Cost	$ 2,896,426	$ 474,513	$ 3,370,939

Land Cost

Channel Length	8055 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	14	2.6	$100,000	$ 260,000
LC Enhancement Buffer	50	9.2	$100,000	$ 920,000
Channel	154	28.5	$100,000	$ 2,850,000
Channel LC Enhancement	39	7.2	$100,000	$ 720,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	257	47.5		$ 4,750,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	31.1	$100,000	$ 3,110,000
LC Enhancement Cost	acre	16.4	$100,000	$ 1,640,000
Total Land Cost	acre	47.5	$100,000	$ 4,750,000

Total Cost

Base Total Cost	$ 8,429,054
Total Landscape Enhancement Cost	$ 2,719,533
Total Cost Including LC Enh.	$ 11,148,587

Open Channel

Structure ID	RRP1A10

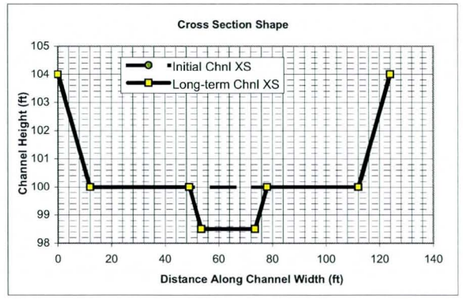
HEC1 ID	RRP1A10

Longitundal Geometry

Length	1465.1	ft
U/S Elev	1276.4	ft
D/S Elev	1305.2	ft
Initial Channel Slope	0.0196	ft/ft
Long-term Channel Slope	0.0080	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	



Initial Channel XS Geometry

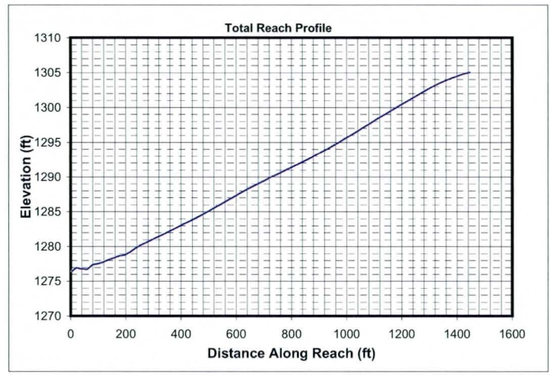
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	100	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	112	112	112	124
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	37	3	20	5.5	3	34	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	49	53.5	73.5	78	112	124
Y	104	100	100	98.5	98.5	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RRP1A									TOTAL
HEC1 Peak-Flow	516									516
Weighting Factor	1.00									
Flow into Channel	516									516

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	0.5	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	516	cfs	
Long-term Max. Chnl Capacity	3529	cfs	
Q2 Channel	52	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	124	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
52	101.7	27.0	0.3	100.0	100.3	1.9	0.3	101.6	0.3	0.13	0.65
155	103.3	52.4	0.5	100.0	100.5	3.0	0.5	103.1	0.5	0.26	0.73
387	105.6	91.7	0.9	100.0	100.9	4.2	0.9	105.4	0.9	0.45	0.80
516	106.7	109.4	1.0	100.0	101.1	4.7	1.1	106.4	1.0	0.53	0.82

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
52	25.7	20.3	0.8	98.5	99.4	2.5	0.9	25.4	0.8	0.45	0.50
155	102.5	68.4	0.7	98.5	100.3	2.3	1.8	101.9	0.7	0.91	0.49
387	105.6	120.0	1.1	98.5	100.8	3.2	2.3	104.9	1.1	1.15	0.53
516	107.0	143.4	1.3	98.5	101.0	3.6	2.5	106.2	1.3	1.26	0.55

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
52										0
155										0
387										0
516										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuosity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
52	1.74	0.9865	0.9372	Erosive	Erosive	Erosive	0.2	Stable	4.8	Stable	Stable
155	1.74	1.1869	1.1275	Erosive	Erosive	Erosive	0.3	Stable	6.7	Stable	Stable
387	1.74	1.3526	1.2850	Erosive	Erosive	Erosive	0.3	Stable	8.2	Stable	Stable
516	1.74	1.4042	1.3340	Erosive	Erosive	Erosive	0.3	Stable	8.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	52	155	387	516	52	155	387	516	52	155	387	516
Bray - Equation #1	19	34	55	64	1.0	1.4	1.9	2.1	2.7	3.2	3.6	3.8
Bray - Equation #2	25	44	72	84	1.1	1.6	2.1	2.3	1.9	2.2	2.5	2.6
Hey	5	10	17	20	2.9	4.4	6.2	6.9				
Ackers & Charlton/Lacey	19	30	44	50					1.5	1.9	2.2	2.3
Parker	49	85	135	156	0.7	1.1	1.6	1.9				
Chang	34	66	115	137	0.1	0.0	-0.2	-0.3				
Kellerhals	13	22	35	41	1.3	2.0	2.9	3.3	3.0	3.4	3.7	3.8
AMAFCA/Schumm	25	102	105	106								
Moody & Odem	9	9	9	9	0.9	0.9	0.9	0.9				
BUREC	10.7	16.1	22.7	25.3	3	4	6	7	2.7	3.5	4.4	4.7
Average	21	42	61	69	1.4	2.0	2.7	3.0	2.4	2.8	3.3	3.4
Values As Designed	25	102	105	106	0.9	1.8	2.3	2.5	2.5	2.3	3.2	3.6
Difference with Design	-4	-60	-44	-37	0.5	0.1	0.4	0.4	-0.2	0.6	0.1	-0.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
52	520	343	759	984	1595	177	158	80	2467	172	550	710
155	2834	1380	2780	6310	2555	973	638	554	7810	735	3029	2691
387	11527	3995	6904	29495	3640	3509	1691	2123	19835	2658	10975	8759
516	17882	5515	9011	47776	4052	5210	2260	3153	26516	4002	16171	12868

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
52	3739	2465	5454	7078	11467	1274	1139	573	17737	1238	3957	5102
155	6792	3308	6662	15122	6124	2332	1529	1327	18718	1761	7259	6449
387	11051	3830	6618	28275	3490	3364	1622	2036	19015	2548	10522	8397
516	12857	3965	6479	34351	2913	3746	1625	2267	19065	2878	11626	9252

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
52	316	168	303	591	465	77	62	66	652	74	365	285
155	816	431	816	1447	1637	192	170	160	1911	195	929	791
387	3306	1422	2393	6730	2457	791	542	730	5039	730	3767	2537
516	5119	2022	3301	10877	2771	1192	749	1123	6777	1112	5711	3705

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
52	2270	1205	2176	4248	3343	552	449	477	4687	529	2624	2051
155	1956	1033	1955	3468	3924	461	407	383	4580	467	2226	1896
387	3169	1364	2294	6452	2356	758	520	700	4830	700	3611	2432
516	3681	1454	2373	7821	1992	857	539	808	4872	800	4106	2664

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
52	0.0029	0.0046	134	0.41	0.047	0.0010	30	0.036	0.0007	0.0159	0.0010	0.0023	0.0094	0.0006	0.0034	0.0195	0.0080
155	0.0013	0.0024	186	0.57	0.050	0.0005	31	0.036	0.0004	0.0159	0.0005	0.0011	0.0094	0.0004	0.0015	0.0196	0.0076
387	0.0007	0.0014	243	0.74	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0094	0.0003	0.0007	0.0196	0.0075
516	0.0005	0.0012	264	0.80	0.053	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0094	0.0002	0.0006	0.0195	0.0074

Drop Structures

Design Slope	0.0080	ft/ft
Total Drop Needed	17.0	ft
Height of Drop Structure	3	ft
No . of Drop Structures	6	
Distance between structs.	244	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.00	sq. mi
Total Sediment Yield Volume	0.00	ac ft

Sedimentation Basins

Length	244 ft	Depth	3 ft
Width	124 ft	Side slope	3 ft/ft
Total Volume per Basin		1.86	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
52	1.1	-0.3	0.1	24.6	0.9	0.8	2.5	0.0080	0.1	1.5	1.5	4.1
155	1.1	-0.6	0.1	24.6	1.8	0.7	2.3	0.0080	0.2	1.5	1.5	4.2
387	1.1	-0.7	0.1	24.6	2.3	1.1	3.2	0.0080	0.3	1.5	1.5	4.3
516	1.1	-0.7	0.2	24.6	2.5	1.3	3.6	0.0080	0.3	1.5	1.5	4.4

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	516	cfs
Stage at Peak Flow	2.9	ft
Volume at Peak Flow	44.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.0	ft
Available Freeboard	2.9	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.00	ac. ft
Outflowing Sediment Volume	0.04	ac. ft
Deposited(+)/Eroded(-) Volume	-0.04	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1465	1465
Side Slope (?H:1V)	3	3
Channel Width (ft)	124	124
Channel XS Area (sq. ft)	484.8	484.8
Channel Perimeter (ft)	126	126

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1465	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	488	sq. Yd
Volume	1302	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1465	1465
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	6348	13185
Left Levee Volume (cu. Yd)	5643	13565
Right Levee Length (ft)	1465	1465
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	6348	13185
Right Levee Volume (cu. Yd)	5643	13565
Total Levee Surface Area (sq. Yd)	12696	26370
Total Levee Volume (cu. Yd)	11286	27130

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1465	1465
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	2116	4883
Left Levee Lining Volume (cu. Yd)	1058	2442
Right Levee Length (ft)	1465	1465
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	2116	4883
Right Levee Lining Volume (cu. Yd)	1058	2442
Total Lining Area (sq. Yd)	4232	9767
Total Lining Volume (cu. Yd)	2116	4884

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	124	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.8	ft
Structure Height	8.8	ft
Number of Structures	6	
Volume per structure	121	cu. Yd
Other Cost	$ -	
Cost per structure	$ 9,075	
Area per structure	41	sq. Yd
Total Area	248	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	3001	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 12,004	
Other Cost	$ -	
Total cost per basin	$ 12,004	
Area per basin	3,364	sq. Yd
Total Area	3,364	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	11,286	cu. Yd	$ 7.00	$ 79,002	12,696	sq. Yd	$ 9.00	$ 114,264	12,696	sq. Yd	$ 11.67	$ 148,120
Levee - LC Enhancement	Fill	15,844	cu. Yd	$ 7.00	$ 110,908	13,674	sq. Yd	$ 9.00	$ 123,066	15,844	sq. Yd	$ 11.67	$ 184,847
Levee Lining	Riprap	2,116	cu. Yd	$ 75.00	$ 158,700	4,232	sq. Yd	$ -	$ -	4,232	sq. Yd	$ 20.83	$ 88,171
Levee Lining -LC Enhancement	Riprap	2,768	cu. Yd	$ 75.00	$ 207,600	5,534	sq. Yd	$ -	$ -	5,534	sq. Yd	$ 20.83	$ 115,301
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,302	cu. Yd	$ 75.00	$ 97,650	488	sq. Yd	$ -	$ -	488	sq. Yd	$ 25.00	$ 12,200
Drop Structures	Riprap	6	EA	$ 9,075.00	$ 54,450	248	sq. Yd	$ -	$ -	248	sq. Yd	$ 33.33	$ 8,267
Drop Str. - LC Enhancement	Riprap	6	EA	$ 907.50	$ 5,445	25	sq. Yd	$ -	$ -	25	sq. Yd	$ 33.33	$ 827
Sedimentation Basins		1	EA	$ 12,004.00	$ 12,004	3,364	sq. Yd	$ -	$ -	3,364	sq. Yd	$ 8.33	$ 28,033
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 114,264	Base Maintenance Cost			$ 284,791
						LC Enhancement Cost			$ 123,066	LC Enhancement Cost			$ 300,974
						Total Landscape Cost			$ 237,330	Total Maintenance Cost			$ 585,766

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 401,806	$ 323,953	$ 725,759
Contingency Cost (25% of Construction Cost)	$ 100,452	$ 80,988	$ 181,440
Engineering Design Cost (5% of Construction Cost)	$ 20,090	$ 16,198	$ 36,288
Total Construction Cost	$ 522,348	$ 421,139	$ 943,487

Land Cost

Channel Length	1465 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	124	4.2	$100,000	$ 420,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	1.7	$100,000	$ 170,000
Levee LC Enhancement	48	1.6	$100,000	$ 160,000
Other	0	0	$100,000	$ -
Total	224	7.5		$ 750,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	5.9	$100,000	$ 590,000
LC Enhancement Cost	acre	1.6	$100,000	$ 160,000
Total Land Cost	acre	7.5	$100,000	$ 750,000

Total Cost

Base Total Cost	$ 1,511,403
Total Landscape Enhancement Cost	$ 1,005,179
Total Cost Including LC Enh.	$ 2,516,582

SUN VALLEY ADMP
Step 2 - Alt. B3
FRS No. 1

FRS No. 1 Sub-area

FEMA Floodplains

Floodplain

Floodway

Alluvial Fan Apices

Concentration Point

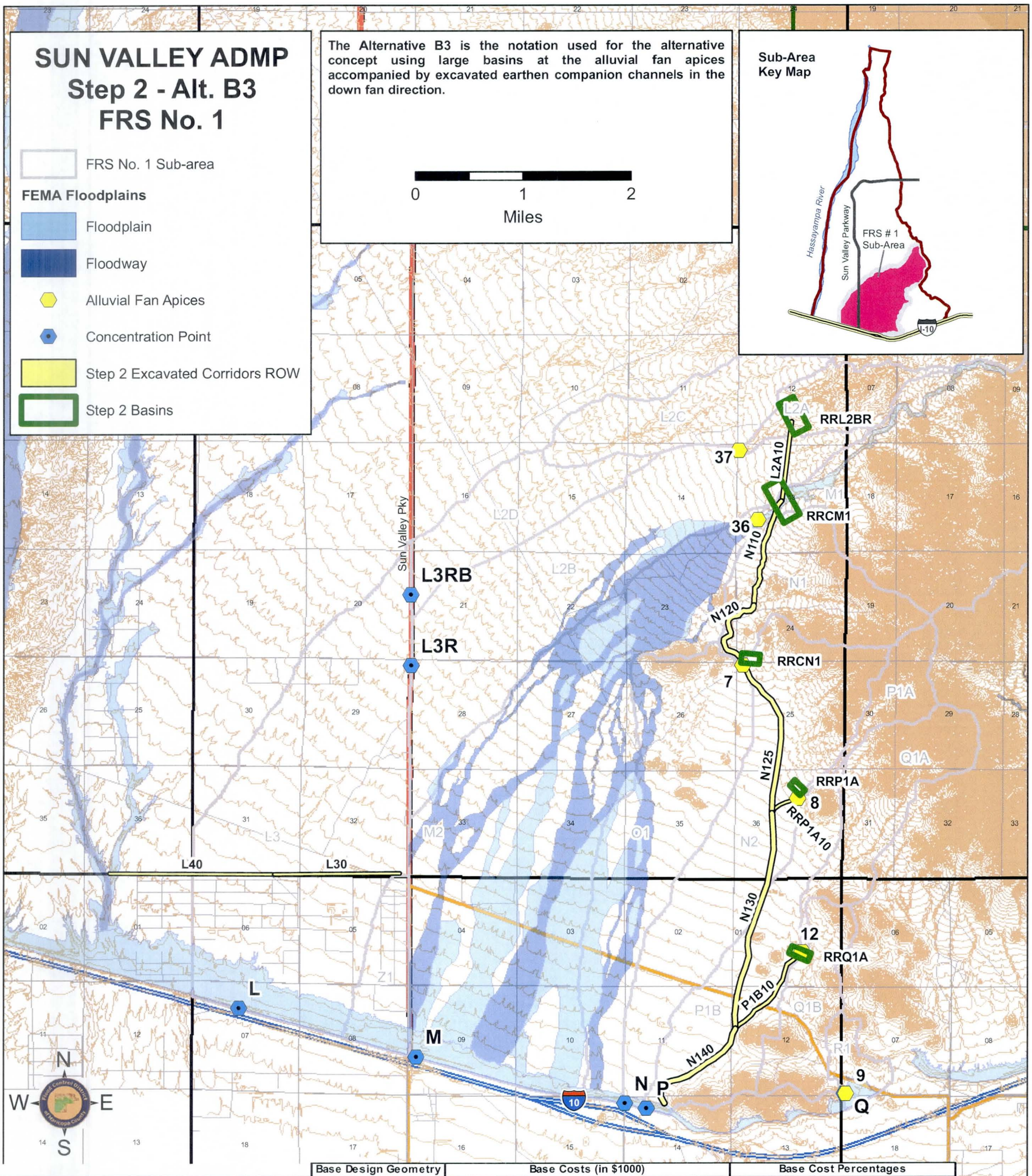
Step 2 Excavated Corridors ROW

Step 2 Basins

The Alternative B3 is the notation used for the alternative concept using large basins at the alluvial fan apices accompanied by excavated earthen companion channels in the down fan direction.

0 1 2

Miles



Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs (in $1000): Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Base Cost Percentages: Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RRL2BR	Online Basin	237	30	581	0	1650	800	11	$ 3,030	$ 5,044	$ 1,320	$ 1,260	$ 10,654	28%	47%	12%	12%	6%
L2A10	Excavated Chl.	322	17	84	0	0.7	109	4	$ 1,710	$ 1,949	$ 229	$ 257	$ 4,145	41%	47%	6%	6%	3%
RRCM1	Online Basin	424	42	877	0	2000	910	11	$ 4,180	$ 7,533	$ 1,820	$ 1,727	$ 15,260	27%	49%	12%	11%	9%
N110	Excavated Chl.	875	29	541	0	1	145	5	$ 2,860	$ 11,903	$ 517	$ 565	$ 15,845	18%	75%	3%	4%	10%
N120	Excavated Chl.	1288	25	244	0	0.8	169	7	$ 2,450	$ 5,561	$ 503	$ 615	$ 9,129	27%	61%	6%	7%	6%
RRCN1	Online Basin	420	10	141	0	900	480	11	$ 990	$ 1,366	$ 432	$ 427	$ 3,214	31%	42%	13%	13%	2%
N125	Excavated Chl.	1313	47	822	0	1.5	171	6	$ 4,740	$ 18,050	$ 980	$ 1,136	$ 24,906	19%	72%	4%	5%	15%
RRP1A	Online Basin	87	6	62	0	700	360	8	$ 580	$ 643	$ 252	$ 254	$ 1,730	34%	37%	15%	15%	1%
N130	Excavated Chl.	1678	66	1581	0	2.1	181	6	$ 6,600	$ 34,319	$ 1,422	$ 1,625	$ 43,966	15%	78%	3%	4%	27%
N140	Excavated Chl.	1977	34	221	0	1.1	181	6	$ 3,440	$ 5,081	$ 743	$ 820	$ 10,083	34%	50%	7%	8%	6%
RRQ1A	Online Basin	106	10	146	0	1000	420	11	$ 960	$ 1,358	$ 420	$ 419	$ 3,156	30%	43%	13%	13%	2%
P1B10	Excavated Chl.	303	23	112	0	1	109	4	$ 2,270	$ 2,582	$ 302	$ 369	$ 5,523	41%	47%	5%	7%	3%
L30	Excavated Chl.	2162	24	97	0	1.2	204	7	$ 2,360	$ 2,835	$ 940	$ 1,768	$ 7,903	30%	36%	12%	22%	5%
L40	Excavated Chl.	2162	31	121	0	1.5	204	7	$ 3,110	$ 2,896	$ 1,240	$ 1,182	$ 8,429	37%	34%	15%	14%	5%
RRP1A10	Excavated Chl.	87	6	10	0	0.3	80	3	$ 550	$ 262	$ 44	$ 56	$ 911	60%	29%	5%	6%	1%
		TOTAL	400	5640	0				$39,830	$101,382	$11,163	$ 12,479	**$ 164,855**	24%	61%	7%	8%	100%
All Channels			302	3833	0	11.2			$30,090	$ 85,439	$ 6,919	$ 8,393	$ 130,841	23%	65%	5%	6%	79%
All Online Basins			98	1807	0				$ 9,740	$ 15,944	$ 4,244	$ 4,087	$ 34,014	29%	47%	12%	12%	21%
All Offline Basins			0	0	0				$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)			$11,682		Basins Cost per ac. ft. (in $1000)				$2.35									

Cost Increase for Landscape Compatibility Enhancement over Base Costs

All Channels % increase	38%	28%	0%				38%	27%	29%	22%	29%
All Online Basins % increase	44%	9%	0%				45%	9%	45%	44%	28%
All Offline Basins % increase	0%	0%	0%				0%	0%	0%	0%	0%
Total % increase	39%	22%	0%				39%	24%	35%	29%	29%

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Costs Summary

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs ($1000): Land Cost	Base Costs ($1000): Constr. Cost	Base Costs ($1000): Lndscp Cost	Base Costs ($1000): 50 Yr Maint. Cost	Base Costs ($1000): Total Cost	Base Cost Percentages: Land Cost %	Base Cost Percentages: Constr. Cost %	Base Cost Percentages: Lndscp Cost %	Base Cost Percentages: 50 Yr Maint. Cost %	Base Cost Percentages: % of Total Cost
RRL2BR	Online Basin	237	30	581	0	1650	800	11	$ 3,030	$ 5,044	$ 1,320	$ 1,260	$ 10,654	28%	47%	12%	12%	6%
L2A10	Excavated Chl.	322	17	84	0	0.7	109	4	$ 1,710	$ 1,949	$ 229	$ 257	$ 4,145	41%	47%	6%	6%	3%
RRCM1	Online Basin	424	42	877	0	2000	910	11	$ 4,180	$ 7,533	$ 1,820	$ 1,727	$ 15,260	27%	49%	12%	11%	9%
N110	Excavated Chl.	875	29	541	0	1	145	5	$ 2,860	$ 11,903	$ 517	$ 565	$ 15,845	18%	75%	3%	4%	10%
N120	Excavated Chl.	1288	25	244	0	0.8	169	7	$ 2,450	$ 5,561	$ 503	$ 615	$ 9,129	27%	61%	6%	7%	6%
RRCN1	Online Basin	420	10	141	0	900	480	11	$ 990	$ 1,366	$ 432	$ 427	$ 3,214	31%	42%	13%	13%	2%
N125	Excavated Chl.	1313	47	822	0	1.5	171	6	$ 4,740	$ 18,050	$ 980	$ 1,136	$ 24,906	19%	72%	4%	5%	15%
RRP1A	Online Basin	87	6	62	0	700	360	8	$ 580	$ 643	$ 252	$ 254	$ 1,730	34%	37%	15%	15%	1%
N130	Excavated Chl.	1678	66	1581	0	2.1	181	6	$ 6,600	$ 34,319	$ 1,422	$ 1,625	$ 43,966	15%	78%	3%	4%	27%
N140	Excavated Chl.	1977	34	221	0	1.1	181	6	$ 3,440	$ 5,081	$ 743	$ 820	$ 10,083	34%	50%	7%	8%	6%
RRQ1A	Online Basin	106	10	146	0	1000	420	11	$ 960	$ 1,358	$ 420	$ 419	$ 3,156	30%	43%	13%	13%	2%
P1B10	Excavated Chl.	303	23	112	0	1	109	4	$ 2,270	$ 2,582	$ 302	$ 369	$ 5,523	41%	47%	5%	7%	3%
L30	Excavated Chl.	2162	24	97	0	1.2	204	7	$ 2,360	$ 2,835	$ 940	$ 1,768	$ 7,903	30%	36%	12%	22%	5%
L40	Excavated Chl.	2162	31	121	0	1.5	204	7	$ 3,110	$ 2,896	$ 1,240	$ 1,182	$ 8,429	37%	34%	15%	14%	5%
RRP1A10	Excavated Chl.	87	6	10	0	0.3	80	3	$ 550	$ 262	$ 44	$ 56	$ 911	60%	29%	5%	6%	1%
	TOTAL	400	5640	0					$ 39,830	$ 101,382	$ 11,163	$ 12,479	**$ 164,855**	24%	61%	7%	8%	100%
All Channels		302	3833	0	11.2				$ 30,090	$ 85,439	$ 6,919	$ 8,393	$ 130,841	23%	65%	5%	6%	79%
All Online Basins		98	1807	0					$ 9,740	$ 15,944	$ 4,244	$ 4,087	$ 34,014	29%	47%	12%	12%	21%
All Offline Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)		$11,682		Basins Cost per ac. ft. (in $1000)					$2.35									

Cost Summary - Landscape Compatibility Enhanced (LCE)

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	LCE Design Geometry: Length (stor-ft; chl-mi)	LCE Design Geometry: ROW Width (ft)	LCE Design Geometry: Depth (ft)	LCE Costs ($1000): Land Cost	LCE Costs ($1000): Constr. Cost	LCE Costs ($1000): Lndscp Cost	LCE Costs ($1000): 50 Yr Maint. Cost	LCE Costs ($1000): Total Cost	LCE Cost Percentages: Land Cost %	LCE Cost Percentages: Constr. Cost %	LCE Cost Percentages: Lndscp Cost %	LCE Cost Percentages: 50 Yr Maint. Cost %	LCE Cost Percentages: % of Total Cost
RRL2BR	Online Basin	237	42	632	0	2030	900	11	$ 4,190	$ 5,476	$ 1,827	$ 1,736	$ 13,229	32%	41%	14%	13%	6%
L2A10	Excavated Chl.	322	24	116	0	0.7	267	4	$ 2,360	$ 2,638	$ 322	$ 344	$ 5,664	42%	47%	6%	6%	3%
RRCM1	Online Basin	424	56	959	0	2430	1010	11	$ 5,640	$ 8,218	$ 2,454	$ 2,322	$ 18,634	30%	44%	13%	12%	9%
N110	Excavated Chl.	875	39	708	0	1	309	5	$ 3,850	$ 15,438	$ 680	$ 719	$ 20,688	19%	75%	3%	3%	10%
N120	Excavated Chl.	1288	33	320	0	0.8	342	7	$ 3,310	$ 7,167	$ 667	$ 769	$ 11,914	28%	60%	6%	6%	6%
RRCN1	Online Basin	420	16	154	0	1200	580	11	$ 1,600	$ 1,470	$ 696	$ 676	$ 4,443	36%	33%	16%	15%	2%
N125	Excavated Chl.	1313	63	1063	0	1.5	341	6	$ 6,340	$ 23,130	$ 1,272	$ 1,409	$ 32,151	20%	72%	4%	4%	15%
RRP1A	Online Basin	87	10	68	0	960	460	8	$ 1,020	$ 694	$ 442	$ 434	$ 2,589	39%	27%	17%	17%	1%
N130	Excavated Chl.	1678	88	2008	0	2.1	351	6	$ 8,750	$ 43,329	$ 1,812	$ 1,991	$ 55,883	16%	78%	3%	4%	26%
N140	Excavated Chl.	1977	46	278	0	1.1	351	6	$ 4,560	$ 6,287	$ 947	$ 1,010	$ 12,803	36%	49%	7%	8%	6%
RRQ1A	Online Basin	106	17	165	0	1390	520	11	$ 1,660	$ 1,514	$ 723	$ 705	$ 4,601	36%	33%	16%	15%	2%
P1B10	Excavated Chl.	303	31	156	0	1	267	4	$ 3,140	$ 3,495	$ 425	$ 484	$ 7,544	42%	46%	6%	6%	4%
L30	Excavated Chl.	2162	36	116	0	1.2	257	7	$ 3,610	$ 3,224	$ 1,178	$ 1,988	$ 10,000	36%	32%	12%	20%	5%
L40	Excavated Chl.	2162	48	144	0	1.5	257	7	$ 4,750	$ 3,371	$ 1,555	$ 1,473	$ 11,149	43%	30%	14%	13%	5%
RRP1A10	Excavated Chl.	87	8	15	0	0.3	232	3	$ 780	$ 381	$ 70	$ 80	$ 1,312	59%	29%	5%	6%	1%
	TOTAL	557	6902	0					$ 55,560	$ 125,833	$ 15,070	$ 16,141	**$ 212,604**	26%	59%	7%	8%	100%
All Channels		416	4924	0	11.2				$ 41,450	$ 108,462	$ 8,928	$ 10,267	$ 169,107	25%	64%	5%	6%	80%
All Online Basins		141	1978	0					$ 14,110	$ 17,371	$ 6,142	$ 5,874	$ 43,497	32%	40%	14%	14%	20%
All Offline Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)		$15,099		Basins Cost per ac. ft. (in $1000)					$3.11									
All Channels % increase		38%	28%	0%					38%	27%	29%	22%	29%					
All Online Basins % increase		44%	9%	0%					45%	9%	45%	44%	28%					
All Offline Basins % increase		0%	0%	0%					0%	0%	0%	0%	0%					
Total % increase		39%	22%	0%					39%	24%	35%	29%	29%					

Hydrology - 6-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
R1	BASIN	506			4.2	0.28	47	12	4	2	1.525	1.527	1.527	1.527	23	23	23	23
Q1B	BASIN	851			4.5	0.94	155	39	13	6	1.533	1.544	1.544	1.544	77	77	77	77
DUMMY	COMBINE	1020			4.5	1.22	192	48	16	7	1.459	1.469	1.469	1.469	95	96	96	96
L1	BASIN	2128			4.7	3.55	543	139	46	20	1.424	1.453	1.453	1.453	269	275	275	275
L1-L2A	ROUTE	2066	14.4	40.14	4.9	3.55	543	139	46	20	1.423	1.453	1.453	1.453	269	275	275	275
L2A	BASIN	692			4.5	0.69	113	28	9	4	1.516	1.516	1.516	1.516	56	56	56	56
L2BR	COMBINE	2391			4.9	4.24	623	159	53	23	1.366	1.391	1.391	1.391	309	314	314	314
RRL2BR	STORAGE	237	9.6	250.16	7.1	4.24	225	149	53	23	0.494	1.309	1.391	1.391	112	296	314	314
L2A-M1	ROUTE	237	100.5	4.52	7.3	4.24	225	149	53	23	0.494	1.309	1.391	1.391	112	296	314	314
M1	BASIN	2809			4.8	5.69	790	203	68	29	1.291	1.327	1.327	1.327	392	402	402	402
CM1	COMBINE	2664			4.9	9.92	894	320	111	48	0.837	1.198	1.243	1.243	443	634	658	658
RRCM1	STORAGE	399	8.6	310.77	7.5	9.92	388	299	111	48	0.363	1.119	1.243	1.243	192	592	658	658
M1-N1	ROUTE	399	99.3	14.42	7.8	9.92	387	298	111	48	0.363	1.118	1.243	1.243	192	592	658	658
N1	BASIN	1253			4.5	1.52	210	53	18	8	1.281	1.286	1.286	1.286	104	105	105	105
CN1	COMBINE	870			4.5	11.45	465	326	121	52	0.377	1.059	1.177	1.177	230	647	719	719
RRCN1	STORAGE	382	7.9	63.27	10	11.45	379	321	121	52	0.308	1.043	1.177	1.177	188	637	719	719
N1-P1A	ROUTE	382	99.2	12.77	10.3	11.45	379	321	121	52	0.308	1.042	1.177	1.177	188	636	719	719
N2A	BASIN	1253			4.5	1.52	210	53	18	8	1.281	1.286	1.286	1.286	104	105	105	105
CN2AR	COMBINE	883			4.5	12.97	458	347	131	56	0.328	0.994	1.124	1.124	227	688	777	777
P1A	BASIN	575			4.4	0.5	89	22	7	3	1.655	1.663	1.663	1.663	44	44	44	44
RRP1A	STORAGE	87	6.6	31.21	5.5	0.5	70	22	7	3	1.305	1.663	1.663	1.663	35	44	44	44
CN2A	COMBINE	929			4.5	13.47	507	359	135	58	0.35	0.992	1.116	1.116	251	713	802	802
P1A-1B	ROUTE	825	100.6	57.77	5.4	13.47	503	358	135	58	0.347	0.989	1.116	1.116	249	711	802	802
P1B	BASIN	852			5	1.94	244	62	21	9	1.172	1.194	1.194	1.194	121	123	123	123
PR	COMBINE	1258			5.3	15.41	638	390	146	63	0.385	0.942	1.055	1.055	316	774	867	867
Q1A	BASIN	990			4.5	1.3	193	49	16	7	1.385	1.396	1.396	1.396	96	97	97	97
RRQ1A	STORAGE	106	9.7	73.8	6.2	1.3	97	48	16	7	0.698	1.386	1.396	1.396	48	96	97	97
Q1A-P	ROUTE	106	100.3	3.67	6.5	1.3	97	48	16	7	0.697	1.386	1.396	1.396	48	96	97	97
P	COMBINE	1303			5.3	16.71	704	418	155	67	0.392	0.93	1.032	1.032	349	829	920	920
N2B	BASIN	1193			5.1	3.33	366	93	31	13	1.023	1.045	1.045	1.045	181	185	185	185
O1	BASIN	1057			5.3	3.09	343	88	29	13	1.033	1.059	1.059	1.059	170	174	174	174
M2	BASIN	1849			5.4	7.44	633	159	53	23	0.791	0.795	0.795	0.795	314	315	315	315
Z1	BASIN	694			4.5	0.66	100	25	8	4	1.405	1.406	1.406	1.406	50	50	50	50
L2B	BASIN	1532			5	4.08	418	104	35	15	0.952	0.952	0.952	0.952	207	207	207	207
L2B-L3	ROUTE	1196	12.8	208.54	6.9	4.08	416	104	35	15	0.948	0.952	0.952	0.952	206	207	207	207
L2C	BASIN	754			4.8	1.33	161	40	13	6	1.125	1.125	1.125	1.125	80	80	80	80
L2C-2D	ROUTE	712	13	29.17	5.2	1.33	161	40	13	6	1.125	1.125	1.125	1.125	80	80	80	80
L2D	BASIN	706			4.7	1.23	136	34	11	5	1.025	1.025	1.025	1.025	67	67	67	67
L3RB	COMBINE	1043			5	2.56	260	65	22	9	0.945	0.946	0.946	0.946	129	129	129	129
L2D-L3	ROUTE	650	12.5	187.08	8.3	2.56	258	65	22	9	0.936	0.946	0.946	0.946	128	129	129	129
L3	BASIN	1832			5.2	5.85	581	146	49	21	0.923	0.926	0.926	0.926	288	289	289	289
L	COMBINE	1638			5.3	12.49	963	250	83	36	0.717	0.745	0.745	0.745	478	496	496	496

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
R1	BASIN	387			12.2	0.28	37	10	3	1	1.223	1.322	1.322	1.322	19	20	20	20
Q1B	BASIN	740			12.5	0.94	134	38	13	5	1.325	1.498	1.5	1.5	66	75	75	75
DUMMY	COMBINE	902			12.5	1.22	170	48	16	7	1.294	1.448	1.45	1.45	84	94	94	94
L1	BASIN	2267			12.7	3.55	527	150	50	22	1.382	1.572	1.576	1.576	261	297	298	298
L1-L2A	ROUTE	2154	14.4	41.37	12.9	3.55	527	150	50	22	1.381	1.571	1.576	1.576	261	297	298	298
L2A	BASIN	570			12.5	0.69	92	23	8	3	1.236	1.236	1.236	1.236	46	46	46	46
L2BR	COMBINE	2519			12.9	4.24	616	172	57	25	1.351	1.509	1.513	1.513	305	341	342	342
RRL2BR	STORAGE	236	9.5	247.85	15.1	4.24	226	157	57	25	0.496	1.377	1.513	1.513	112	311	342	342
L2A-M1	ROUTE	236	100.5	4.51	15.3	4.24	226	157	57	25	0.496	1.376	1.513	1.513	112	311	342	342
M1	BASIN	3301			12.8	5.69	825	236	79	34	1.349	1.543	1.548	1.548	409	468	469	469
CM1	COMBINE	3400			12.8	9.92	1003	374	135	59	0.94	1.403	1.522	1.522	497	743	805	806
RRCM1	STORAGE	424	9.7	351.97	15.7	9.92	415	339	135	59	0.389	1.271	1.522	1.522	206	673	805	806
M1-N1	ROUTE	424	99.4	15.01	16	9.92	415	339	135	59	0.389	1.27	1.522	1.522	206	672	805	806
N1	BASIN	1211			12.5	1.52	192	52	17	7	1.172	1.269	1.27	1.27	95	103	103	103
CN1	COMBINE	1288			12.5	11.45	532	380	151	65	0.432	1.234	1.471	1.471	264	753	898	898
RRCN1	STORAGE	420	9.5	78.16	18.1	11.45	418	370	151	65	0.339	1.203	1.471	1.471	207	734	898	898
N1-P1A	ROUTE	420	99.3	13.62	18.4	11.45	418	370	151	65	0.339	1.202	1.471	1.471	207	734	898	898
N2A	BASIN	1211			12.5	1.52	192	52	17	7	1.172	1.269	1.27	1.27	95	103	103	103
CN2AR	COMBINE	1313			12.5	12.97	545	410	166	72	0.39	1.175	1.43	1.43	270	813	989	989
P1A	BASIN	441			12.4	0.5	73	21	7	3	1.351	1.542	1.545	1.545	36	41	41	41
RRP1A	STORAGE	77	5.1	23.93	13.5	0.5	61	21	7	3	1.136	1.535	1.545	1.545	30	41	41	41
CN2A	COMBINE	1366			12.5	13.47	602	427	172	74	0.415	1.179	1.427	1.427	299	847	1025	1026
P1A-1B	ROUTE	1135	101	74.11	13.1	13.47	597	426	172	74	0.412	1.176	1.427	1.427	296	845	1025	1026
P1B	BASIN	842			13	1.94	231	61	20	9	1.108	1.174	1.175	1.175	114	121	121	121
PR	COMBINE	1914			13.1	15.41	789	476	190	82	0.476	1.148	1.376	1.376	391	944	1131	1131
Q1A	BASIN	915			12.5	1.3	173	48	16	7	1.242	1.372	1.374	1.374	86	95	95	95
RRQ1A	STORAGE	100	8.7	65.43	14.1	1.3	92	47	16	7	0.66	1.334	1.374	1.374	46	92	95	95
Q1A-P	ROUTE	100	100.3	3.52	14.5	1.3	92	47	16	7	0.659	1.334	1.374	1.374	46	92	95	95
P	COMBINE	1977			13.1	16.71	871	517	204	88	0.485	1.15	1.362	1.362	432	1025	1213	1213
N2B	BASIN	1331			13.1	3.33	378	99	33	14	1.057	1.102	1.103	1.103	187	195	196	196
O1	BASIN	1163			13.3	3.09	349	91	30	13	1.05	1.095	1.096	1.096	173	180	180	180
M2	BASIN	2347			13.4	7.44	786	198	66	29	0.983	0.989	0.99	0.99	390	392	392	392
Z1	BASIN	558			12.5	0.66	80	21	7	3	1.127	1.161	1.161	1.161	40	41	41	41
L2B	BASIN	1700			13	4.08	449	112	37	16	1.024	1.024	1.024	1.024	223	223	223	223
L2B-L3	ROUTE	1323	12.9	226.51	14.8	4.08	447	112	37	16	1.02	1.024	1.024	1.024	222	223	223	223
L2C	BASIN	692			12.8	1.33	145	36	12	5	1.013	1.013	1.013	1.013	72	72	72	72
L2C-2D	ROUTE	651	12.9	27.24	13.2	1.33	145	36	12	5	1.013	1.013	1.013	1.013	72	72	72	72
L2D	BASIN	655			12.7	1.23	124	31	10	4	0.934	0.934	0.934	0.934	61	61	61	61
L3RB	COMBINE	1104			13	2.56	266	66	22	10	0.965	0.965	0.965	0.965	132	132	132	132
L2D-L3	ROUTE	705	12.5	201.22	16.1	2.56	263	66	22	10	0.956	0.965	0.965	0.965	130	132	132	132
L3	BASIN	2129			13.2	5.85	658	166	56	24	1.045	1.058	1.058	1.058	326	330	330	330
L	COMBINE	2162			13.3	12.49	1287	335	112	48	0.958	0.997	0.997	0.997	638	664	664	664

Channels Hydraulics Summary

		Design Geometry						Hydraulics										
Structure ID	Type	Initial Slope (ft/ft)	Long-term Slope (ft/ft)	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Chnl Mannings n	Flow Rate (cfs)	Wetted Perimeter (ft)	Wetted XS Area (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flow Depth (ft)	Freeboard (ft)	Top Width (ft)	Velocity (ft/s)	Froude Number	Shear Stress (lb/sq. ft)
L2A10	Excavated	0.0128	0.0060	0.70	3	4.0	0.045	322	52.3	88.5	1.7	1.7	2.7	1.3	51	3.6	0.49	1.03
N110	Excavated	0.0234	0.0080	1.00	3	5.0	0.045	875	85.3	179.8	2.1	2.1	3.2	1.8	84	4.9	0.59	1.60
N120	Excavated	0.0129	0.0050	0.80	3	6.5	0.045	1288	107.9	286.8	2.7	2.7	4.4	2.1	106	4.5	0.48	1.38
N125	Excavated	0.0131	0.0050	1.50	3	6.0	0.045	1313	115.4	298.0	2.6	2.6	4.8	1.2	114	4.4	0.48	1.50
N130	Excavated	0.0132	0.0050	2.10	3	6.0	0.045	1678	125.7	357.2	2.8	2.9	4.9	1.1	124	4.7	0.49	1.52
N140	Excavated	0.0072	0.0040	1.10	3	6.0	0.045	1977	129.2	426.1	3.3	3.3	5.4	0.6	127	4.6	0.45	1.35
P1B10	Excavated	0.0112	0.0060	1.00	3	4.0	0.045	303	50.5	84.1	1.7	1.7	2.5	1.5	50	3.6	0.49	0.92
L30	Excavated	0.0048	0.0048	1.20	3	6.5	0.045	2162	146.5	447.6	3.1	3.1	5.0	1.5	145	4.8	0.48	1.49
L40	Excavated	0.0040	0.0040	1.50	3	6.5	0.045	2162	147.7	474.3	3.2	3.2	5.2	1.3	146	4.6	0.45	1.29
RRP1A10	Excavated	0.0196	0.0090	0.30	3	3.0	0.045	87	24.2	26.2	1.1	1.1	1.9	1.1	24	3.3	0.55	1.08

Basins Hydraulics Summary

			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac.	Peak Inflow into Basin (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Freeboard (ft)
RRL2BR	Online Basin	0.0240	1650	800	11.0	261.7	250.2	342.0	2519	237	9.6	1.4
RRCM1	Online Basin	0.0250	2000	910	11.0	363.5	352.0	806.0	3400	424	9.7	1.3
RRCN1	Online Basin	0.0210	900	480	11.0	82.2	78.2	898.0	1288	420	9.5	1.5
RRP1A	Online Basin	0.0222	700	360	8.0	33.4	31.2	44.0	575	87	6.6	1.4
RRQ1A	Online Basin	0.0300	1000	420	11.0	76.6	73.8	97.0	990	106	9.7	1.3

Online Basin

HEC1 ID	RRL2BR

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	4.2	sq. mi
Total Sediment Yield Volume	8.1	ac ft

Required Minimum Sediment Volume

Sediment Volume	8.1	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.024	0.024
Basin Length (ft)	1650	1930
Basin Width (ft)	800	800
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	11	11
Freeboard (ft)	1	1
Effective Basin Width (ft)	742	685
Top Area (acres)	30.3	35.4
U/S-D/S Height Difference (ft)	19.2	19.2
Excess Area on Upstream (acres)	2.3	5.2

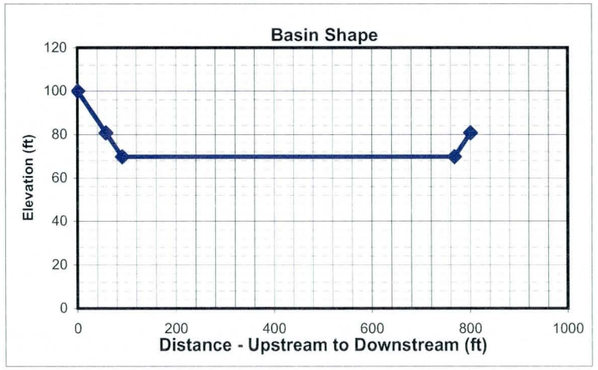
			Base	LC Enhanced
Bottom Length (ft)	1584	Allocated Storage Volume (ac. ft)	261.7	261.7
Bottom Width (ft)	676	Total Available Volume (ac. ft) (incl. Freeboard)	289.6	291.7
		Total Excavation Volume (ac. ft)	580.7	632.2

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	4.50	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	2	4	6	7	8	9	10	11	13
Volume	0.00	49.79	100.84	153.15	179.79	206.76	234.04	261.66	289.60	346.47
Outflow	0.0	108.3	153.2	187.6	202.6	216.6	229.7	242.2	254.0	276.1



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	314.0	342	342.0
Peak Inflow (cfs)	2391	2519	2519.0
Peak Outflow (cfs)	237	236	237.0
Stage at Peak Outflow (ft)	9.6	9.5	9.6
Volume at Peak Outflow (ac. ft)	250.2	247.85	250.2

Volume Check

Total Volume needed	258.3	ac. ft
Total Volume Provided	261.7	ac. ft

Volume OK?	Yes

Stage Check

Depth Needed	10.6	ft
Depth Provided	11	ft

Depth OK?	Yes

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	507000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	1650	ft
Base Total ROW Width	800	ft
LC Enh. Total ROW Length	2030	ft
LC Enh. Total ROW Length	900	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	936863	1019949
Excavated Area (sq. Yd)	146667	203000

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	96	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	1061	sq. Yd
Material Volume	531	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	579	ft
Unit Cost	160	per ft
Cost per outlet	$92,640	
Other Cost	$ -	
Total Cost	$92,640	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		936,863	cu. Yd	$ 4.00	$ 3,747,452	146,667	sq. Yd	$ 9.00	$ 1,320,003	146,667	sq. Yd	$ 8.33	$ 1,222,225
Basin - LC Enhancement		83,086	cu. Yd	$ 4.00	$ 332,344	56,333	sq. Yd	$ 9.00	$ 506,997	56,333	sq. Yd	$ 8.33	$ 469,442
Inlet	Riprap	531	sq. Yd	$ 75.00	$ 39,825	1,061	sq. Yd	$ -	$ -	1,061	sq. Yd	$ 33.33	$ 35,367
Inlet - LC Enhancement (20%Inlet)					$ 7,965				$ -				$ 7,073
Outlet	Pipe	1	EA	$ 92,640	$ 92,640	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 4,632				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,320,003	Base Maintenance Cost			$ 1,259,808
						LC Enh. Landscape Cost			$ 506,997	LC Enh. Maintenance Cost			$ 476,626
						Total Landscape Cost			$ 1,827,000	Total Maintenance Cost			$ 1,736,434

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,879,917	$ 332,344	$ 4,212,261
Contingency Cost (25% of Construction Cost)	$ 969,979	$ 83,086	$ 1,053,065
Engineering Design Cost (5% of Construction Cost)	$ 193,996	$ 16,617	$ 210,613
Total Construction Cost	$ 5,043,892	$ 432,047	$ 5,475,939

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	11.6	$100,000	$ 1,160,000
Basin	30.3	$100,000	$ 3,030,000
Other		$100,000	$ -
Total	41.9	$100,000	$ 4,190,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	30.3	$100,000	$ 3,030,000
LC Enhancement Cost	acre	11.6	$100,000	$ 1,160,000
Total Land Cost	acre	41.9	$100,000	$ 4,190,000

Total Cost

Base Total Cost	$ 10,653,703
Total LC Enhancement Cost	$ 2,575,670
Total Cost Including LC Enh.	$ 13,229,373

Open Channel

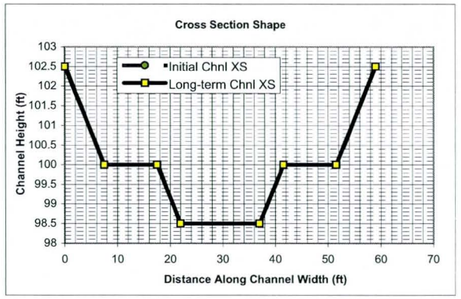
Structure ID	L2A10	HEC1 ID	L2A-M1

Longitundal Geometry

Length	3875.0	ft
U/S Elev	1616.0	ft
D/S Elev	1566.2	ft
Initial Channel Slope	0.0128	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	3



Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	2.5	10	3	15	4	3	10	2.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	7.5	17.5	22	37	41.5	51.5	59
Y	102.5	100	100	98.5	98.5	100	100	102.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	2.5	10	3	15	4	3	10	2.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	7.5	17.5	22	37	41.5	51.5	59
Y	102.5	100	100	98.5	98.5	100	100	102.5

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RRL2BR	L2B							TOTAL
HEC1 Peak-Flow	237	1700							1937
Weighting Factor	1.00	0.05							
Flow into Channel	237	85							322

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

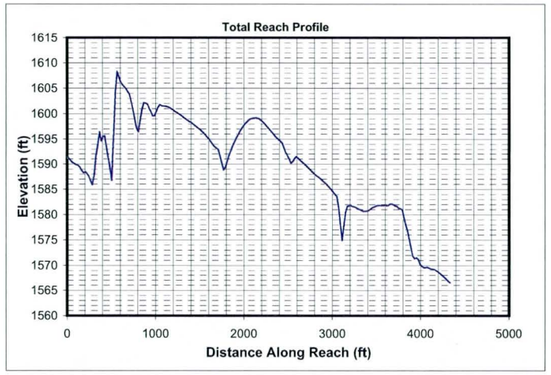
Hydrology

Drainage Area	0.5	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	322	cfs	
Long-term Max. Chnl Capacity	770	cfs	
Q2 Channel	32	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	59	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		



Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
32	20.5	15.3	0.7	98.5	99.4	2.1	0.9	20.2	0.8	0.32	0.43
97	46.1	40.8	0.9	98.5	100.3	2.4	1.8	45.6	0.9	0.66	0.44
242	50.4	73.4	1.5	98.5	100.9	3.3	2.4	49.7	1.5	0.91	0.48
322	52.3	88.5	1.7	98.5	101.2	3.6	2.7	51.4	1.7	1.03	0.49

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
32	20.5	15.3	0.7	98.5	99.4	2.1	0.9	20.2	0.8	0.32	0.43
97	46.1	40.8	0.9	98.5	100.3	2.4	1.8	45.6	0.9	0.66	0.44
242	50.4	73.4	1.5	98.5	100.9	3.3	2.4	49.7	1.5	0.91	0.48
322	52.3	88.5	1.7	98.5	101.2	3.6	2.7	51.4	1.7	1.03	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
32										0
97										0
242										0
322										0

Allowable Velocity

Channel Lining: Natural - Coarse Gravel (noncolloidal)

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
32	1.74	1.3091	1.2436	Erosive	Erosive	Erosive	0.3	Stable	4.1	Stable	Stable
97	1.74	1.3618	1.2937	Erosive	Erosive	Erosive	0.3	Stable	6.0	Stable	Stable
242	1.74	1.5158	1.4400	Erosive	Erosive	Erosive	0.4	Stable	7.7	Stable	Stable
322	1.74	1.5626	1.4845	Erosive	Erosive	Erosive	0.4	Stable	8.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	6

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	32	97	242	322	32	97	242	322	32	97	242	322
Bray - Equation #1	15	26	43	50	0.8	1.2	1.7	1.8	2.6	3.0	3.4	3.5
Bray - Equation #2	19	35	56	65	0.9	1.3	1.8	2.0	1.8	2.1	2.3	2.4
Hey	4	8	13	15	2.4	3.7	5.2	5.8				
Ackers & Charlton/Lacey	15	25	36	41					1.4	1.7	2.0	2.1
Parker	39	68	107	123	0.6	0.9	1.4	1.5				
Chang	23	45	79	94	0.2	0.1	0.0	0.0				
Kellerhals	10	18	28	32	1.1	1.7	2.4	2.7	2.9	3.2	3.5	3.6
AMAFCA/Schumm	20	46	50	52								
Moody & Odem	9	9	9	9	0.9	0.9	0.9	0.9				
BUREC	9.4	14.3	20.1	22.4	3	4	5	6	2.1	2.8	3.5	3.8
Average	16	29	44	50	1.2	1.7	2.3	2.6	2.2	2.6	3.0	3.1
Values As Designed	20	46	50	51	0.9	1.8	2.4	2.7	2.1	2.4	3.3	3.6
Difference with Design	-4	-16	-6	-1	0.3	-0.1	-0.1	-0.2	0.1	0.2	-0.3	-0.5

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
32	115	78	167	606	492	33	21	22	846	57	267	246
97	405	247	561	2219	1238	128	74	86	2566	194	948	788
242	1585	772	1499	9912	1825	540	236	370	6536	691	3536	2500
322	2421	1083	2069	15764	2064	819	326	561	8742	1027	5233	3646

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
32	1327	894	1920	6977	5668	381	244	257	9745	661	3078	2832
97	1555	949	2153	8523	4754	492	286	331	9854	745	3640	3026
242	2434	1185	2304	15227	2804	829	362	568	10040	1061	5432	3841
322	2790	1248	2384	18163	2378	944	375	646	10072	1183	6030	4201

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
32	115	66	107	193	285	22	21	22	249	27	130	112
97	405	212	360	708	733	85	74	86	771	91	470	363
242	1585	684	1051	3164	1139	339	236	370	2034	339	1844	1162
322	2421	967	1443	5032	1303	506	326	561	2736	513	2769	1689

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
32	1327	756	1237	2227	3278	256	244	257	2865	308	1497	1296
97	1555	816	1384	2721	2815	325	286	331	2961	350	1804	1395
242	2434	1051	1614	4861	1749	520	362	568	3125	521	2832	1785
322	2790	1114	1662	5798	1502	583	375	646	3153	591	3191	1946

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
32	0.0012	0.0016	182	0.56	0.050	0.0004	31	0.036	0.0003	0.0159	0.0003	0.0009	0.0110	0.0008	0.0027	0.0059	0.0046
97	0.0010	0.0014	199	0.61	0.050	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0007	0.0110	0.0005	0.0012	0.0059	0.0045
242	0.0005	0.0008	254	0.78	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0110	0.0003	0.0006	0.0059	0.0044
322	0.0004	0.0007	274	0.84	0.054	0.0002	32	0.036	0.0001	0.0159	0.0001	0.0004	0.0110	0.0003	0.0005	0.0059	0.0044

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	26.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	431	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.21	sq. mi
Total Sediment Yield Volume	0.40	ac ft

Sedimentation Basins

Length	431 ft	Depth	3 ft	
Width	59 ft	Side slope	3 ft/ft	
Total Volume per Basin		1.45	ac. ft.	
Basin Trap Efficiency		0.6		
No. of Basins		1		

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
32	1.1	-0.3	0.1	24.6	0.9	0.8	2.1	0.0060	0.1	0.0	1.5	2.1
97	1.1	-0.6	0.1	24.6	1.8	0.9	2.4	0.0060	0.2	0.0	1.5	2.2
242	1.1	-0.7	0.1	24.6	2.4	1.5	3.3	0.0060	0.3	0.0	1.5	2.4
322	1.1	-0.8	0.2	24.6	2.7	1.7	3.6	0.0060	0.3	0.0	1.5	2.5

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	237	cfs
Stage at Peak Flow	100.5	ft
Volume at Peak Flow	342.0	ac. ft

Freeboard

Max. Flow Depth	2.7	ft
Channel Depth as designed	4.0	ft
Available Freeboard	1.3	ft
Required Freeboard	1	ft

Sediment Volume

Inflowing Sediment Volume	0.40	ac. ft
Outflowing Sediment Volume	0.25	ac. ft
Deposited(+)/Eroded(-) Volume	0.15	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	3875	3875
Side Slope (?H:1V)	3	6
Channel Width (ft)	59	83
Channel XS Area (sq. ft)	158	206
Channel Perimeter (ft)	60	83

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	134983	187556
Excavated Area (sq. Yd)	25403	35736

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3875	ft
Thickness	1.5	ft
Protection Depth	3	ft
Tie-in Length/Depth	3.0	ft
Total Depth	6.0	ft
Area needed	646	sq. Yd
Volume	1292	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3875	3875
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	3875	3875
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	59	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	6.7	ft	
Structure Height	9.7	ft	
Number of Structures	9		
Volume per structure	64	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 4,800		
Area per structure	20	sq. Yd	
Total Area	177	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	2339	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 9,356	
Other Cost	$ -	
Total cost per basin	$ 9,356	
Area per basin	2,823	sq. Yd
Total Area	2,823	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction					Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	134,983	cu. Yd	$ 10.00	$ 1,349,830	25,403	sq. Yd	$ 9.00	$ 228,627	25,403	sq. Yd	$ 8.33	$ 211,692
Exc. Chl - LC Enhancement	Excavated	52,573	cu. Yd	$ 10.00	$ 525,730	10,333	sq. Yd	$ 9.00	$ 92,997	10,333	sq. Yd	$ 8.33	$ 86,108
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,292	cu. Yd	$ 75.00	$ 96,900	646	sq. Yd	$ -	$ -	646	sq. Yd	$ 25.00	$ 16,150
Drop Structures	Riprap	9	EA	$ 4,800.00	$ 43,200	177	sq. Yd	$ -	$ -	177	sq. Yd	$ 33.33	$ 5,900
Drop Str. - LC Enhancement	Riprap	9	EA	$ 480.00	$ 4,320	18	sq. Yd	$ -	$ -	18	sq. Yd	$ 33.33	$ 590
Sedimentation Basins		1	EA	$ 9,356.00	$ 9,356	2,823	sq. Yd	$ -	$ -	2,823	sq. Yd	$ 8.33	$ 23,525
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 228,627	Base Maintenance Cost			$ 257,267
						LC Enhancement Cost			$ 92,997	LC Enhancement Cost			$ 86,698
						Total Landscape Cost			$ 321,624	Total Maintenance Cost			$ 343,965

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,499,286	$ 530,050	$ 2,029,336
Contingency Cost (25% of Construction Cost)	$ 374,822	$ 132,513	$ 507,334
Engineering Design Cost (5% of Construction Cost)	$ 74,964	$ 26,503	$ 101,467
Total Construction Cost	$ 1,949,072	$ 689,065	$ 2,638,137

Land Cost

Channel Length	3875	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	11.9	$100,000	$ 1,190,000
LC Enhancement Buffer	50	4.4	$100,000	$ 440,000
Channel	59	5.2	$100,000	$ 520,000
Channel LC Enhancement	24	2.1	$100,000	$ 210,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	267	23.6		$ 2,360,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	17.1	$100,000	$ 1,710,000
LC Enhancement Cost	acre	6.5	$100,000	$ 650,000
Total Land Cost	acre	23.6	$100,000	$ 2,360,000

Total Cost

Base Total Cost	$	4,144,965
Total Landscape Enhancement Cost	$	1,518,760
Total Cost Including LC Enh.	$	5,663,726

Online Basin

HEC1 ID	RRCM1

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID	L2A-M1						Total Volume (ac. ft)
Inflow Volume (ac. ft)	342						342
Volume Fraction	1						
Weighted Volume	342						342
Sediment Conc. (ppm)	1946						
Sediment Volume (ac. ft)	0.25						0.25
Weighting Factor	1						
Weighted Sed. Vol. (ac. ft)	0.25						0.25

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	5.7	sq. mi
Total Sediment Yield Volume	10.8	ac ft

Required Minimum Sediment Volume

Sediment Volume	11.1	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.025	0.025
Basin Length (ft)	2000	2330
Basin Width (ft)	910	910
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	11	11
Freeboard (ft)	1	1
Effective Basin Width (ft)	842	774
Top Area (acres)	41.8	48.7
U/S-D/S Height Difference (ft)	22.8	22.8
Excess Area on Upstream (acres)	3.3	7.4

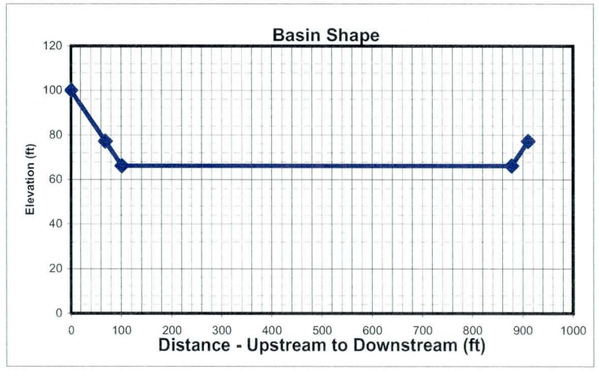
			Base	LC Enhanced
Bottom Length (ft)	1934	Allocated Storage Volume (ac. ft)	363.5	364.2
Bottom Width (ft)	776	Total Available Volume (ac. ft) (incl. Freeboard)	401.9	405.1
		Total Excavation Volume (ac. ft)	877.4	959

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	6.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	3	5	6	7	8	10	12	14
Volume	0.00	34.64	105.05	176.97	213.50	250.41	287.71	363.47	440.79	519.68
Outflow	0.0	136.1	235.8	304.4	333.5	360.2	385.1	430.5	471.6	509.4



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	658.0	806	806.0
Peak Inflow (cfs)	2664	3400	3400.0
Peak Outflow (cfs)	399	424	424.0
Stage at Peak Outflow (ft)	8.6	9.7	9.7
Volume at Peak Outflow (ac. ft)	310.8	351.97	352.0

Volume Check

Total Volume needed	363.1	ac. ft
Total Volume Provided	363.5	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	10.7	ft
Depth Provided	11	ft
Depth OK?	Yes	

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	634300	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	2000	ft
Base Total ROW Width	910	ft
LC Enh. Total ROW Length	2430	ft
LC Enh. Total ROW Length	1010	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	1415539	1547187
Excavated Area (sq. Yd)	202222	272700

Inlet			***Outlet***		
Inlet Type	Riprap		Outlet Type	Pipe	
(Riprap, Concrete)			(None, Riprap Weir, Concrete Weir, Pipe)		
			Pipe Length	550	ft
Inlet Length	107	ft	Unit Cost	160	per ft
Inlet Width	100	ft	Cost per outlet	$88,000	
Material Thickness	1.5	ft	Other Cost	$ -	
Inlet Area	1188	sq. Yd	Total Cost	$88,000	
Material Volume	594	cu. Yd	Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		1,415,539	cu. Yd	$ 4.00	$ 5,662,156	202,222	sq. Yd	$ 9.00	$ 1,819,998	202,222	sq. Yd	$ 8.33	$ 1,685,183
Basin - LC Enhancement		131,648	cu. Yd	$ 4.00	$ 526,592	70,478	sq. Yd	$ 9.00	$ 634,302	70,478	sq. Yd	$ 8.33	$ 587,317
Inlet	Riprap	594	sq. Yd	$ 75.00	$ 44,550	1,188	sq. Yd	$ -	$ -	1,188	sq. Yd	$ 33.33	$ 39,600
Inlet - LC Enhancement (20%Inlet)					$ 8,910				$ -				$ 7,920
Outlet	Pipe	1	EA	$ 88,000	$ 88,000	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 4,400				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,819,998	Base Maintenance Cost			$ 1,727,000
						LC Enh. Landscape Cost			$ 634,302	LC Enh. Maintenance Cost			$ 595,348
						Total Landscape Cost			$ 2,454,300	Total Maintenance Cost			$ 2,322,348

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 5,794,706	$ 526,592	$ 6,321,298
Contingency Cost (25% of Construction Cost)	$ 1,448,677	$ 131,648	$ 1,580,325
Engineering Design Cost (5% of Construction Cost)	$ 289,735	$ 26,330	$ 316,065
Total Construction Cost	$ 7,533,118	$ 684,570	$ 8,217,687

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	14.6	$100,000	$ 1,460,000
Basin	41.8	$100,000	$ 4,180,000
Other		$100,000	$ -
Total	56.4	$100,000	$ 5,640,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	41.8	$100,000	$ 4,180,000
LC Enhancement Cost	acre	14.6	$100,000	$ 1,460,000
Total Land Cost	acre	56.4	$100,000	$ 5,640,000

Total Cost

Base Total Cost	$ 15,260,116
Total LC Enhancement Cost	$ 3,374,219
Total Cost Including LC Enh.	$ 18,634,335

Open Channel

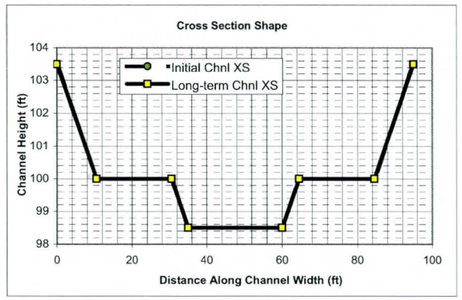
Structure ID	N110	HEC1 ID	M1-N1

Longitundal Geometry

Length	5444.1	ft
U/S Elev	1565.0	ft
D/S Elev	1437.4	ft
Initial Channel Slope	0.0234	ft/ft
Long-term Channel Slope	0.0080	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	4



Initial Channel XS Geometry

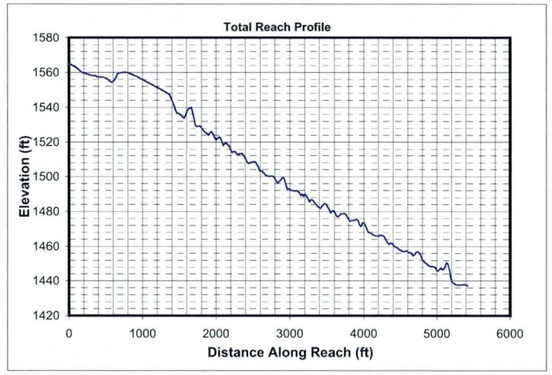
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3.5	20	3	25	5	3	20	3.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	10.5	30.5	35	60	64.5	84.5	95
Y	103.5	100	100	98.5	98.5	100	100	103.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3.5	20	3	25	5	3	20	3.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	10.5	30.5	35	60	64.5	84.5	95
Y	103.5	100	100	98.5	98.5	100	100	103.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RRCM1	N1								TOTAL
HEC1 Peak-Flow	424	1253								1677
Weighting Factor	1.00	0.36								
Flow into Channel	424	451								875

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	11.45	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	875	cfs	
Long-term Max. Chnl Capacity	2330	cfs	
Q2 Channel	88	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	95	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
88	31.8	30.4	1.0	98.5	99.6	2.9	1.1	31.5	1.0	0.54	0.52
263	77.8	84.1	1.1	98.5	100.5	3.1	2.0	77.2	1.1	1.01	0.53
656	83.0	149.6	1.8	98.5	101.4	4.4	2.9	82.1	1.8	1.42	0.57
875	85.3	179.8	2.1	98.5	101.7	4.9	3.2	84.3	2.1	1.60	0.59

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
88	31.8	30.4	1.0	98.5	99.6	2.9	1.1	31.5	1.0	0.54	0.52
263	77.8	84.1	1.1	98.5	100.5	3.1	2.0	77.2	1.1	1.01	0.53
656	83.0	149.6	1.8	98.5	101.4	4.4	2.9	82.1	1.8	1.42	0.57
875	85.3	179.8	2.1	98.5	101.7	4.9	3.2	84.3	2.1	1.60	0.59

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
88										0
263										0
656										0
875										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
88	1.74	1.3851	1.3159	Erosive	Erosive	Erosive	0.3	Stable	5.5	Stable	Stable
263	1.74	1.4221	1.3510	Erosive	Erosive	Erosive	0.3	Stable	7.7	Stable	Stable
656	1.74	1.5805	1.5015	Erosive	Erosive	Erosive	0.4	Stable	9.9	Stable	Stable
875	1.74	1.6291	1.5476	Erosive	Erosive	Erosive	0.4	Stable	10.8	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	88	263	656	875	88	263	656	875	88	263	656	875
Bray - Equation #1	25	45	73	85	1.2	1.7	2.3	2.5	3.0	3.4	3.9	4.1
Bray - Equation #2	33	59	95	111	1.3	1.9	2.5	2.8	2.0	2.4	2.7	2.8
Hey	7	14	23	27	3.5	5.4	7.6	8.5				
Ackers & Charlton/Lacey	24	37	55	62					1.7	2.0	2.4	2.5
Parker	64	111	176	203	0.9	1.4	2.0	2.3				
Chang	46	91	158	188	0.1	-0.1	-0.4	-0.6				
Kellerhals	17	29	46	53	1.6	2.5	3.6	4.1	3.2	3.6	3.9	4.0
AMAFCA/Schumm	32	77	82	84								
Moody & Odem	31	31	31	31	1.4	1.4	1.4	1.4				
BUREC	13.0	19.6	27.7	30.8	3	5	7	8	3.0	4.0	5.0	5.4
Average	29	51	77	87	1.7	2.4	3.3	3.7	2.6	3.1	3.6	3.8
Values As Designed	31	77	82	84	1.1	2.0	2.9	3.2	2.9	3.1	4.4	4.9
Difference with Design	-2	-26	-5	3	0.6	0.4	0.5	0.4	-0.3	0.0	-0.8	-1.1

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
88	636	372	859	6253	1281	300	115	139	5852	348	1804	1633
263	2140	1125	2656	21612	3362	1016	362	472	17592	1133	5916	5217
656	8498	3275	6331	98194	4743	4896	984	1781	44212	3953	20163	17912
875	13049	4525	8324	157194	5296	7840	1322	2632	59002	5841	29177	26746

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
88	2696	1577	3644	26512	5432	1273	489	589	24813	1477	7651	6923
263	3025	1590	3754	30544	4752	1436	512	668	24864	1601	8362	7373
656	4804	1851	3579	55512	2681	2768	556	1007	24995	2235	11399	10126
875	5533	1918	3529	66650	2245	3324	561	1116	25017	2476	12371	11340

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
88	636	311	525	1247	658	155	115	139	1126	144	734	526
263	2140	950	1606	4311	1751	515	362	472	3407	476	2451	1676
656	8498	2839	4223	19588	2581	1857	984	1781	8711	1807	8959	5621
875	13049	3946	5477	31358	2911	2743	1322	2632	11658	2518	13237	8259

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
88	2696	1318	2226	5289	2790	657	489	589	4773	611	3114	2232
263	3025	1342	2270	6093	2474	729	512	668	4815	673	3463	2369
656	4804	1605	2388	11074	1459	1050	556	1007	4925	1021	5065	3178
875	5533	1673	2322	13296	1234	1163	561	1116	4943	1067	5612	3502

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
88	0.0008	0.0013	279	0.85	0.054	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0006	0.0079	0.0005	0.0019	0.0079	0.0042
263	0.0007	0.0011	296	0.90	0.054	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0006	0.0079	0.0003	0.0008	0.0079	0.0042
656	0.0004	0.0007	383	1.17	0.057	0.0002	33	0.036	0.0001	0.0159	0.0001	0.0003	0.0079	0.0002	0.0004	0.0079	0.0041
875	0.0003	0.0006	414	1.26	0.058	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0003	0.0079	0.0002	0.0003	0.0079	0.0040

Drop Structures

Design Slope	0.0080	ft/ft
Total Drop Needed	84.0	ft
Height of Drop Structure	3	ft
No . of Drop Structures	29	
Distance between structs.	188	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.50	sq. mi
Total Sediment Yield Volume	0.95	ac ft

Sedimentation Basins

Length	188 ft	Depth	3 ft	
Width	95 ft	Side slope	3 ft/ft	
Total Volume per Basin		1.06	ac. ft.	
Basin Trap Efficiency		0.6		
No. of Basins		2		

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
88	1.1	-0.3	0.1	24.6	1.1	1.0	2.9	0.0080	0.1	0.0	1.5	2.2
263	1.1	-0.6	0.1	24.6	2.0	1.1	3.1	0.0080	0.2	0.0	1.5	2.3
656	1.1	-0.7	0.3	24.6	2.9	1.8	4.4	0.0080	0.3	0.0	1.5	2.5
875	1.1	-0.8	0.3	24.6	3.2	2.1	4.9	0.0080	0.4	0.0	1.5	2.7

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	424	cfs
Stage at Peak Flow	99.4	ft
Volume at Peak Flow	806.0	ac. ft

Freeboard

Max. Flow Depth	3.2	ft
Channel Depth as designed	5.0	ft
Available Freeboard	1.8	ft
Required Freeboard	1	ft

Sediment Volume

Inflowing Sediment Volume	0.95	ac. ft
Outflowing Sediment Volume	1.07	ac. ft
Deposited(+)/Eroded(-) Volume	-0.12	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	5444	5444
Side Slope (?H:1V)	3	6
Channel Width (ft)	95	125
Channel XS Area (sq. ft)	340	415
Channel Perimeter (ft)	97	126

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	873192	1142410
Excavated Area (sq. Yd)	57464	75611

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5444	ft
Thickness	1.5	ft
Protection Depth	3	ft
Tie-in Length/Depth	3.0	ft
Total Depth	6.0	ft
Area needed	907	sq. Yd
Volume	1815	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5444	5444
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	5444	5444
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	95	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	9.0	ft
Structure Height	12.0	ft
Number of Structures	29	
Volume per structure	126	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 9,450	
Area per structure	32	sq. Yd
Total Area	918	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	1710	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 6,840	
Other Cost	$ -	
Total cost per basin	$ 6,840	
Area per basin	1,982	sq. Yd
Total Area	3,964	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	873,192	cu. Yd	$ 10.00	$ 8,731,920	57,464	sq. Yd	$ 9.00	$ 517,176	57,464	sq. Yd	$ 8.33	$ 478,867
Exc. Chl - LC Enhancement	Excavated	269,218	cu. Yd	$ 10.00	$ 2,692,180	18,147	sq. Yd	$ 9.00	$ 163,323	18,147	sq. Yd	$ 8.33	$ 151,225
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,815	cu. Yd	$ 75.00	$ 136,125	907	sq. Yd	$ -	$ -	907	sq. Yd	$ 25.00	$ 22,675
Drop Structures	Riprap	29	EA	$ 9,450.00	$ 274,050	918	sq. Yd	$ -	$ -	918	sq. Yd	$ 33.33	$ 30,600
Drop Str. - LC Enhancement	Riprap	29	EA	$ 945.00	$ 27,405	92	sq. Yd	$ -	$ -	92	sq. Yd	$ 33.33	$ 3,060
Sedimentation Basins		2	EA	$ 6,840.00	$ 13,680	3,964	sq. Yd	$ -	$ -	3,964	sq. Yd	$ 8.33	$ 33,033
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 517,176	Base Maintenance Cost			$ 565,175
						LC Enhancement Cost			$ 163,323	LC Enhancement Cost			$ 154,285
						Total Landscape Cost			$ 680,499	Total Maintenance Cost			$ 719,460

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 9,155,775	$ 2,719,585	$ 11,875,360
Contingency Cost (25% of Construction Cost)	$ 2,288,944	$ 679,896	$ 2,968,840
Engineering Design Cost (5% of Construction Cost)	$ 457,789	$ 135,979	$ 593,768
Total Construction Cost	$ 11,902,508	$ 3,535,461	$ 15,437,968

Land Cost

Channel Length	5444	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	16.7	$100,000	$ 1,670,000
LC Enhancement Buffer	50	6.2	$100,000	$ 620,000
Channel	95	11.9	$100,000	$ 1,190,000
Channel LC Enhancement	30	3.7	$100,000	$ 370,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	309	38.5		$ 3,850,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	28.6	$100,000	$ 2,860,000
LC Enhancement Cost	acre	9.9	$100,000	$ 990,000
Total Land Cost	acre	38.5	$100,000	$ 3,850,000

Total Cost

Base Total Cost	$ 15,844,859
Total Landscape Enhancement Cost	$ 4,843,069
Total Cost Including LC Enh.	$ 20,687,927

Open Channel

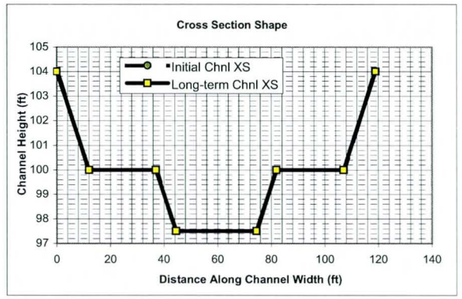
Structure ID	N120	HEC1 ID	M1-N1

Longitudal Geometry

Length	4224.1	ft
U/S Elev	1437.4	ft
D/S Elev	1382.8	ft
Initial Channel Slope	0.0129	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	4



Initial Channel XS Geometry

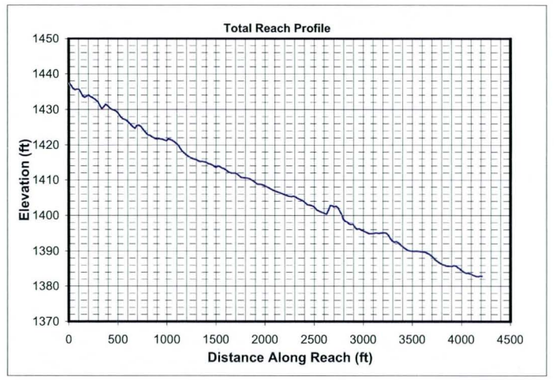
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	25	3	30	6.5	3	25	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	37	44.5	74.5	82	107	119
Y	104	100	100	97.5	97.5	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	25	3	30	6.5	3	25	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	37	44.5	74.5	82	107	119
Y	104	100	100	97.5	97.5	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	CN1									TOTAL
HEC1 Peak-Flow	1288									1288
Weighting Factor	1.00									
Flow into Channel	1288									1288

Reach Sediment Inflow Characteristics

U/S Contributing ID	M1-N1_N110									TOTAL
Flow Volume (ac. ft)	806.00									806
Sediment Conc. (ppm)	3502									
Sediment Volume (ac. ft)	1.07									1.07
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	1.07									1.07

Hydrology

Drainage Area	11.45	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	1288	cfs	
Long-term Max. Chnl Capacity	3234	cfs	
Q2 Channel	129	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	119	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
129	38.9	47.9	1.2	97.5	98.9	2.7	1.4	38.4	1.2	0.44	0.42
386	98.5	134.2	1.4	97.5	100.4	2.9	2.9	97.5	1.4	0.91	0.43
966	105.0	238.7	2.3	97.5	101.5	4.0	4.0	103.8	2.3	1.23	0.47
1288	107.9	286.8	2.7	97.5	101.9	4.5	4.4	106.5	2.7	1.38	0.48

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
129	38.9	47.9	1.2	97.5	98.9	2.7	1.4	38.4	1.2	0.44	0.42
386	98.5	134.2	1.4	97.5	100.4	2.9	2.9	97.5	1.4	0.91	0.43
966	105.0	238.7	2.3	97.5	101.5	4.0	4.0	103.8	2.3	1.23	0.47
1288	107.9	286.8	2.7	97.5	101.9	4.5	4.4	106.5	2.7	1.38	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)								TOTAL
	M1-N1_N110								
129	526								526
386	1676								1676
966	5621								5621
1288	8259								8259

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
129	1.74	1.4634	1.3902	Erosive	Erosive	Erosive	0.3	Stable	5.1	Stable	Stable
386	1.74	1.4940	1.4193	Erosive	Erosive	Erosive	0.4	Stable	7.6	Stable	Stable
966	1.74	1.6524	1.5697	Erosive	Erosive	Erosive	0.4	Stable	9.6	Stable	Stable
1288	1.74	1.7009	1.6158	Erosive	Erosive	Erosive	0.4	Stable	10.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	129	386	966	1288	129	386	966	1288	129	386	966	1288
Bray - Equation #1	31	55	89	104	1.3	1.9	2.6	2.9	3.1	3.6	4.1	4.3
Bray - Equation #2	40	72	117	136	1.5	2.1	2.9	3.2	2.1	2.5	2.8	3.0
Hey	9	17	28	33	4.1	6.2	8.8	9.8				
Ackers & Charlton/Lacey	28	44	65	73					1.8	2.2	2.5	2.6
Parker	78	135	214	247	1.0	1.6	2.4	2.7				
Chang	50	98	172	205	0.2	0.0	-0.3	-0.4				
Kellerhals	20	35	56	65	1.9	2.9	4.2	4.8	3.3	3.7	4.1	4.2
AMAFCA/Schumm	38	98	104	107								
Moody & Odem	31	31	31	31	1.4	1.4	1.4	1.4				
BUREC	16.4	24.8	35.0	38.9	4	7	9	10	2.8	3.7	4.6	5.0
Average	34	61	91	104	2.0	2.9	3.9	4.3	2.6	3.1	3.6	3.8
Values As Designed	38	98	104	106	1.4	2.9	4.0	4.4	2.7	2.9	4.0	4.5
Difference with Design	-4	-37	-13	-3	0.6	-0.1	0.0	-0.1	-0.1	0.3	-0.4	-0.7

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
129	540	326	665	4009	1282	186	89	127	3498	283	1500	1137
386	1781	982	2028	13519	3453	626	281	425	10529	914	4889	3584
966	7075	2955	5338	61430	4921	2692	813	1663	26587	3281	17444	12200
1288	10866	4114	6924	98344	5508	4355	1104	2477	35509	4886	25566	18150

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
129	1555	938	1915	11547	3693	536	255	365	10077	816	4320	3274
386	1710	943	1947	12980	3316	601	270	408	10109	877	4694	3441
966	2717	1135	2050	23593	1890	1034	312	639	10211	1260	6700	4685
1288	3130	1185	1994	28327	1587	1254	318	713	10228	1407	7364	5228

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
129	540	274	429	964	689	107	89	127	797	115	639	433
386	1781	834	1330	3250	1880	357	281	425	2419	373	2109	1367
966	7075	2582	3608	14770	2817	1339	813	1663	6273	1354	8014	4573
1288	10866	3619	4868	23646	3190	1988	1104	2477	8415	1471	11966	6692

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
129	1555	788	1234	2776	1985	309	255	365	2295	330	1840	1249
386	1710	801	1277	3121	1805	342	270	408	2323	359	2025	1313
966	2717	992	1386	5673	1082	514	312	639	2409	520	3078	1756
1288	3130	1042	1402	6811	919	573	318	713	2424	424	3447	1927

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
129	0.0007	0.0010	235	0.72	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0069	0.0004	0.0016	0.0049	0.0032
386	0.0006	0.0009	247	0.75	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0005	0.0069	0.0003	0.0007	0.0049	0.0031
966	0.0003	0.0005	319	0.97	0.055	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0069	0.0002	0.0004	0.0049	0.0031
1288	0.0003	0.0005	345	1.05	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0069	0.0001	0.0003	0.0049	0.0030

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	33.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	12	
Distance between structs.	352	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.98	sq. mi
Total Sediment Yield Volume	1.87	ac ft

Sedimentation Basins

Length	352 ft	Depth	3 ft
Width	119 ft	Side slope	3 ft/ft
Total Volume per Basin		2.60	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		3	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
129	1.1	-0.4	0.1	24.6	1.4	1.2	2.7	0.0050	0.1	0.0	2.5	3.5
386	1.1	-0.9	0.1	24.6	2.9	1.4	2.9	0.0050	0.3	0.0	2.5	3.7
966	1.1	-1.0	0.2	24.6	4.0	2.3	4.0	0.0050	0.4	0.0	2.5	4.0
1288	1.1	-1.1	0.3	24.6	4.4	2.7	4.5	0.0050	0.5	0.0	2.5	4.1

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	424	cfs
Stage at Peak Flow	99.4	ft
Volume at Peak Flow	806.0	ac. ft

Freeboard

Max. Flow Depth	4.4	ft
Channel Depth as designed	6.5	ft
Available Freeboard	2.1	ft
Required Freeboard	1.2	ft

Sediment Volume

Inflowing Sediment Volume	2.93	ac. ft
Outflowing Sediment Volume	0.59	ac. ft
Deposited(+)/Eroded(-) Volume	2.34	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	4224	4224
Side Slope (?H:1V)	3	6
Channel Width (ft)	119	158
Channel XS Area (sq. ft)	521.8	648.55
Channel Perimeter (ft)	121	159

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	393471	515499
Excavated Area (sq. Yd)	55851	74155

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	4224	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	704	sq. Yd
Volume	1877	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	4224	4224
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	4224	4224
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	119	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	9.8	ft
Structure Height	12.8	ft
Number of Structures	12	
Volume per structure	169	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 12,675	
Area per structure	40	sq. Yd
Total Area	476	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	3	
Total Volume per Basin	4195	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 16,780	
Other Cost	$ -	
Total cost per basin	$ 16,780	
Area per basin	4,654	sq. Yd
Total Area	13,962	sq. Yd

Structure Type	Structure Cost											
	Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	393,471	cu. Yd	$ 10.00	$ 3,934,710	55,851	sq. Yd	$ 9.00	$ 502,659	55,851	sq. Yd	$ 8.33	$ 465,425
Exc. Chl - LC Enhancement	Excavated	122,028	cu. Yd	$ 10.00	$ 1,220,280	18,304	sq. Yd	$ 9.00	$ 164,736	18,304	sq. Yd	$ 8.33	$ 152,533
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,877	cu. Yd	$ 75.00	$ 140,775	704	sq. Yd	$ -	$ -	704	sq. Yd	$ 25.00	$ 17,600
Drop Structures	Riprap	12	EA	$ 12,675.00	$ 152,100	476	sq. Yd	$ -	$ -	476	sq. Yd	$ 33.33	$ 15,867
Drop Str. - LC Enhancement	Riprap	12	EA	$ 1,267.50	$ 15,210	48	sq. Yd	$ -	$ -	48	sq. Yd	$ 33.33	$ 1,587
Sedimentation Basins		3	EA	$ 16,780.00	$ 50,340	13,962	sq. Yd	$ -	$ -	13,962	sq. Yd	$ 8.33	$ 116,350
Other					$ -				$ -				$ -

Base Landscape Cost	$ 502,659	Base Maintenance Cost	$ 615,242
LC Enhancement Cost	$ 164,736	LC Enhancement Cost	$ 154,120
Total Landscape Cost	$ 667,395	Total Maintenance Cost	$ 769,362

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 4,277,925	$ 1,235,490	$ 5,513,415
Contingency Cost (25% of Construction Cost)	$ 1,069,481	$ 308,873	$ 1,378,354
Engineering Design Cost (5% of Construction Cost)	$ 213,896	$ 61,775	$ 275,671
Total Construction Cost	$ 5,561,303	$ 1,606,137	$ 7,167,440

Land Cost

Channel Length	4224 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	134	13	$100,000	$ 1,300,000
LC Enhancement Buffer	50	4.8	$100,000	$ 480,000
Channel	119	11.5	$100,000	$ 1,150,000
Channel LC Enhancement	39	3.8	$100,000	$ 380,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	342	33.1		$ 3,310,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	24.5	$100,000	$ 2,450,000
LC Enhancement Cost	acre	8.6	$100,000	$ 860,000
Total Land Cost	acre	33.1	$100,000	$ 3,310,000

Total Cost

Base Total Cost	$ 9,129,203
Total Landscape Enhancement Cost	$ 2,784,993
Total Cost Including LC Enh.	$ 11,914,196

Online Basin

HEC1 ID	RRCN1

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID	M1-N1						Total Volume (ac. ft)
Inflow Volume (ac. ft)	806						806
Volume Fraction	1						
Weighted Volume	806						806
Sediment Conc. (ppm)	1927						
Sediment Volume (ac. ft)	0.59						0.59
Weighting Factor	1						
Weighted Sed. Vol. (ac. ft)	0.59						0.59

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.5	sq. mi
Total Sediment Yield Volume	2.9	ac ft

Required Minimum Sediment Volume

Sediment Volume	3.5	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.021	0.021
Basin Length (ft)	900	1100
Basin Width (ft)	480	480
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	11	11
Freeboard (ft)	1	1
Effective Basin Width (ft)	450	420
Top Area (acres)	9.9	12.1
U/S-D/S Height Difference (ft)	10.1	10.1
Excess Area on Upstream (acres)	0.7	1.5

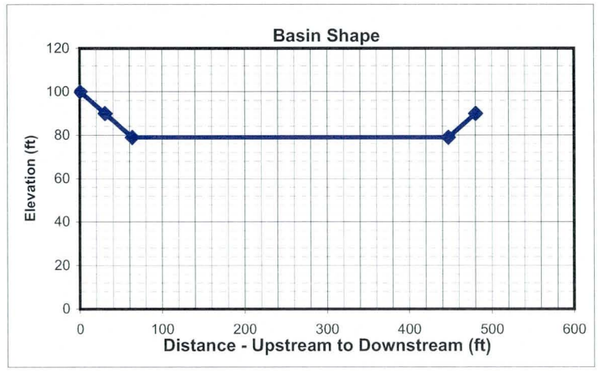
			Base	LC Enhanced
Bottom Length (ft)	834	Allocated Storage Volume (ac. ft)	82.2	82.4
Bottom Width (ft)	384	Total Available Volume (ac. ft) (incl. Freeboard)	91.4	92.8
		Total Excavation Volume (ac. ft)	141.4	153.9

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	6.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	3	5	6	7	8	9	11	13
Volume	0.00	7.44	22.82	38.89	47.19	55.67	64.33	73.16	91.39	110.36
Outflow	0.0	136.1	235.8	304.4	333.5	360.2	385.1	408.4	451.5	490.9



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	719.0	898	898.0
Peak Inflow (cfs)	870	1288	1288.0
Peak Outflow (cfs)	382	420	420.0
Stage at Peak Outflow (ft)	7.9	9.5	9.5
Volume at Peak Outflow (ac. ft)	63.3	78.16	78.2

Volume Check

Total Volume needed	81.7	ac. ft
Total Volume Provided	82.2	ac. ft

Volume OK?	Yes

Stage Check

Depth Needed	10.5	ft
Depth Provided	11	ft

Depth OK?	Yes

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	264000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	900	ft
Base Total ROW Width	480	ft
LC Enh. Total ROW Length	1200	ft
LC Enh. Total ROW Length	580	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	228125	248292
Excavated Area (sq. Yd)	48000	77333

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	67	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	741	sq. Yd
Material Volume	371	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	688	ft
Unit Cost	160	per ft
Cost per outlet	$110,080	
Other Cost	$ -	
Total Cost	$110,080	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		228,125	cu. Yd	$ 4.00	$ 912,500	48,000	sq. Yd	$ 9.00	$ 432,000	48,000	sq. Yd	$ 8.33	$ 400,000
Basin - LC Enhancement		20,167	cu. Yd	$ 4.00	$ 80,668	29,333	sq. Yd	$ 9.00	$ 263,997	29,333	sq. Yd	$ 8.33	$ 244,442
Inlet	Riprap	371	sq. Yd	$ 75.00	$ 27,825	741	sq. Yd	$ -	$ -	741	sq. Yd	$ 33.33	$ 24,700
Inlet - LC Enhancement (20%Inlet)					$ 5,565				$ -				$ 4,940
Outlet	Pipe	1	EA	$ 110,080	$ 110,080	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 5,504				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 432,000	Base Maintenance Cost			$ 426,917
						LC Enh. Landscape Cost			$ 263,997	LC Enh. Maintenance Cost			$ 249,493
						Total Landscape Cost			$ 695,997	Total Maintenance Cost			$ 676,409

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,050,405	$ 80,668	$ 1,131,073
Contingency Cost (25% of Construction Cost)	$ 262,601	$ 20,167	$ 282,768
Engineering Design Cost (5% of Construction Cost)	$ 52,520	$ 4,033	$ 56,554
Total Construction Cost	$ 1,365,527	$ 104,868	$ 1,470,395

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	6.1	$100,000	$ 610,000
Basin	9.9	$100,000	$ 990,000
Other		$100,000	$ -
Total	16.0	$100,000	$ 1,600,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	9.9	$100,000	$ 990,000
LC Enhancement Cost	acre	6.1	$100,000	$ 610,000
Total Land Cost	acre	16	$100,000	$ 1,600,000

Total Cost

Base Total Cost	$ 3,214,443
Total LC Enhancement Cost	$ 1,228,358
Total Cost Including LC Enh.	$ 4,442,801

Open Channel

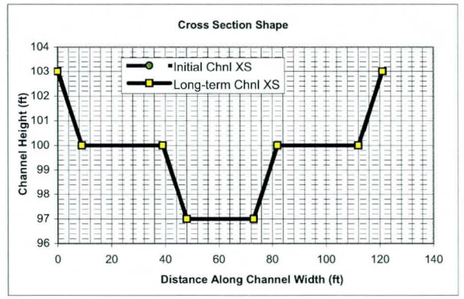
Structure ID	N125	HEC1 ID	N1-P1A

Longitudal Geometry

Length	8101.2	ft
U/S Elev	1382.8	ft
D/S Elev	1276.4	ft
Initial Channel Slope	0.0131	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	4



Initial Channel XS Geometry

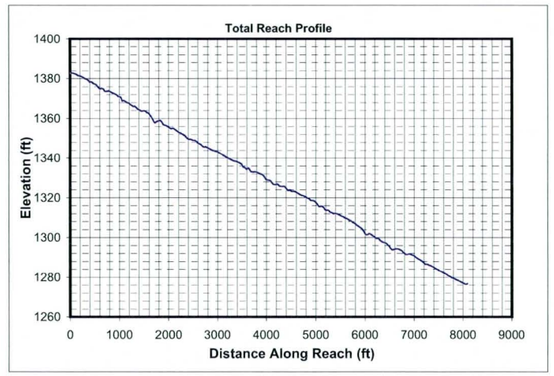
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	30	3	25	6	3	30	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	39	48	73	82	112	121
Y	103	100	100	97	97	100	100	103

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	30	3	25	6	3	30	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	39	48	73	82	112	121
Y	103	100	100	97	97	100	100	103



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	CN2AR								TOTAL
HEC1 Peak-Flow	1313								1313
Weighting Factor	1.00								
Flow into Channel	1313								1313

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	12.97	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	1313	cfs	
Long-term Max. Chnl Capacity	2392	cfs	
Q2 Channel	131	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	121	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
131	34.9	46.4	1.3	97.0	98.6	2.8	1.6	34.4	1.3	0.49	0.43
394	43.4	97.8	2.3	97.0	99.9	4.0	2.9	42.4	2.3	0.91	0.47
985	112.6	248.3	2.2	97.0	101.4	4.0	4.4	111.2	2.2	1.36	0.47
1313	115.4	298.0	2.6	97.0	101.8	4.4	4.8	113.8	2.6	1.50	0.48

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
131	34.9	46.4	1.3	97.0	98.6	2.8	1.6	34.4	1.3	0.49	0.43
394	43.4	97.8	2.3	97.0	99.9	4.0	2.9	42.4	2.3	0.91	0.47
985	112.6	248.3	2.2	97.0	101.4	4.0	4.4	111.2	2.2	1.36	0.47
1313	115.4	298.0	2.6	97.0	101.8	4.4	4.8	113.8	2.6	1.50	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
131										0
394										0
985										0
1313										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
131	1.74	1.4878	1.4134	Erosive	Erosive	Erosive	0.3	Stable	5.5	Stable	Stable
394	1.74	1.6531	1.5704	Erosive	Erosive	Erosive	0.4	Stable	8.2	Stable	Stable
985	1.74	1.6432	1.5610	Erosive	Erosive	Erosive	0.4	Stable	10.0	Stable	Stable
1313	1.74	1.6921	1.6075	Erosive	Erosive	Erosive	0.4	Stable	10.8	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	131	394	985	1313	131	394	985	1313	131	394	985	1313
Bray - Equation #1	31	56	90	105	1.3	1.9	2.6	2.9	3.1	3.6	4.1	4.3
Bray - Equation #2	41	73	118	138	1.5	2.1	2.9	3.2	2.1	2.5	2.9	3.0
Hey	9	17	29	34	4.1	6.2	8.8	9.9				
Ackers & Charlton/Lacey	28	44	65	73					1.8	2.2	2.5	2.7
Parker	79	136	216	249	1.0	1.7	2.4	2.7				
Chang	51	100	174	207	0.2	0.0	-0.3	-0.4				
Kellerhals	21	36	56	65	1.9	3.0	4.3	4.8	3.3	3.7	4.1	4.2
AMAFCA/Schumm	34	42	111	114								
Moody & Odem	32	32	32	32	1.4	1.4	1.4	1.4				
BUREC	16.5	25.0	35.2	39.2	4	7	9	10	2.8	3.7	4.7	5.0
Average	34	56	93	106	2.0	2.9	4.0	4.4	2.7	3.2	3.7	3.8
Values As Designed	34	42	111	114	1.6	2.9	4.4	4.8	2.8	4.0	4.0	4.4
Difference with Design	0	14	-19	-8	0.4	0.0	-0.4	-0.4	-0.2	-0.9	-0.3	-0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
131	588	342	687	4576	1214	208	94	140	3659	308	1641	1223
394	2831	1214	2171	25530	2031	1102	326	668	11091	1337	7093	5036
985	7012	2971	5502	61846	5231	2519	824	1656	27717	3302	17639	12384
1313	10787	4146	7128	99190	5845	4362	1122	2475	37021	4921	25900	18445

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
131	1661	966	1942	12929	3429	588	264	396	10338	869	4638	3456
394	2666	1143	2045	24046	1913	1038	307	629	10446	1259	6681	4743
985	2642	1119	2073	23300	1971	949	310	624	10442	1244	6645	4665
1313	3048	1172	2014	28027	1652	1233	317	699	10461	1391	7318	5212

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
131	588	289	449	1076	653	118	94	140	820	124	697	459
394	2831	1058	1455	6001	1153	538	326	668	2558	558	3219	1851
985	7012	2588	3651	14537	2963	1335	824	1656	6386	1432	7983	4579
1313	10787	3636	4991	23315	3351	1987	1122	2475	8570	1557	11948	6704

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
131	1661	815	1269	3039	1846	333	264	396	2317	351	1970	1296
394	2666	996	1370	5652	1086	507	307	629	2409	525	3032	1744
985	2642	975	1375	5477	1116	503	310	624	2406	539	3007	1725
1313	3048	1027	1410	6588	947	561	317	699	2421	440	3376	1894

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
131	0.0006	0.0009	246	0.75	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0005	0.0069	0.0004	0.0016	0.0049	0.0032
394	0.0003	0.0005	320	0.98	0.055	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0069	0.0002	0.0007	0.0049	0.0031
985	0.0003	0.0005	317	0.97	0.055	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0003	0.0069	0.0002	0.0004	0.0049	0.0031
1313	0.0003	0.0005	343	1.04	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0069	0.0001	0.0003	0.0049	0.0030

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	65.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	22	
Distance between structs.	368	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.50	sq. mi
Total Sediment Yield Volume	2.85	ac ft

Sedimentation Basins

Length	368 ft	Depth	3 ft
Width	121 ft	Side slope	3 ft/ft
Total Volume per Basin		2.77	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		4	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
131	1.1	-0.5	0.1	24.6	1.6	1.3	2.8	0.0050	0.2	0.0	3.0	4.2
394	1.1	-0.8	0.2	24.6	2.9	2.3	4.0	0.0050	0.3	0.0	3.0	4.5
985	1.1	-1.2	0.2	24.6	4.4	2.2	4.0	0.0050	0.5	0.0	3.0	4.7
1313	1.1	-1.2	0.3	24.6	4.8	2.6	4.4	0.0050	0.6	0.0	3.0	4.8

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	420	cfs
Stage at Peak Flow	99.3	ft
Volume at Peak Flow	898.0	ac. ft

Freeboard

Max. Flow Depth	4.8	ft
Channel Depth as designed	6.0	ft
Available Freeboard	1.2	ft
Required Freeboard	1.3	ft

Sediment Volume

Inflowing Sediment Volume	2.85	ac. ft
Outflowing Sediment Volume	0.64	ac. ft
Deposited(+)/Eroded(-) Volume	2.21	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	8101	8101
Side Slope (?H:1V)	3	6
Channel Width (ft)	121	157
Channel XS Area (sq. ft)	438	546
Channel Perimeter (ft)	123	158

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	1326597	1714592
Excavated Area (sq. Yd)	108913	141317

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	8101	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	1350	sq. Yd
Volume	3600	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	8101	8101
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	8101	8101
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	121	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	9.5	ft
Structure Height	12.5	ft
Number of Structures	22	
Volume per structure	168	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 12,600	
Area per structure	40	sq. Yd
Total Area	887	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	4	
Total Volume per Basin	4469	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 17,876	
Other Cost	$ -	
Total cost per basin	$ 17,876	
Area per basin	4,951	sq. Yd
Total Area	19,804	sq. Yd

Structure Type	Structure Cost											
	Excavation/Construction					Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	1,326,597	cu. Yd	$ 10.00	$ 13,265,970	108,913	sq. Yd	$ 9.00	$ 980,217	108,913	sq. Yd	$ 8.33	$ 907,608
Exc. Chl - LC Enhancement	Excavated	387,995	cu. Yd	$ 10.00	$ 3,879,950	32,404	sq. Yd	$ 9.00	$ 291,636	32,404	sq. Yd	$ 8.33	$ 270,033
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	3,600	cu. Yd	$ 75.00	$ 270,000	1,350	sq. Yd	$ -	$ -	1,350	sq. Yd	$ 25.00	$ 33,750
Drop Structures	Riprap	22	EA	$ 12,600.00	$ 277,200	887	sq. Yd	$ -	$ -	887	sq. Yd	$ 33.33	$ 29,567
Drop Str. - LC Enhancement	Riprap	22	EA	$ 1,260.00	$ 27,720	89	sq. Yd	$ -	$ -	89	sq. Yd	$ 33.33	$ 2,957
Sedimentation Basins		4	EA	$ 17,876.00	$ 71,504	19,804	sq. Yd	$ -	$ -	19,804	sq. Yd	$ 8.33	$ 165,033
Other					$ -				$ -				$ -
Base Landscape Cost									$ 980,217	Base Maintenance Cost			$ 1,135,958
LC Enhancement Cost									$ 291,636	LC Enhancement Cost			$ 272,990
Total Landscape Cost									$ 1,271,853	Total Maintenance Cost			$ 1,408,948

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 13,884,674	$ 3,907,670	$ 17,792,344
Contingency Cost (25% of Construction Cost)	$ 3,471,169	$ 976,918	$ 4,448,086
Engineering Design Cost (5% of Construction Cost)	$ 694,234	$ 195,384	$ 889,617
Total Construction Cost	$ 18,050,076	$ 5,079,971	$ 23,130,047

Land Cost

Channel Length	8101 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	24.9	$100,000	$ 2,490,000
LC Enhancement Buffer	50	9.3	$100,000	$ 930,000
Channel	121	22.5	$100,000	$ 2,250,000
Channel LC Enhancement	36	6.7	$100,000	$ 670,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	341	63.4		$ 6,340,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	47.4	$100,000	$ 4,740,000
LC Enhancement Cost	acre	16	$100,000	$ 1,600,000
Total Land Cost	acre	63.4	$100,000	$ 6,340,000

Total Cost

Base Total Cost	$ 24,906,252
Total Landscape Enhancement Cost	$ 7,244,597
Total Cost Including LC Enh.	$ 32,150,849

Online Basin

HEC1 ID	RRP1A

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.5	sq. mi
Total Sediment Yield Volume	1.0	ac ft

Required Minimum Sediment Volume

Sediment Volume	1.0	ac. ft

Geometry

	Base	LC Enhanced
Topography slope (ft/ft)	0.0222	0.0222
Basin Length (ft)	700	860
Basin Width (ft)	360	360
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	8	8
Freeboard (ft)	1	1
Effective Basin Width (ft)	336	312
Top Area (acres)	5.8	7.1
U/S-D/S Height Difference (ft)	8.0	8.0
Excess Area on Upstream (acres)	0.4	1.0

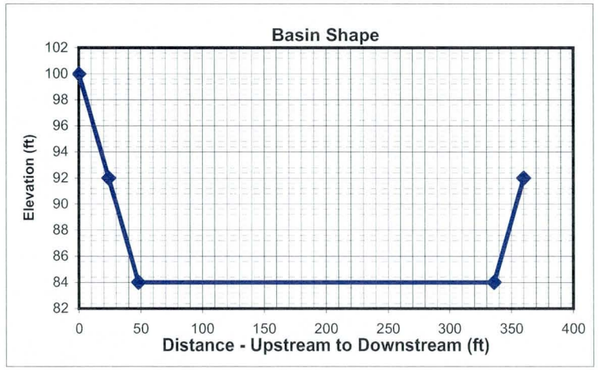
			Base	LC Enhanced
Bottom Length (ft)	652	Allocated Storage Volume (ac. ft)	33.4	33.5
Bottom Width (ft)	288	Total Available Volume (ac. ft) (incl. Freeboard)	38.8	39.5
		Total Excavation Volume (ac. ft)	61.9	67.9

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	3.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	2	3	4	5	6	7	8.5	10
Volume	0.00	4.38	8.88	13.52	18.30	23.21	28.25	33.44	41.49	49.86
Outflow	0.0	34.0	48.1	59.0	68.1	76.1	83.4	90.0	99.2	107.6



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	44.0	41	44.0
Peak Inflow (cfs)	575	441	575.0
Peak Outflow (cfs)	87	77	87.0
Stage at Peak Outflow (ft)	6.6	5.1	6.6
Volume at Peak Outflow (ac. ft)	31.2	23.93	31.2

Volume Check

Total Volume needed	32.2	ac. ft
Total Volume Provided	33.4	ac. ft

Volume OK?	Yes

Stage Check

Depth Needed	7.6	ft
Depth Provided	8	ft

Depth OK?	Yes

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	189600	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	700	ft
Base Total ROW Width	360	ft
LC Enh. Total ROW Length	960	ft
LC Enh. Total ROW Length	460	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	99865	109545
Excavated Area (sq. Yd)	28000	49067

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	51	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	562	sq. Yd
Material Volume	281	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	465	ft
Unit Cost	160	per ft
Cost per outlet	$74,400	
Other Cost	$ -	
Total Cost	$74,400	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		99,865	cu. Yd	$ 4.00	$ 399,460	28,000	sq. Yd	$ 9.00	$ 252,000	28,000	sq. Yd	$ 8.33	$ 233,333
Basin - LC Enhancement		9,680	cu. Yd	$ 4.00	$ 38,720	21,067	sq. Yd	$ 9.00	$ 189,603	21,067	sq. Yd	$ 8.33	$ 175,558
Inlet	Riprap	281	sq. Yd	$ 75.00	$ 21,075	562	sq. Yd	$ -	$ -	562	sq. Yd	$ 33.33	$ 18,733
Inlet - LC Enhancement (20%Inlet)					$ 4,215				$ -				$ 3,747
Outlet	Pipe	1	EA	$ 74,400	$ 74,400	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 3,720				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 252,000	Base Maintenance Cost			$ 254,283
						LC Enh. Landscape Cost			$ 189,603	LC Enh. Maintenance Cost			$ 179,416
						Total Landscape Cost			$ 441,600	Total Maintenance Cost			$ 433,699

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 494,935	$ 38,720	$ 533,655
Contingency Cost (25% of Construction Cost)	$ 123,734	$ 9,680	$ 133,414
Engineering Design Cost (5% of Construction Cost)	$ 24,747	$ 1,936	$ 26,683
Total Construction Cost	$ 643,416	$ 50,336	$ 693,752

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	4.4	$100,000	$ 440,000
Basin	5.8	$100,000	$ 580,000
Other		$100,000	$ -
Total	10.2	$100,000	$ 1,020,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	5.8	$100,000	$ 580,000
LC Enhancement Cost	acre	4.4	$100,000	$ 440,000
Total Land Cost	acre	10.2	$100,000	$ 1,020,000

Total Cost

Base Total Cost	$ 1,729,699
Total LC Enhancement Cost	$ 859,355
Total Cost Including LC Enh.	$ 2,589,054

Open Channel

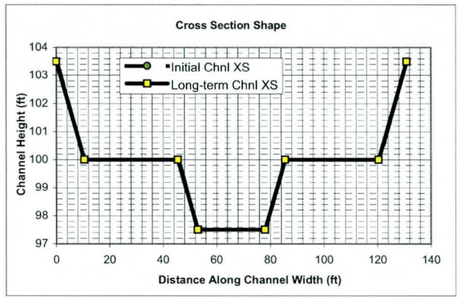
Structure ID	N130	HEC1 ID	P1A-1B

Longitundal Geometry

Length	10853.3	ft
U/S Elev	1276.4	ft
D/S Elev	1133.0	ft
Initial Channel Slope	0.0132	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	11



Initial Channel XS Geometry

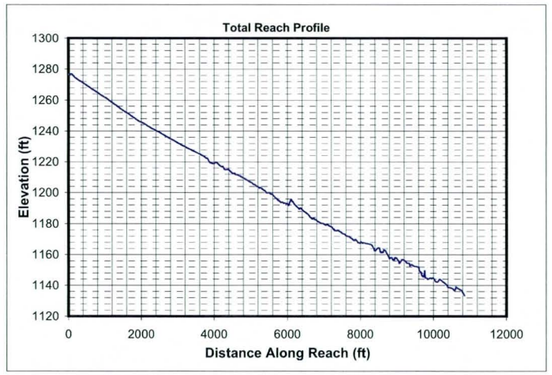
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3.5	35	3	25	6	3	35	3.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	10.5	45.5	53	78	85.5	120.5	131
Y	103.5	100	100	97.5	97.5	100	100	103.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3.5	35	3	25	6	3	35	3.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	10.5	45.5	53	78	85.5	120.5	131
Y	103.5	100	100	97.5	97.5	100	100	103.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	P1A-1B	P1B							TOTAL
HEC1 Peak-Flow	1135	852							1987
Weighting Factor	1.00	0.64							
Flow into Channel	1135	543							1678

Reach Sediment Inflow Characteristics

U/S Contributing ID	N1-P1A_N125	P1A-1B_RRP1A10							TOTAL
Flow Volume (ac. ft)	898.00	1026.00							1924
Sediment Conc. (ppm)	1894	2821							
Sediment Volume (ac. ft)	0.64	1.09							1.73
Weighting Factor	1	1							
Weighted Sed. Vol. (ac. ft)	0.64	1.09							1.73

Hydrology

Drainage Area	15.41	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	1678	cfs	
Long-term Max. Chnl Capacity	2859	cfs	
Q2 Channel	168	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	131	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
168	36.4	54.6	1.5	97.5	99.3	3.1	1.8	35.8	1.5	0.56	0.44
503	115.7	167.8	1.5	97.5	100.8	3.0	3.3	114.6	1.5	1.02	0.44
1259	122.6	297.7	2.4	97.5	101.9	4.2	4.4	121.2	2.5	1.36	0.48
1678	125.7	357.2	2.8	97.5	102.4	4.7	4.9	124.1	2.9	1.52	0.49

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
168	36.4	54.6	1.5	97.5	99.3	3.1	1.8	35.8	1.5	0.56	0.44
503	115.7	167.8	1.5	97.5	100.8	3.0	3.3	114.6	1.5	1.02	0.44
1259	122.6	297.7	2.4	97.5	101.9	4.2	4.4	121.2	2.5	1.36	0.48
1678	125.7	357.2	2.8	97.5	102.4	4.7	4.9	124.1	2.9	1.52	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
	N1-P1A_N125	P1A-1B_RRP1A10								
168	459	47								506
503	1851	150								2002
1259	4579	462								5041
1678	6704	662								7365

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
168	1.74	1.5259	1.4496	Erosive	Erosive	Erosive	0.4	Stable	6.0	Stable	Stable
503	1.74	1.5130	1.4373	Erosive	Erosive	Erosive	0.4	Stable	8.1	Stable	Stable
1259	1.74	1.6724	1.5888	Erosive	Erosive	Erosive	0.4	Stable	10.2	Stable	Stable
1678	1.74	1.7214	1.6353	Erosive	Erosive	Erosive	0.4	Stable	11.0	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	168	503	1259	1678	168	503	1259	1678	168	503	1259	1678
Bray - Equation #1	35	63	102	119	1.5	2.1	2.9	3.2	3.2	3.8	4.3	4.5
Bray - Equation #2	46	83	134	157	1.6	2.3	3.1	3.4	2.2	2.6	3.0	3.1
Hey	10	20	33	39	4.5	6.9	9.7	10.8				
Ackers & Charlton/Lacey	31	49	72	81					1.9	2.3	2.6	2.8
Parker	89	154	244	281	1.2	1.8	2.7	3.0				
Chang	59	116	202	240	0.1	0.0	-0.4	-0.5				
Kellerhals	23	40	64	74	2.1	3.3	4.7	5.3	3.4	3.8	4.2	4.3
AMAFCA/Schumm	36	115	121	124								
Moody & Odem	34	34	34	34	1.4	1.4	1.4	1.4				
BUREC	18.1	27.4	38.6	43.0	5	7	10	11	3.0	3.9	5.0	5.3
Average	38	70	105	119	2.2	3.1	4.3	4.8	2.8	3.3	3.8	4.0
Values As Designed	36	115	121	124	1.8	3.3	4.4	4.9	3.1	3.0	4.2	4.7
Difference with Design	3	-44	-17	-5	0.4	-0.1	-0.1	-0.1	-0.3	0.3	-0.4	-0.7

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
168	838	458	901	6818	1363	303	126	202	4740	430	2313	1681
503	2456	1314	2703	19562	4262	883	376	590	14206	1262	6804	4947
1259	9795	3927	6932	89263	6033	3907	1070	2275	35829	4536	24080	17059
1678	15065	5461	9021	143140	6737	6312	1449	3379	47843	6757	35226	25490

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
168	1854	1013	1993	15074	3014	670	278	447	10480	951	5114	3717
503	1810	969	1992	14417	3141	651	277	435	10470	930	5015	3646
1259	2887	1158	2044	26314	1778	1152	315	671	10562	1337	7099	5029
1678	3331	1207	1994	31648	1489	1396	320	747	10578	1494	7788	5636

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
168	838	390	579	1586	742	168	126	202	1061	176	993	624
503	2456	1117	1743	4551	2307	492	376	590	3171	512	2907	1838
1259	9795	3432	4779	20768	3429	1828	1070	2275	8195	1618	10970	6196
1678	15065	4802	6260	33304	3872	2713	1449	3379	10986	1753	16357	9086

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
168	1854	861	1280	3507	1640	371	278	447	2346	389	2195	1379
503	1810	823	1284	3354	1700	363	277	435	2337	377	2142	1355
1259	2887	1012	1409	6122	1011	539	315	671	2416	477	3234	1827
1678	3331	1062	1384	7363	856	600	320	747	2429	388	3617	2009

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Sif (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
168	0.0005	0.0008	262	0.80	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0063	0.0004	0.0014	0.0049	0.0030
503	0.0006	0.0008	258	0.79	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0063	0.0002	0.0006	0.0049	0.0030
1259	0.0003	0.0005	333	1.02	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0063	0.0001	0.0003	0.0049	0.0029
1678	0.0002	0.0004	361	1.10	0.056	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0063	0.0001	0.0003	0.0049	0.0029

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	89.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	30	
Distance between structs.	362	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.83	sq. mi
Total Sediment Yield Volume	3.47	ac ft

Sedimentation Basins

Length	362 ft	Depth	3 ft	
Width	131 ft	Side slope	3 ft/ft	
Total Volume per Basin		2.97	ac. ft.	
Basin Trap Efficiency		0.6		
No. of Basins		5		

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
168	1.1	-0.5	0.1	24.6	1.8	1.5	3.1	0.0050	0.2	0.0	2.5	3.6
503	1.1	-1.0	0.1	24.6	3.3	1.5	3.0	0.0050	0.3	0.0	2.5	3.8
1259	1.1	-1.1	0.2	24.6	4.4	2.5	4.2	0.0050	0.5	0.0	2.5	4.1
1678	1.1	-1.2	0.3	24.6	4.9	2.9	4.7	0.0050	0.6	0.0	2.5	4.2

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1135	cfs
Stage at Peak Flow	101.0	ft
Volume at Peak Flow	1026.0	ac. ft

Freeboard

Max. Flow Depth	4.9	ft
Channel Depth as designed	6.0	ft
Available Freeboard	1.1	ft
Required Freeboard	1.3	ft

Sediment Volume

Inflowing Sediment Volume	5.20	ac. ft
Outflowing Sediment Volume	0.78	ac. ft
Deposited(+)/Eroded(-) Volume	4.42	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	10853	10853
Side Slope (?H:1V)	3	6
Channel Width (ft)	131	167
Channel XS Area (sq. ft)	503	611
Channel Perimeter (ft)	133	168

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	2550299	3238994
Excavated Area (sq. Yd)	157971	201383

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	10853	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	1809	sq. Yd
Volume	4824	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	10853	10853
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	10853	10853
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	131	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	10.4	ft
Structure Height	13.4	ft
Number of Structures	30	
Volume per structure	195	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 14,625	
Area per structure	44	sq. Yd
Total Area	1,310	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	5	
Total Volume per Basin	4792	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 19,168	
Other Cost	$ -	
Total cost per basin	$ 19,168	
Area per basin	5,266	sq. Yd
Total Area	26,330	sq. Yd

Structure Type	Structure Cost											
	Excavation/Construction					Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	2,550,299	cu. Yd	$ 10.00	$ 25,502,990	157,971	sq. Yd	$ 9.00	$ 1,421,739	157,971	sq. Yd	$ 8.33	$ 1,316,425
Exc. Chl - LC Enhancement	Excavated	688,695	cu. Yd	$ 10.00	$ 6,886,950	43,412	sq. Yd	$ 9.00	$ 390,708	43,412	sq. Yd	$ 8.33	$ 361,767
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	4,824	cu. Yd	$ 75.00	$ 361,800	1,809	sq. Yd	$ -	$ -	1,809	sq. Yd	$ 25.00	$ 45,225
Drop Structures	Riprap	30	EA	$ 14,625.00	$ 438,750	1,310	sq. Yd	$ -	$ -	1,310	sq. Yd	$ 33.33	$ 43,667
Drop Str. - LC Enhancement	Riprap	30	EA	$ 1,462.50	$ 43,875	131	sq. Yd	$ -	$ -	131	sq. Yd	$ 33.33	$ 4,367
Sedimentation Basins		5	EA	$ 19,168.00	$ 95,840	26,330	sq. Yd	$ -	$ -	26,330	sq. Yd	$ 8.33	$ 219,417
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,421,739	Base Maintenance Cost			$ 1,624,733
						LC Enhancement Cost			$ 390,708	LC Enhancement Cost			$ 366,133
						Total Landscape Cost			$ 1,812,447	Total Maintenance Cost			$ 1,990,867

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 26,399,380	$ 6,930,825	$ 33,330,205
Contingency Cost (25% of Construction Cost)	$ 6,599,845	$ 1,732,706	$ 8,332,551
Engineering Design Cost (5% of Construction Cost)	$ 1,319,969	$ 346,541	$ 1,666,510
Total Construction Cost	$ 34,319,194	$ 9,010,073	$ 43,329,267

Land Cost

Channel Length	10853 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	33.4	$100,000	$ 3,340,000
LC Enhancement Buffer	50	12.5	$100,000	$ 1,250,000
Channel	131	32.6	$100,000	$ 3,260,000
Channel LC Enhancement	36	9	$100,000	$ 900,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	351	87.5		$ 8,750,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	66	$100,000	$ 6,600,000
LC Enhancement Cost	acre	21.5	$100,000	$ 2,150,000
Total Land Cost	acre	87.5	$100,000	$ 8,750,000

Total Cost

Base Total Cost	$ 43,965,666
Total Landscape Enhancement Cost	$ 11,916,914
Total Cost Including LC Enh.	$ 55,882,580

Open Channel

Structure ID	N140

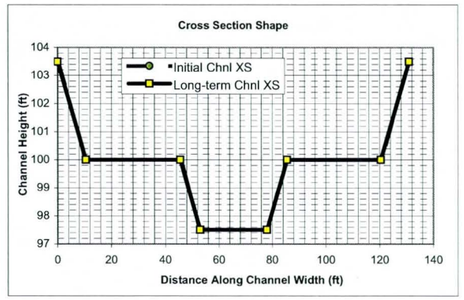
HEC1 ID	P1A-1B

Longitudal Geometry

Length	5668.0	ft
U/S Elev	1133.0	ft
D/S Elev	1092.0	ft
Initial Channel Slope	0.0072	ft/ft
Long-term Channel Slope	0.0040	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	11



Initial Channel XS Geometry

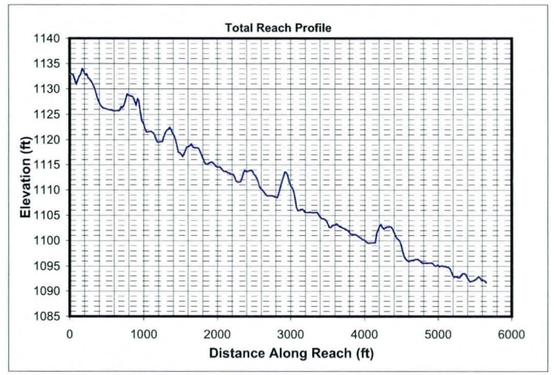
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3.5	35	3	25	6	3	35	3.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	10.5	45.5	53	78	85.5	120.5	131
Y	103.5	100	100	97.5	97.5	100	100	103.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3.5	35	3	25	6	3	35	3.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	10.5	45.5	53	78	85.5	120.5	131
Y	103.5	100	100	97.5	97.5	100	100	103.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	P								TOTAL
HEC1 Peak-Flow	1977								1977
Weighting Factor	1.00								
Flow into Channel	1977								1977

Reach Sediment Inflow Characteristics

U/S Contributing ID	P1A-1B_N130	Q1A-P_P1B10							TOTAL
Flow Volume (ac. ft)	1026.00	97.00							1123
Sediment Conc. (ppm)	2009	1930							
Sediment Volume (ac. ft)	0.78	0.07							0.85
Weighting Factor	1	1							
Weighted Sed. Vol. (ac. ft)	0.78	0.07							0.85

Hydrology

Drainage Area	16.71	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	1977	cfs	
Long-term Max. Chnl Capacity	2558	cfs	
Q2 Channel	198	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	131	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
198	38.3	65.8	1.7	97.5	99.6	3.0	2.1	37.6	1.7	0.52	0.40
593	117.4	199.1	1.7	97.5	101.0	3.0	3.5	116.3	1.7	0.88	0.40
1483	125.6	354.5	2.8	97.5	102.3	4.2	4.8	124.0	2.9	1.21	0.44
1977	129.2	426.1	3.3	97.5	102.9	4.6	5.4	127.4	3.3	1.35	0.45

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
198	38.3	65.8	1.7	97.5	99.6	3.0	2.1	37.6	1.7	0.52	0.40
593	117.4	199.1	1.7	97.5	101.0	3.0	3.5	116.3	1.7	0.88	0.40
1483	125.6	354.5	2.8	97.5	102.3	4.2	4.8	124.0	2.9	1.21	0.44
1977	129.2	426.1	3.3	97.5	102.9	4.6	5.4	127.4	3.3	1.35	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
	P1A-1B_N130	Q1A-P_P1B10								
198	624	105								728
593	1838	340								2179
1483	6196	1086								7282
1977	9086	1576								10661

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
198	1.74	1.5679	1.4895	Erosive	Erosive	Erosive	0.4	Stable	6.0	Stable	Stable
593	1.74	1.5614	1.4833	Erosive	Erosive	Erosive	0.4	Stable	7.7	Stable	Stable
1483	1.74	1.7193	1.6334	Erosive	Erosive	Erosive	0.4	Stable	9.8	Stable	Stable
1977	1.74	1.7630	1.6748	Erosive	Erosive	Erosive	0.5	Stable	10.7	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	198	593	1483	1977	198	593	1483	1977	198	593	1483	1977
Bray - Equation #1	39	69	112	130	1.5	2.2	3.0	3.3	3.3	3.9	4.4	4.6
Bray - Equation #2	51	90	147	171	1.7	2.4	3.3	3.6	2.3	2.7	3.0	3.1
Hey	12	22	36	42	4.8	7.3	10.3	11.5				
Ackers & Charlton/Lacey	33	53	77	87					1.9	2.3	2.7	2.8
Parker	97	167	265	305	1.2	2.0	2.9	3.2				
Chang	60	119	207	247	0.2	0.1	-0.3	-0.4				
Kellerhals	25	44	69	80	2.3	3.5	5.0	5.7	3.5	3.9	4.2	4.4
AMAFCA/Schumm	38	116	124	128								
Moody & Odem	35	35	35	35	1.4	1.4	1.4	1.4				
BUREC	20.1	30.4	42.8	47.7	5	8	11	13	2.9	3.8	4.8	5.1
Average	41	75	112	127	2.3	3.4	4.7	5.1	2.8	3.3	3.8	4.0
Values As Designed	38	116	124	127	2.1	3.5	4.8	5.4	3.0	3.0	4.2	4.6
Difference with Design	3	-42	-12	0	0.2	-0.2	-0.2	-0.3	-0.2	0.3	-0.4	-0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
198	769	402	675	3397	1083	197	110	194	2223	296	1587	994
593	2303	1174	2038	9997	3304	587	332	580	6665	881	4749	2964
1483	9136	3561	5548	45341	4787	2295	960	2230	16947	3295	17360	10133
1977	14023	4969	7169	72532	5379	3450	1305	3311	22661	4694	25638	15012

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
198	1443	754	1266	6375	2033	369	206	364	4173	556	2979	1865
593	1441	734	1275	6253	2067	367	207	363	4169	551	2971	1854
1483	2286	891	1388	11345	1198	574	240	558	4240	824	4344	2535
1977	2632	932	1345	13611	1009	647	245	621	4252	881	4811	2817

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
198	769	363	521	1400	733	140	110	194	885	157	922	563
593	2303	1059	1574	4121	2234	420	332	580	2649	464	2755	1681
1483	9136	3273	4263	18689	3355	1577	960	2230	6881	1156	10470	5635
1977	14023	4585	5769	29897	3801	2341	1305	3311	9233	1256	15641	8287

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
198	1443	680	978	2628	1376	264	206	364	1660	294	1730	1057
593	1441	663	985	2578	1397	263	207	363	1657	291	1723	1051
1483	2286	819	1067	4676	839	395	240	558	1722	289	2620	1410
1977	2632	860	1083	5610	713	439	245	621	1733	236	2935	1555

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
198	0.0005	0.0007	207	0.63	0.051	0.0002	31	0.036	0.0001	0.0159	0.0001	0.0004	0.0060	0.0003	0.0013	0.0039	0.0026
593	0.0005	0.0007	206	0.63	0.051	0.0002	31	0.036	0.0001	0.0159	0.0001	0.0004	0.0060	0.0002	0.0006	0.0040	0.0026
1483	0.0003	0.0004	266	0.81	0.053	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0060	0.0001	0.0003	0.0039	0.0026
1977	0.0002	0.0004	287	0.88	0.054	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0060	0.0001	0.0002	0.0039	0.0026

Drop Structures

Design Slope	0.0040	ft/ft
Total Drop Needed	18.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	7	
Distance between structs.	810	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.70	sq. mi
Total Sediment Yield Volume	1.34	ac ft

Sedimentation Basins

Length	810 ft	Depth	3 ft
Width	131 ft	Side slope	3 ft/ft
Total Volume per Basin		6.73	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
198	1.1	-0.6	0.1	24.6	2.1	1.7	3.0	0.0040	0.2	0.0	2.5	3.6
593	1.1	-1.1	0.1	24.6	3.5	1.7	3.0	0.0040	0.4	0.0	2.5	3.8
1483	1.1	-1.3	0.2	24.6	4.8	2.9	4.2	0.0040	0.5	0.0	2.5	4.1
1977	1.1	-1.3	0.3	24.6	5.4	3.3	4.6	0.0040	0.6	0.0	2.5	4.3

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	1135	cfs
Stage at Peak Flow	101.0	ft
Volume at Peak Flow	1026.0	ac. ft

Freeboard

Max. Flow Depth	5.4	ft
Channel Depth as designed	6.0	ft
Available Freeboard	0.6	ft
Required Freeboard	1.4	ft

Sediment Volume

Inflowing Sediment Volume	2.19	ac. ft
Outflowing Sediment Volume	0.60	ac. ft
Deposited(+)/Eroded(-) Volume	1.58	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	5668	5668
Side Slope (?H:1V)	3	6
Channel Width (ft)	131	167
Channel XS Area (sq. ft)	503	611
Channel Perimeter (ft)	133	168

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	356708	448389
Excavated Area (sq. Yd)	82501	105173

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5668	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	945	sq. Yd
Volume	2519	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5668	5668
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	5668	5668
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	131	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	11.3	ft
Structure Height	14.3	ft
Number of Structures	7	
Volume per structure	208	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 15,600	
Area per structure	44	sq. Yd
Total Area	306	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	10858	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 43,432	
Other Cost	$ -	
Total cost per basin	$ 43,432	
Area per basin	11,786	sq. Yd
Total Area	11,786	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	356,708	cu. Yd	$ 10.00	$ 3,567,080	82,501	sq. Yd	$ 9.00	$ 742,509	82,501	sq. Yd	$ 8.33	$ 687,508
Exc. Chl - LC Enhancement	Excavated	91,681	cu. Yd	$ 10.00	$ 916,810	22,672	sq. Yd	$ 9.00	$ 204,048	22,672	sq. Yd	$ 8.33	$ 188,933
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	2,519	cu. Yd	$ 75.00	$ 188,925	945	sq. Yd	$ -	$ -	945	sq. Yd	$ 25.00	$ 23,625
Drop Structures	Riprap	7	EA	$ 15,600.00	$ 109,200	306	sq. Yd	$ -	$ -	306	sq. Yd	$ 33.33	$ 10,200
Drop Str. - LC Enhancement	Riprap	7	EA	$ 1,560.00	$ 10,920	31	sq. Yd	$ -	$ -	31	sq. Yd	$ 33.33	$ 1,020
Sedimentation Basins		1	EA	$ 43,432.00	$ 43,432	11,786	sq. Yd	$ -	$ -	11,786	sq. Yd	$ 8.33	$ 98,217
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 742,509	Base Maintenance Cost			$ 819,550
						LC Enhancement Cost			$ 204,048	LC Enhancement Cost			$ 189,953
						Total Landscape Cost			$ 946,557	Total Maintenance Cost			$ 1,009,503

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,908,637	$ 927,730	$ 4,836,367
Contingency Cost (25% of Construction Cost)	$ 977,159	$ 231,933	$ 1,209,092
Engineering Design Cost (5% of Construction Cost)	$ 195,432	$ 46,387	$ 241,818
Total Construction Cost	$ 5,081,228	$ 1,206,049	$ 6,287,277

Land Cost

Channel Length	5668 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	17.4	$100,000	$ 1,740,000
LC Enhancement Buffer	50	6.5	$100,000	$ 650,000
Channel	131	17	$100,000	$ 1,700,000
Channel LC Enhancement	36	4.7	$100,000	$ 470,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	351	45.6		$ 4,560,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	34.4	$100,000	$ 3,440,000
LC Enhancement Cost	acre	11.2	$100,000	$ 1,120,000
Total Land Cost	acre	45.6	$100,000	$ 4,560,000

Total Cost

Base Total Cost	$ 10,083,287
Total Landscape Enhancement Cost	$ 2,720,050
Total Cost Including LC Enh.	$ 12,803,337

Online Basin

HEC1 ID	RRQ1A

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.3	sq. mi
Total Sediment Yield Volume	2.5	ac ft

Required Minimum Sediment Volume

Sediment Volume	2.5	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.03	0.03
Basin Length (ft)	1000	1290
Basin Width (ft)	420	420
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	11	11
Freeboard (ft)	1	1
Effective Basin Width (ft)	382	344
Top Area (acres)	9.6	12.4
U/S-D/S Height Difference (ft)	12.6	12.6
Excess Area on Upstream (acres)	0.9	2.3

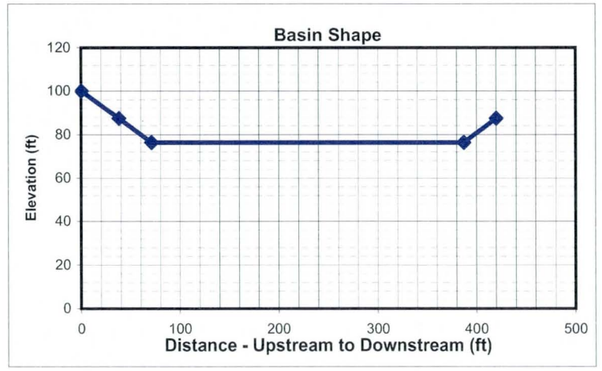
			Base	LC Enhanced
Bottom Length (ft)	934	Allocated Storage Volume (ac. ft)	76.6	76.3
Bottom Width (ft)	316	Total Available Volume (ac. ft) (incl. Freeboard)	85.3	86.3
		Total Excavation Volume (ac. ft)	146.1	164.7

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	3.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1.5	3	4.5	6	7	8	9	10	12
Volume	0.00	10.36	21.11	32.26	43.81	51.74	59.86	68.15	76.64	94.18
Outflow	0.0	41.7	59.0	72.2	83.4	90.0	96.3	102.1	107.6	117.9



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	97.0	95	97.0
Peak Inflow (cfs)	990	915	990.0
Peak Outflow (cfs)	106	100	106.0
Stage at Peak Outflow (ft)	9.7	8.7	9.7
Volume at Peak Outflow (ac. ft)	73.8	65.43	73.8

Volume Check

Total Volume needed	76.3	ac. ft
Total Volume Provided	76.6	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	10.7	ft
Depth Provided	11	ft
Depth OK?	Yes	

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	302800	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	1000	ft
Base Total ROW Width	420	ft
LC Enh. Total ROW Length	1390	ft
LC Enh. Total ROW Length	520	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	235708	265716
Excavated Area (sq. Yd)	46667	80311

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	75	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	829	sq. Yd
Material Volume	415	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	440	ft
Unit Cost	160	per ft
Cost per outlet	$70,400	
Other Cost	$ -	
Total Cost	$70,400	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		235,708	cu. Yd	$ 4.00	$ 942,832	46,667	sq. Yd	$ 9.00	$ 420,003	46,667	sq. Yd	$ 8.33	$ 388,892
Basin - LC Enhancement		30,008	cu. Yd	$ 4.00	$ 120,032	33,644	sq. Yd	$ 9.00	$ 302,796	33,644	sq. Yd	$ 8.33	$ 280,367
Inlet	Riprap	415	sq. Yd	$ 75.00	$ 31,125	829	sq. Yd	$ -	$ -	829	sq. Yd	$ 33.33	$ 27,633
Inlet - LC Enhancement (20%Inlet)					$ 6,225				$ -				$ 5,527
Outlet	Pipe	1	EA	$ 70,400	$ 70,400	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 3,520				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 420,003	Base Maintenance Cost			$ 418,742
						LC Enh. Landscape Cost			$ 302,796	LC Enh. Maintenance Cost			$ 286,004
						Total Landscape Cost			$ 722,799	Total Maintenance Cost			$ 704,746

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,044,357	$ 120,032	$ 1,164,389
Contingency Cost (25% of Construction Cost)	$ 261,089	$ 30,008	$ 291,097
Engineering Design Cost (5% of Construction Cost)	$ 52,218	$ 6,002	$ 58,219
Total Construction Cost	$ 1,357,664	$ 156,042	$ 1,513,706

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	7.0	$100,000	$ 700,000
Basin	9.6	$100,000	$ 960,000
Other		$100,000	$ -
Total	16.6	$100,000	$ 1,660,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	9.6	$100,000	$ 960,000
LC Enhancement Cost	acre	7.0	$100,000	$ 700,000
Total Land Cost	acre	16.6	$100,000	$ 1,660,000

Total Cost

Base Total Cost	$ 3,156,409
Total LC Enhancement Cost	$ 1,444,842
Total Cost Including LC Enh.	$ 4,601,251

Open Channel

Structure ID	P1B10

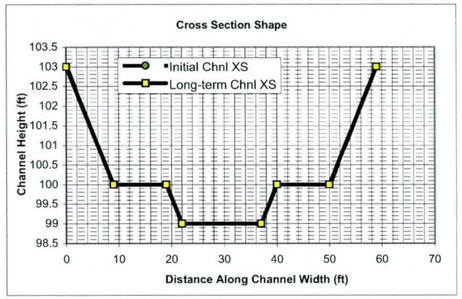
HEC1 ID	Q1A-P

Longitudinal Geometry

Length	5122.9	ft
U/S Elev	1190.4	ft
D/S Elev	1133.0	ft
Initial Channel Slope	0.0112	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	7



Initial Channel XS Geometry

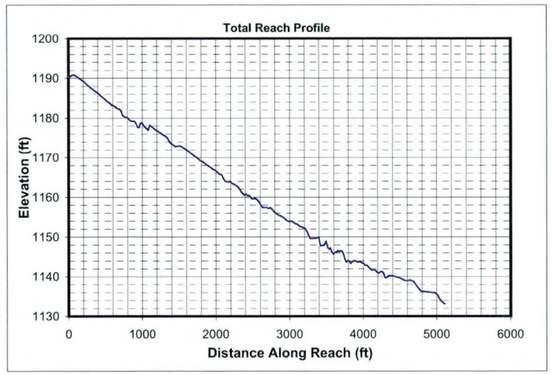
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	10	3	15	4	3	10	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	19	22	37	40	50	59
Y	103	100	100	99	99	100	100	103

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	10	3	15	4	3	10	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	19	22	37	40	50	59
Y	103	100	100	99	99	100	100	103



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RRQ1A	P1B							TOTAL
HEC1 Peak-Flow	106	852							958
Weighting Factor	1.00	0.23							
Flow into Channel	106	197							303

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	1.384	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	303	cfs	
Long-term Max. Chnl Capacity	853	cfs	
Q2 Channel	30	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	59	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
30	20.3	14.7	0.7	99.0	99.8	2.1	0.8	20.0	0.7	0.31	0.43
91	44.4	38.8	0.9	99.0	100.5	2.3	1.5	43.9	0.9	0.56	0.44
227	48.7	69.7	1.4	99.0	101.2	3.3	2.2	48.0	1.5	0.81	0.48
303	50.5	84.1	1.7	99.0	101.5	3.6	2.5	49.7	1.7	0.92	0.49

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
30	20.3	14.7	0.7	99.0	99.8	2.1	0.8	20.0	0.7	0.31	0.43
91	44.4	38.8	0.9	99.0	100.5	2.3	1.5	43.9	0.9	0.56	0.44
227	48.7	69.7	1.4	99.0	101.2	3.3	2.2	48.0	1.5	0.81	0.48
303	50.5	84.1	1.7	99.0	101.5	3.6	2.5	49.7	1.7	0.92	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
30										0
91										0
227										0
303										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
30	1.74	1.2994	1.2344	Erosive	Erosive	Erosive	0.3	Stable	4.0	Stable	Stable
91	1.74	1.3570	1.2892	Erosive	Erosive	Erosive	0.3	Stable	5.5	Stable	Stable
227	1.74	1.5107	1.4352	Erosive	Erosive	Erosive	0.4	Stable	7.2	Stable	Stable
303	1.74	1.5574	1.4796	Erosive	Erosive	Erosive	0.4	Stable	7.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	30	91	227	303	30	91	227	303	30	91	227	303
Bray - Equation #1	14	26	42	48	0.8	1.2	1.6	1.8	2.5	3.0	3.4	3.5
Bray - Equation #2	19	34	54	63	0.9	1.3	1.8	2.0	1.8	2.0	2.3	2.4
Hey	4	7	12	15	2.4	3.6	5.1	5.7				
Ackers & Charlton/Lacey	15	24	35	40					1.4	1.7	2.0	2.1
Parker	38	65	104	120	0.6	0.9	1.3	1.5				
Chang	22	43	76	90	0.2	0.1	0.0	0.0				
Kellerhals	10	17	27	31	1.1	1.7	2.4	2.7	2.9	3.2	3.5	3.6
AMAFCA/Schumm	20	44	48	50								
Moody & Odem	14	14	14	14	1.0	1.0	1.0	1.0				
BUREC	9.2	13.9	19.6	21.9	2	4	5	6	2.1	2.8	3.5	3.7
Average	16	29	43	49	1.2	1.7	2.3	2.6	2.1	2.5	2.9	3.1
Values As Designed	20	44	48	50	0.8	1.5	2.2	2.5	2.1	2.3	3.3	3.6
Difference with Design	-4	-15	-5	0	0.3	0.2	0.1	0.1	0.1	0.2	-0.3	-0.5

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
30	105	70	142	448	436	27	19	20	641	47	215	197
91	377	227	484	1673	1083	109	69	80	1952	162	782	636
227	1474	713	1321	7463	1612	459	221	344	4995	581	2949	2012
303	2250	1001	1820	11863	1827	695	306	522	6686	866	4377	2928

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
30	1292	852	1740	5483	5339	335	236	245	7846	576	2635	2416
91	1539	928	1974	6828	4421	446	284	325	7968	660	3191	2597
227	2406	1164	2157	12184	2632	749	361	561	8154	949	4814	3285
303	2755	1225	2228	14525	2237	851	375	639	8186	1061	5359	3586

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
30	105	60	99	175	275	20	19	20	232	25	118	105
91	377	200	337	655	699	78	69	80	724	85	436	340
227	1474	645	987	2924	1088	315	221	344	1912	315	1716	1086
303	2250	911	1355	4647	1247	471	306	522	2573	476	2578	1576

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
30	1292	740	1214	2148	3367	244	236	245	2844	301	1446	1280
91	1539	818	1373	2675	2851	320	284	325	2954	346	1781	1388
227	2406	1053	1612	4773	1777	515	361	561	3121	514	2801	1772
303	2755	1115	1659	5690	1526	577	375	639	3150	583	3156	1930

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
30	0.0013	0.0017	168	0.51	0.049	0.0004	30	0.036	0.0003	0.0159	0.0003	0.0009	0.0112	0.0008	0.0029	0.0059	0.0047
91	0.0010	0.0014	184	0.56	0.050	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0007	0.0112	0.0005	0.0013	0.0059	0.0046
227	0.0005	0.0008	236	0.72	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0112	0.0003	0.0006	0.0059	0.0045
303	0.0004	0.0007	254	0.77	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0112	0.0003	0.0005	0.0059	0.0044

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	26.7	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	569	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.45	sq. mi
Total Sediment Yield Volume	0.85	ac ft

Sedimentation Basins

Length	569 ft	Depth	3 ft
Width	59 ft	Side slope	3 ft/ft
Total Volume per Basin		1.93	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
30	1.1	-0.3	0.1	24.6	0.8	0.7	2.1	0.0060	0.1	0.0	1.0	1.4
91	1.1	-0.5	0.1	24.6	1.5	0.9	2.3	0.0060	0.2	0.0	1.0	1.5
227	1.1	-0.6	0.1	24.6	2.2	1.5	3.3	0.0060	0.2	0.0	1.0	1.7
303	1.1	-0.7	0.2	24.6	2.5	1.7	3.6	0.0060	0.3	0.0	1.0	1.8

Toe Protection Needed	2.0	ft

HEC1 Results For Open Channel

Peak Flow	106	cfs
Stage at Peak Flow	100.3	ft
Volume at Peak Flow	97.0	ac. ft

Freeboard

Max. Flow Depth	2.5	ft
Channel Depth as designed	4.0	ft
Available Freeboard	1.5	ft
Required Freeboard	1	ft

Sediment Volume

Inflowing Sediment Volume	0.85	ac. ft
Outflowing Sediment Volume	0.07	ac. ft
Deposited(+)/Eroded(-) Volume	0.78	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	5123	5123
Side Slope (?H:1V)	3	6
Channel Width (ft)	59	83
Channel XS Area (sq. ft)	168	216
Channel Perimeter (ft)	60	83

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	181178	251018
Excavated Area (sq. Yd)	33584	47245

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5123	ft
Thickness	1.5	ft
Protection Depth	2	ft
Tie-in Length/Depth	3.0	ft
Total Depth	5.0	ft
Area needed	854	sq. Yd
Volume	1423	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5123	5123
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	5123	5123
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	59	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.6	ft
Structure Height	9.6	ft
Number of Structures	9	
Volume per structure	63	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 4,725	
Area per structure	20	sq. Yd
Total Area	177	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	3114	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 12,456	
Other Cost	$ -	
Total cost per basin	$ 12,456	
Area per basin	3,731	sq. Yd
Total Area	7,462	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	181,178	cu. Yd	$ 10.00	$ 1,811,780	33,584	sq. Yd	$ 9.00	$ 302,256	33,584	sq. Yd	$ 8.33	$ 279,867
Exc. Chl - LC Enhancement	Excavated	69,840	cu. Yd	$ 10.00	$ 698,400	13,661	sq. Yd	$ 9.00	$ 122,949	13,661	sq. Yd	$ 8.33	$ 113,842
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,423	cu. Yd	$ 75.00	$ 106,725	854	sq. Yd	$ -	$ -	854	sq. Yd	$ 25.00	$ 21,350
Drop Structures	Riprap	9	EA	$ 4,725.00	$ 42,525	177	sq. Yd	$ -	$ -	177	sq. Yd	$ 33.33	$ 5,900
Drop Str. - LC Enhancement	Riprap	9	EA	$ 472.50	$ 4,253	18	sq. Yd	$ -	$ -	18	sq. Yd	$ 33.33	$ 590
Sedimentation Basins		2	EA	$ 12,456.00	$ 24,912	7,462	sq. Yd	$ -	$ -	7,462	sq. Yd	$ 8.33	$ 62,183
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 302,256	Base Maintenance Cost			$ 369,300
						LC Enhancement Cost			$ 122,949	LC Enhancement Cost			$ 114,432
						Total Landscape Cost			$ 425,205	Total Maintenance Cost			$ 483,732

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,985,942	$ 702,653	$ 2,688,595
Contingency Cost (25% of Construction Cost)	$ 496,486	$ 175,663	$ 672,149
Engineering Design Cost (5% of Construction Cost)	$ 99,297	$ 35,133	$ 134,430
Total Construction Cost	$ 2,581,725	$ 913,448	$ 3,495,173

Land Cost

Channel Length	5123 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	15.8	$100,000	$ 1,580,000
LC Enhancement Buffer	50	5.9	$100,000	$ 590,000
Channel	59	6.9	$100,000	$ 690,000
Channel LC Enhancement	24	2.8	$100,000	$ 280,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	267	31.4		$ 3,140,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	22.7	$100,000	$ 2,270,000
LC Enhancement Cost	acre	8.7	$100,000	$ 870,000
Total Land Cost	acre	31.4	$100,000	$ 3,140,000

Total Cost

Base Total Cost	$ 5,523,281
Total Landscape Enhancement Cost	$ 2,020,829
Total Cost Including LC Enh.	$ 7,544,110

Open Channel

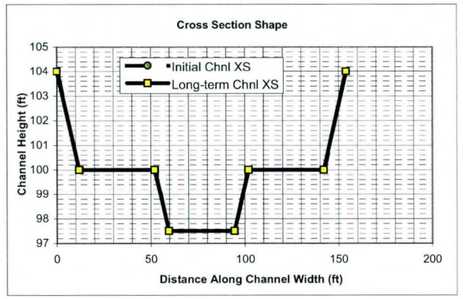
Structure ID	L30	HEC1 ID	L30

Longitudinal Geometry

Length	6103.1	ft
U/S Elev	1119.1	ft
D/S Elev	1148.6	ft
Initial Channel Slope	0.0048	ft/ft
Long-term Channel Slope	0.0048	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	



Initial Channel XS Geometry

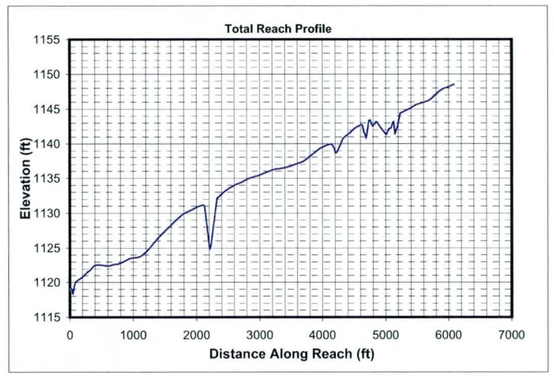
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	40	3	35	6.5	3	40	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	52	59.5	94.5	102	142	154
Y	104	100	100	97.5	97.5	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	40	3	35	6.5	3	40	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	52	59.5	94.5	102	142	154
Y	104	100	100	97.5	97.5	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	L									TOTAL
HEC1 Peak-Flow	2162									2162
Weighting Factor	1.00									
Flow into Channel	2162									2162

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	12.5	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	2162	cfs	
Long-term Max. Chnl Capacity	4102	cfs	
Q2 Channel	216	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	154	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
216	46.1	70.8	1.5	97.5	99.3	3.1	1.8	45.5	1.6	0.53	0.43
649	135.8	210.9	1.6	97.5	100.8	3.1	3.3	134.7	1.6	0.99	0.43
1622	143.2	373.3	2.6	97.5	102.0	4.3	4.5	141.8	2.6	1.34	0.47
2162	146.5	447.6	3.1	97.5	102.5	4.8	5.0	144.9	3.1	1.49	0.48

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
216	46.1	70.8	1.5	97.5	99.3	3.1	1.8	45.5	1.6	0.53	0.43
649	135.8	210.9	1.6	97.5	100.8	3.1	3.3	134.7	1.6	0.99	0.43
1622	143.2	373.3	2.6	97.5	102.0	4.3	4.5	141.8	2.6	1.34	0.47
2162	146.5	447.6	3.1	97.5	102.5	4.8	5.0	144.9	3.1	1.49	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
216										0
649										0
1622										0
2162										0

Allowable Velocity

Channel Lining

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
216	1.74	1.5315	1.4549	Erosive	Erosive	Erosive	0.4	Stable	5.9	Stable	Stable
649	1.74	1.5335	1.4569	Erosive	Erosive	Erosive	0.4	Stable	8.0	Stable	Stable
1622	1.74	1.6939	1.6092	Erosive	Erosive	Erosive	0.4	Stable	10.2	Stable	Stable
2162	1.74	1.7432	1.6561	Erosive	Erosive	Erosive	0.5	Stable	11.1	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	6

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	216	649	1622	2162	216	649	1622	2162	216	649	1622	2162
Bray - Equation #1	40	72	117	136	1.6	2.3	3.1	3.4	3.4	3.9	4.4	4.6
Bray - Equation #2	53	95	154	179	1.8	2.5	3.4	3.8	2.3	2.7	3.1	3.2
Hey	12	23	38	44	5.0	7.5	10.7	11.9				
Ackers & Charlton/Lacey	34	55	80	91					2.0	2.4	2.7	2.9
Parker	101	175	277	319	1.3	2.0	3.0	3.4				
Chang	68	133	232	276	0.1	-0.1	-0.5	-0.7				
Kellerhals	26	46	72	84	2.3	3.6	5.2	5.9	3.5	3.9	4.3	4.4
AMAFCA/Schumm	46	135	142	145								
Moody & Odem	32	32	32	32	1.4	1.4	1.4	1.4				
BUREC	20.1	30.3	42.8	47.7	5	8	11	13	3.1	4.1	5.2	5.6
Average	43	80	119	135	2.4	3.4	4.7	5.2	2.9	3.4	4.0	4.1
Values As Designed	46	135	142	145	1.8	3.3	4.5	5.0	3.1	3.1	4.3	4.8
Difference with Design	-2	-55	-23	-10	0.6	0.1	0.3	0.2	-0.2	0.3	-0.4	-0.7

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	1035	484	715	1953	935	205	154	251	1300	217	1236	771
649	3153	1416	2157	5922	2777	623	469	766	3903	657	3762	2328
1622	12611	4333	5950	27117	4105	2309	1323	2928	10069	1834	14170	7886
2162	19419	6058	7681	43546	4626	3427	1789	4343	13497	1982	21125	11590

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	1775	831	1227	3351	1604	351	265	431	2231	372	2122	1324
649	1803	810	1234	3387	1589	356	268	438	2233	376	2152	1331
1622	2885	991	1361	6204	939	528	303	670	2304	420	3242	1804
2162	3332	1040	1318	7473	794	588	307	745	2316	340	3625	1989

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	1035	484	713	1928	929	204	154	251	1283	215	1227	766
649	3153	1414	2149	5847	2761	620	469	766	3852	650	3733	2310
1622	12611	4328	5926	26777	4084	2297	1323	2928	9941	1797	14066	7825
2162	19419	6052	7658	43001	4602	3409	1789	4343	13325	1943	20974	11501

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	1775	830	1223	3309	1594	350	265	431	2201	369	2105	1314
649	1803	809	1229	3345	1579	355	268	438	2203	372	2135	1321
1622	2885	990	1356	6127	934	526	303	670	2274	411	3218	1790
2162	3332	1038	1314	7379	790	585	307	745	2287	333	3599	1974

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
216	0.0005	0.0008	160	0.49	0.049	0.0002	30	0.036	0.0001	0.0159	0.0002	0.0004	0.0058	0.0003	0.0014	0.0047	0.0028
649	0.0005	0.0008	161	0.49	0.049	0.0002	30	0.036	0.0001	0.0159	0.0002	0.0004	0.0058	0.0002	0.0006	0.0048	0.0028
1622	0.0003	0.0005	209	0.64	0.051	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0002	0.0058	0.0001	0.0003	0.0047	0.0027
2162	0.0002	0.0004	226	0.69	0.052	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0002	0.0058	0.0001	0.0002	0.0047	0.0027

Drop Structures

Design Slope	0.0048	ft/ft
Total Drop Needed	0.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	1	
Distance between structs.	6103	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	5.85	sq. mi
Total Sediment Yield Volume	11.12	ac ft

Sedimentation Basins

Length	6103 ft	Depth	3 ft	
Width	154 ft	Side slope	3 ft/ft	
Total Volume per Basin		60.86	ac. ft.	
Basin Trap Efficiency		0.6		
No. of Basins		1		

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
216	1.1	-0.5	0.1	24.6	1.8	1.6	3.1	0.0048	0.2	0.0	2.5	3.6
649	1.1	-1.0	0.1	24.6	3.3	1.6	3.1	0.0048	0.4	0.0	2.5	3.8
1622	1.1	-1.1	0.3	24.6	4.5	2.6	4.3	0.0048	0.5	0.0	2.5	4.1
2162	1.1	-1.2	0.3	24.6	5.0	3.1	4.8	0.0048	0.6	0.0	2.5	4.2

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	226	cfs
Stage at Peak Flow	100.3	ft
Volume at Peak Flow	342.0	ac. ft

Freeboard

Max. Flow Depth	5.0	ft
Channel Depth as designed	6.5	ft
Available Freeboard	1.5	ft
Required Freeboard	1.3	ft

Sediment Volume

Inflowing Sediment Volume	11.12	ac. ft
Outflowing Sediment Volume	0.25	ac. ft
Deposited(+)/Eroded(-) Volume	10.86	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	6103	6103
Side Slope (?H:1V)	3	6
Channel Width (ft)	154	193
Channel XS Area (sq. ft)	674.2	800.95
Channel Perimeter (ft)	156	194

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	156694	186433
Excavated Area (sq. Yd)	104429	130875

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	6103	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	1017	sq. Yd
Volume	2712	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	6103	6103
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	6103	6103
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	154	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	11.0	ft	
Structure Height	14.0	ft	
Number of Structures	1		
Volume per structure	240	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 18,000		
Area per structure	51	sq. Yd	
Total Area	51	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	98187	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 392,748	
Other Cost	$ -	
Total cost per basin	$ 392,748	
Area per basin	104,430	sq. Yd
Total Area	104,430	sq. Yd

Structure Type	Structure Cost											
	Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	156,694	cu. Yd	$ 10.00	$ 1,566,940	104,429	sq. Yd	$ 9.00	$ 939,861	104,429	sq. Yd	$ 8.33	$ 870,242
Exc. Chl - LC Enhancement	Excavated	29,739	cu. Yd	$ 10.00	$ 297,390	26,446	sq. Yd	$ 9.00	$ 238,014	26,446	sq. Yd	$ 8.33	$ 220,383
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	2,712	cu. Yd	$ 75.00	$ 203,400	1,017	sq. Yd	$ -	$ -	1,017	sq. Yd	$ 25.00	$ 25,425
Drop Structures	Riprap	1	EA	$ 18,000.00	$ 18,000	51	sq. Yd	$ -	$ -	51	sq. Yd	$ 33.33	$ 1,700
Drop Str. - LC Enhancement	Riprap	1	EA	$ 1,800.00	$ 1,800	5	sq. Yd	$ -	$ -	5	sq. Yd	$ 33.33	$ 170
Sedimentation Basins		1	EA	$ 392,748.00	$ 392,748	104,430	sq. Yd	$ -	$ -	104,430	sq. Yd	$ 8.33	$ 870,250
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 939,861	Base Maintenance Cost			$ 1,767,617
						LC Enhancement Cost			$ 238,014	LC Enhancement Cost			$ 220,553
						Total Landscape Cost			$ 1,177,875	Total Maintenance Cost			$ 1,988,170

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,181,088	$ 299,190	$ 2,480,278
Contingency Cost (25% of Construction Cost)	$ 545,272	$ 74,798	$ 620,070
Engineering Design Cost (5% of Construction Cost)	$ 109,054	$ 14,960	$ 124,014
Total Construction Cost	$ 2,835,414	$ 388,947	$ 3,224,361

Land Cost

Channel Length	6103 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	14	2	$100,000	$ 200,000
LC Enhancement Buffer	50	7	$100,000	$ 700,000
Channel	154	21.6	$100,000	$ 2,160,000
Channel LC Enhancement	39	5.5	$100,000	$ 550,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	257	36.1		$ 3,610,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	23.6	$100,000	$ 2,360,000
LC Enhancement Cost	acre	12.5	$100,000	$ 1,250,000
Total Land Cost	acre	36.1	$100,000	$ 3,610,000

Total Cost

Base Total Cost	$ 7,902,892
Total Landscape Enhancement Cost	$ 2,097,514
Total Cost Including LC Enh.	$ 10,000,406

Open Channel

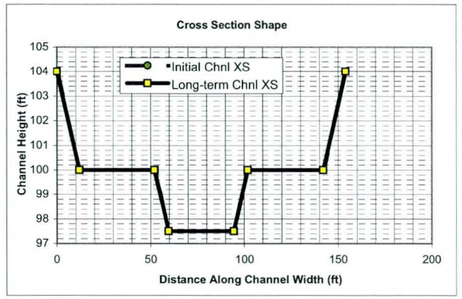
Structure ID	L40	HEC1 ID	L40

Longitundal Geometry

Length	8055.0	ft
U/S Elev	1119.1	ft
D/S Elev	1087.1	ft
Initial Channel Slope	0.0040	ft/ft
Long-term Channel Slope	0.0040	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	



Initial Channel XS Geometry

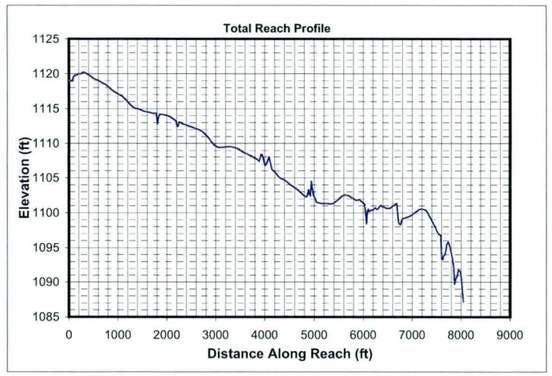
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	40	3	35	6.5	3	40	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	52	59.5	94.5	102	142	154
Y	104	100	100	97.5	97.5	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	40	3	35	6.5	3	40	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	52	59.5	94.5	102	142	154
Y	104	100	100	97.5	97.5	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	L								TOTAL
HEC1 Peak-Flow	2162								2162
Weighting Factor	1.00								
Flow into Channel	2162								2162

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	12.5	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	2162	cfs	
Long-term Max. Chnl Capacity	3745	cfs	
Q2 Channel	216	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	154	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
216	46.7	75.2	1.6	97.5	99.4	2.9	1.9	46.1	1.6	0.46	0.40
649	136.4	223.1	1.6	97.5	100.9	2.9	3.4	135.3	1.6	0.84	0.40
1622	144.2	395.3	2.7	97.5	102.1	4.1	4.6	142.7	2.8	1.15	0.43
2162	147.7	474.3	3.2	97.5	102.7	4.6	5.2	146.0	3.2	1.29	0.45

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
216	46.7	75.2	1.6	97.5	99.4	2.9	1.9	46.1	1.6	0.46	0.40
649	136.4	223.1	1.6	97.5	100.9	2.9	3.4	135.3	1.6	0.84	0.40
1622	144.2	395.3	2.7	97.5	102.1	4.1	4.6	142.7	2.8	1.15	0.43
2162	147.7	474.3	3.2	97.5	102.7	4.6	5.2	146.0	3.2	1.29	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
216										0
649										0
1622										0
2162										0

Allowable Velocity

Channel Lining

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
216	1.74	1.5461	1.4688	Erosive	Erosive	Erosive	0.4	Stable	5.5	Stable	Stable
649	1.74	1.5497	1.4722	Erosive	Erosive	Erosive	0.4	Stable	7.5	Stable	Stable
1622	1.74	1.7096	1.6241	Erosive	Erosive	Erosive	0.4	Stable	9.5	Stable	Stable
2162	1.74	1.7518	1.6642	Erosive	Erosive	Erosive	0.5	Stable	10.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	6

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	216	649	1622	2162	216	649	1622	2162	216	649	1622	2162
Bray - Equation #1	40	72	117	136	1.6	2.3	3.1	3.4	3.4	3.9	4.4	4.6
Bray - Equation #2	53	95	154	179	1.8	2.5	3.4	3.8	2.3	2.7	3.1	3.2
Hey	12	23	38	44	5.0	7.5	10.7	11.9				
Ackers & Charlton/Lacey	34	55	80	91					2.0	2.4	2.7	2.9
Parker	101	175	277	319	1.3	2.0	3.0	3.4				
Chang	64	125	219	261	0.2	0.0	-0.3	-0.5				
Kellerhals	26	46	72	84	2.3	3.6	5.2	5.9	3.5	3.9	4.3	4.4
AMAFCA/Schumm	46	135	143	146								
Moody & Odem	32	32	32	32	1.4	1.4	1.4	1.4				
BUREC	20.8	31.4	44.3	49.3	6	8	12	13	2.9	3.9	4.9	5.2
Average	43	79	118	134	2.4	3.5	4.8	5.3	2.8	3.3	3.9	4.1
Values As Designed	46	135	143	146	1.9	3.4	4.6	5.2	2.9	2.9	4.1	4.6
Difference with Design	-3	-56	-25	-12	0.5	0.1	0.2	0.1	-0.1	0.4	-0.2	-0.5

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	797	387	568	1400	851	145	117	200	949	161	948	593
649	2442	1139	1714	4271	2517	443	357	612	2852	488	2900	1794
1622	9754	3551	4625	19522	3768	1685	1048	2392	7433	1291	11150	6020
2162	15011	4986	6343	31327	4260	2508	1428	3565	9979	1398	16713	8865

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	1368	664	975	2402	1460	248	201	342	1629	276	1626	1017
649	1397	651	981	2443	1440	253	204	350	1631	279	1659	1026
1622	2232	813	1058	4467	862	386	240	547	1701	295	2551	1377
2162	2576	856	1088	5376	731	430	245	612	1712	240	2868	1521

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	797	387	570	1415	855	145	117	200	960	162	954	597
649	2442	1140	1720	4316	2530	445	357	612	2884	493	2920	1805
1622	9754	3555	4641	19729	3785	1692	1048	2392	7514	1313	11221	6059
2162	15011	4990	6359	31659	4278	2519	1428	3565	10087	1422	16817	8921

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	1368	664	978	2428	1468	249	201	342	1647	278	1637	1024
649	1397	652	984	2469	1447	254	204	350	1650	282	1670	1033
1622	2232	813	1062	4514	866	387	240	547	1719	300	2567	1386
2162	2576	856	1091	5433	734	432	245	612	1731	244	2886	1531

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
216	0.0005	0.0007	149	0.45	0.048	0.0002	30	0.036	0.0001	0.0159	0.0002	0.0004	0.0058	0.0003	0.0014	0.0039	0.0026
649	0.0005	0.0007	150	0.46	0.048	0.0002	30	0.036	0.0001	0.0159	0.0002	0.0004	0.0058	0.0002	0.0006	0.0040	0.0026
1622	0.0003	0.0004	194	0.59	0.050	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0002	0.0058	0.0001	0.0003	0.0040	0.0025
2162	0.0002	0.0004	210	0.64	0.051	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0002	0.0058	0.0001	0.0002	0.0039	0.0025

Drop Structures

Design Slope	0.0040	ft/ft
Total Drop Needed	0.0	ft
Height of Drop Structure	3	ft
No . of Drop Structures	0	
Distance between structs.	N/A	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	5.85	sq. mi
Total Sediment Yield Volume	11.12	ac ft

Sedimentation Basins

Length	0 ft	Depth	3 ft
Width	154 ft	Side slope	3 ft/ft
Total Volume per Basin		0.00	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		0	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
216	1.1	-0.6	0.1	24.6	1.9	1.6	2.9	0.0040	0.2	0.0	2.5	3.6
649	1.1	-1.0	0.1	24.6	3.4	1.6	2.9	0.0040	0.4	0.0	2.5	3.8
1622	1.1	-1.2	0.2	24.6	4.6	2.8	4.1	0.0040	0.5	0.0	2.5	4.1
2162	1.1	-1.3	0.3	24.6	5.2	3.2	4.6	0.0040	0.6	0.0	2.5	4.2

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	226	cfs
Stage at Peak Flow	100.3	ft
Volume at Peak Flow	342.0	ac. ft

Freeboard

Max. Flow Depth	5.2	ft
Channel Depth as designed	6.5	ft
Available Freeboard	1.3	ft
Required Freeboard	1.4	ft

Sediment Volume

Inflowing Sediment Volume	11.12	ac. ft
Outflowing Sediment Volume	0.20	ac. ft
Deposited(+)/Eroded(-) Volume	10.92	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	8055	8055
Side Slope (?H:1V)	3	6
Channel Width (ft)	154	193
Channel XS Area (sq. ft)	674.2	800.95
Channel Perimeter (ft)	156	194

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	195952	232453
Excavated Area (sq. Yd)	137830	172735

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	8055	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	1343	sq. Yd
Volume	3580	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	8055	8055
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	8055	8055
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	154	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	11.0	ft
Structure Height	14.0	ft
Number of Structures	0	
Volume per structure	239	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 17,925	
Area per structure	51	sq. Yd
Total Area	0	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	0	
Total Volume per Basin	0	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ -	
Other Cost	$ -	
Total cost per basin	$ -	
Area per basin	0	sq. Yd
Total Area	0	sq. Yd

Structure Type	Structure Cost											
	Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	195,952	cu. Yd	$ 10.00	$ 1,959,520	137,830	sq. Yd	$ 9.00	$ 1,240,470	137,830	sq. Yd	$ 8.33	$ 1,148,583
Exc. Chl - LC Enhancement	Excavated	36,501	cu. Yd	$ 10.00	$ 365,010	34,905	sq. Yd	$ 9.00	$ 314,145	34,905	sq. Yd	$ 8.33	$ 290,875
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	3,580	cu. Yd	$ 75.00	$ 268,500	1,343	sq. Yd	$ -	$ -	1,343	sq. Yd	$ 25.00	$ 33,575
Drop Structures	Riprap	0	EA	$ 17,925.00	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 33.33	$ -
Drop Str. - LC Enhancement	Riprap	0	EA	$ 1,792.50	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 33.33	$ -
Sedimentation Basins		0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 8.33	$ -
Other					$ -				$ -				$ -
Base Landscape Cost									$ 1,240,470	Base Maintenance Cost			$ 1,182,158
LC Enhancement Cost									$ 314,145	LC Enhancement Cost			$ 290,875
Total Landscape Cost									$ 1,554,615	Total Maintenance Cost			$ 1,473,033

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,228,020	$ 365,010	$ 2,593,030
Contingency Cost (25% of Construction Cost)	$ 557,005	$ 91,253	$ 648,258
Engineering Design Cost (5% of Construction Cost)	$ 111,401	$ 18,251	$ 129,652
Total Construction Cost	$ 2,896,426	$ 474,513	$ 3,370,939

Land Cost

Channel Length	8055 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	14	2.6	$100,000	$ 260,000
LC Enhancement Buffer	50	9.2	$100,000	$ 920,000
Channel	154	28.5	$100,000	$ 2,850,000
Channel LC Enhancement	39	7.2	$100,000	$ 720,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	257	47.5		$ 4,750,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	31.1	$100,000	$ 3,110,000
LC Enhancement Cost	acre	16.4	$100,000	$ 1,640,000
Total Land Cost	acre	47.5	$100,000	$ 4,750,000

Total Cost

Base Total Cost	$ 8,429,054
Total Landscape Enhancement Cost	$ 2,719,533
Total Cost Including LC Enh.	$ 11,148,587

Open Channel

Structure ID	RRP1A10

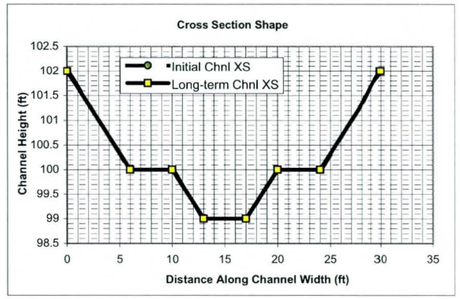
HEC1 ID	RRP1A10

Longitudal Geometry

Length	1465.1	ft
U/S Elev	1276.4	ft
D/S Elev	1305.2	ft
Initial Channel Slope	0.0196	ft/ft
Long-term Channel Slope	0.0090	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	



Initial Channel XS Geometry

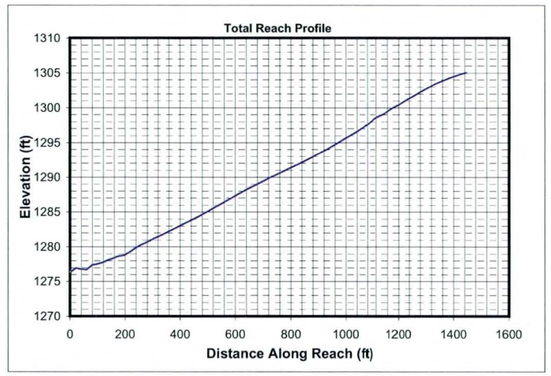
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	2	4	3	4	3	3	4	2	3

PT. ID	1	2	3	4	5	6	7	8
X	0	6	10	13	17	20	24	30
Y	102	100	100	99	99	100	100	102

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	2	4	3	4	3	3	4	2	3

PT. ID	1	2	3	4	5	6	7	8
X	0	6	10	13	17	20	24	30
Y	102	100	100	99	99	100	100	102



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RRP1A								TOTAL
HEC1 Peak-Flow	87								87
Weighting Factor	1.00								
Flow into Channel	87								87

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	0.5	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	87	cfs	
Long-term Max. Chnl Capacity	253	cfs	
Q2 Channel	9	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	30	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
9	8.5	4.3	0.5	99.0	99.7	2.0	0.7	8.2	0.5	0.40	0.49
26	19.9	11.8	0.6	99.0	100.3	2.2	1.3	19.5	0.6	0.70	0.50
65	22.9	21.6	0.9	99.0	100.7	3.0	1.7	22.3	1.0	0.97	0.54
87	24.2	26.2	1.1	99.0	100.9	3.3	1.9	23.6	1.1	1.08	0.55

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
9	8.5	4.3	0.5	99.0	99.7	2.0	0.7	8.2	0.5	0.40	0.49
26	19.9	11.8	0.6	99.0	100.3	2.2	1.3	19.5	0.6	0.70	0.50
65	22.9	21.6	0.9	99.0	100.7	3.0	1.7	22.3	1.0	0.97	0.54
87	24.2	26.2	1.1	99.0	100.9	3.3	1.9	23.6	1.1	1.08	0.55

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
9										0
26										0
65										0
87										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
9	1.74	1.1969	1.1371	Erosive	Erosive	Erosive	0.3	Stable	4.2	Stable	Stable
26	1.74	1.2398	1.1778	Erosive	Erosive	Erosive	0.3	Stable	5.8	Stable	Stable
65	1.74	1.3850	1.3157	Erosive	Erosive	Erosive	0.3	Stable	7.3	Stable	Stable
87	1.74	1.4286	1.3572	Erosive	Erosive	Erosive	0.3	Stable	7.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	9	26	65	87	9	26	65	87	9	26	65	87
Bray - Equation #1	7	13	22	25	0.5	0.8	1.1	1.2	2.1	2.5	2.8	3.0
Bray - Equation #2	10	17	28	33	0.6	0.9	1.2	1.3	1.5	1.7	1.9	2.0
Hey	2	3	6	7	1.5	2.2	3.2	3.5				
Ackers & Charlton/Lacey	9	14	21	23					1.1	1.4	1.6	1.7
Parker	20	35	55	64	0.3	0.5	0.8	0.9				
Chang	12	23	40	48	0.1	0.1	0.0	0.0				
Kellerhals	5	9	15	17	0.6	1.0	1.4	1.6	2.5	2.8	3.1	3.2
AMAFCA/Schumm	8	20	22	24								
Moody & Odem	9	9	9	9	0.9	0.9	0.9	0.9				
BUREC	5.4	8.1	11.4	12.7	1	2	3	3	1.8	2.3	3.0	3.2
Average	9	15	23	26	0.8	1.1	1.5	1.6	1.8	2.2	2.5	2.6
Values As Designed	8	20	22	24	0.7	1.3	1.7	1.9	2.0	2.2	3.0	3.3
Difference with Design	1	-4	1	3	0.0	-0.2	-0.3	-0.3	-0.2	-0.1	-0.5	-0.7

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
9	43	30	73	245	209	15	9	7	434	23	96	108
26	147	94	243	869	540	56	32	28	1312	76	336	339
65	559	290	645	3752	821	229	100	121	3335	256	1229	1031
87	845	406	887	5895	939	345	138	184	4459	374	1807	1480

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
9	1813	1266	3126	10457	8899	636	393	312	18506	978	4114	4591
26	2089	1335	3452	12353	7677	793	453	396	18656	1074	4778	4823
65	3180	1648	3669	21334	4668	1303	569	689	18962	1453	6989	5860
87	3605	1730	3783	25138	4005	1473	589	784	19016	1597	7704	6311

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
9	43	25	47	76	120	10	9	7	125	11	47	47
26	147	80	155	270	317	36	32	28	385	37	167	150
65	559	256	449	1166	506	142	100	121	1011	130	641	462
87	845	360	614	1832	586	211	138	184	1359	194	955	662

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
9	1813	1067	1993	3250	5118	421	393	312	5348	474	2006	2018
26	2089	1142	2204	3839	4500	517	453	396	5479	524	2369	2137
65	3180	1453	2553	6630	2877	809	569	689	5747	740	3642	2626
87	3605	1535	2619	7812	2497	901	589	784	5794	825	4072	2821

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
9	0.0017	0.0023	186	0.57	0.050	0.0005	31	0.036	0.0004	0.0159	0.0005	0.0012	0.0170	0.0014	0.0044	0.0087	0.0071
26	0.0014	0.0020	200	0.61	0.051	0.0005	31	0.036	0.0003	0.0159	0.0004	0.0010	0.0170	0.0009	0.0019	0.0088	0.0069
65	0.0008	0.0013	253	0.77	0.053	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0170	0.0006	0.0010	0.0087	0.0067
87	0.0007	0.0011	272	0.83	0.053	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0170	0.0005	0.0008	0.0087	0.0067

Drop Structures

Design Slope	0.0090	ft/ft
Total Drop Needed	15.6	ft
Height of Drop Structure	3	ft
No . of Drop Structures	6	
Distance between structs.	244	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.00	sq. mi
Total Sediment Yield Volume	0.00	ac ft

Sedimentation Basins

Length	244 ft	Depth	3 ft
Width	30 ft	Side slope	3 ft/ft
Total Volume per Basin		0.34	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
9	1.1	-0.3	0.1	24.6	0.7	0.5	2.0	0.0090	0.1	0.0	1.0	1.4
26	1.1	-0.4	0.1	24.6	1.3	0.6	2.2	0.0090	0.1	0.0	1.0	1.5
65	1.1	-0.5	0.1	24.6	1.7	1.0	3.0	0.0090	0.2	0.0	1.0	1.6
87	1.1	-0.6	0.2	24.6	1.9	1.1	3.3	0.0090	0.2	0.0	1.0	1.7

Toe Protection Needed	2.0	ft

HEC1 Results For Open Channel

Peak Flow	87	cfs
Stage at Peak Flow	6.6	ft
Volume at Peak Flow	44.0	ac. ft

Freeboard

Max. Flow Depth	1.9	ft
Channel Depth as designed	3.0	ft
Available Freeboard	1.1	ft
Required Freeboard	1	ft

Sediment Volume

Inflowing Sediment Volume	0.00	ac. ft
Outflowing Sediment Volume	0.05	ac. ft
Deposited(+)/Eroded(-) Volume	-0.05	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	1465	1465
Side Slope (?H:1V)	3	6
Channel Width (ft)	30	48
Channel XS Area (sq. ft)	55	82
Channel Perimeter (ft)	31	49

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	15643	24704
Excavated Area (sq. Yd)	4883	7813

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1465	ft
Thickness	1.5	ft
Protection Depth	2	ft
Tie-in Length/Depth	3.0	ft
Total Depth	5.0	ft
Area needed	244	sq. Yd
Volume	407	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1465	1465
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	1465	1465
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	30	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	5.0	ft	
Structure Height	8.0	ft	
Number of Structures	6		
Volume per structure	27	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 2,025		
Area per structure	10	sq. Yd	
Total Area	60	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	549	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 2,196	
Other Cost	$ -	
Total cost per basin	$ 2,196	
Area per basin	814	sq. Yd
Total Area	814	sq. Yd

Structure Type	Structure Cost											
	Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	15,643	cu. Yd	$ 10.00	$ 156,430	4,883	sq. Yd	$ 9.00	$ 43,947	4,883	sq. Yd	$ 8.33	$ 40,692
Exc. Chl - LC Enhancement	Excavated	9,061	cu. Yd	$ 10.00	$ 90,610	2,930	sq. Yd	$ 9.00	$ 26,370	2,930	sq. Yd	$ 8.33	$ 24,417
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	407	cu. Yd	$ 75.00	$ 30,525	244	sq. Yd	$ -	$ -	244	sq. Yd	$ 25.00	$ 6,100
Drop Structures	Riprap	6	EA	$ 2,025.00	$ 12,150	60	sq. Yd	$ -	$ -	60	sq. Yd	$ 33.33	$ 2,000
Drop Str. - LC Enhancement	Riprap	6	EA	$ 202.50	$ 1,215	6	sq. Yd	$ -	$ -	6	sq. Yd	$ 33.33	$ 200
Sedimentation Basins		1	EA	$ 2,196.00	$ 2,196	814	sq. Yd	$ -	$ -	814	sq. Yd	$ 8.33	$ 6,783
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 43,947	Base Maintenance Cost			$ 55,575
						LC Enhancement Cost			$ 26,370	LC Enhancement Cost			$ 24,617
						Total Landscape Cost			$ 70,317	Total Maintenance Cost			$ 80,192

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 201,301	$ 91,825	$ 293,126
Contingency Cost (25% of Construction Cost)	$ 50,325	$ 22,956	$ 73,282
Engineering Design Cost (5% of Construction Cost)	$ 10,065	$ 4,591	$ 14,656
Total Construction Cost	$ 261,691	$ 119,373	$ 381,064

Land Cost

Channel Length	1465 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	4.5	$100,000	$ 450,000
LC Enhancement Buffer	50	1.7	$100,000	$ 170,000
Channel	30	1	$100,000	$ 100,000
Channel LC Enhancement	18	0.6	$100,000	$ 60,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	232	7.8		$ 780,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	5.5	$100,000	$ 550,000
LC Enhancement Cost	acre	2.3	$100,000	$ 230,000
Total Land Cost	acre	7.8	$100,000	$ 780,000

Total Cost

Base Total Cost	$	911,213
Total Landscape Enhancement Cost	$	400,359
Total Cost Including LC Enh.	$	1,311,572

SUN VALLEY ADMP
Step 2 - Alt. B4-1
FRS No. 1

FRS No. 1 Sub-area

FEMA Floodplains

Floodplain

Floodway

Alluvial Fan Apices

Concentration Point

Step 2 Excavated Corridors ROW

Step 2 Leveed Corridors ROW

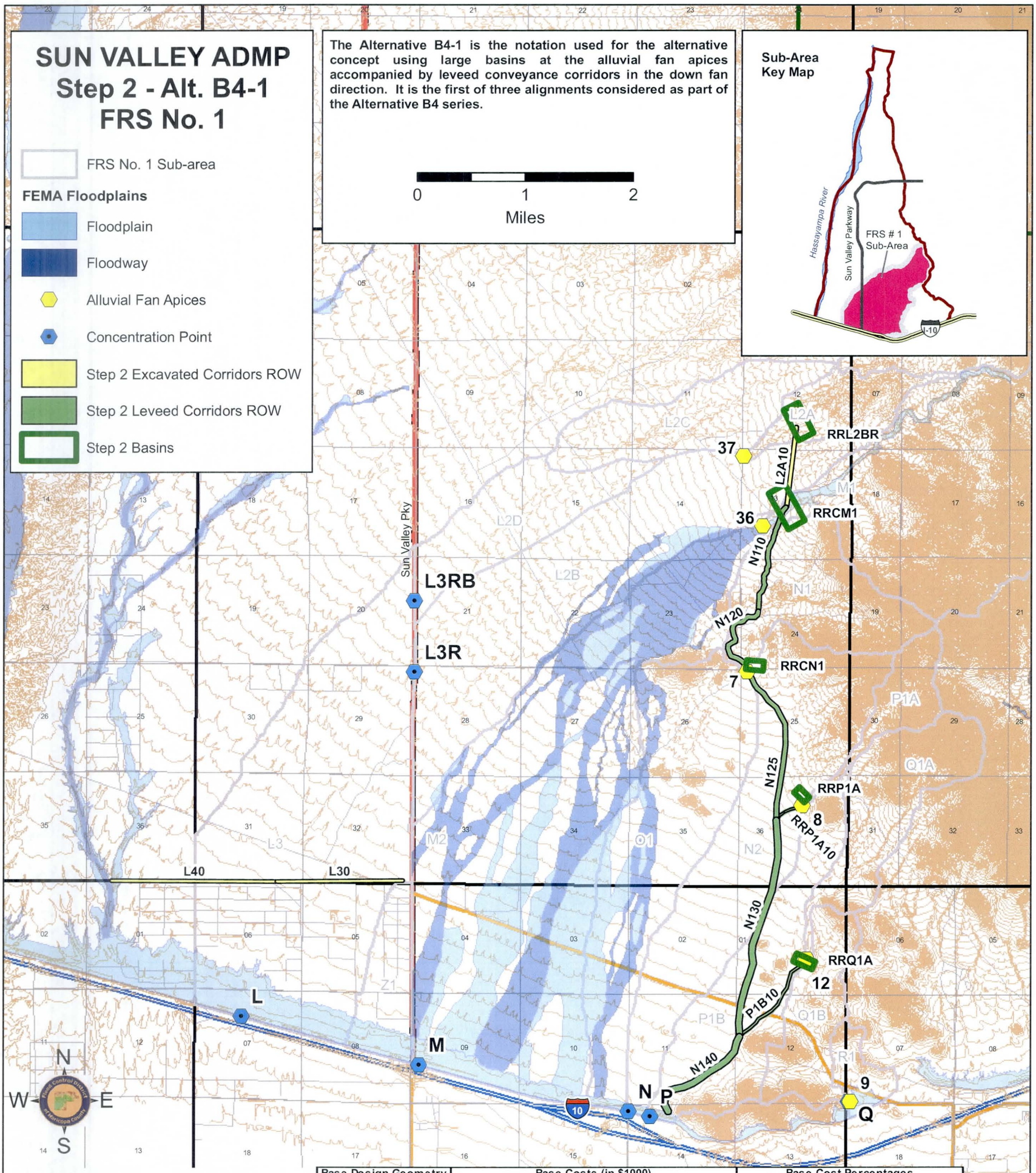
Step 2 Basins

The Alternative B4-1 is the notation used for the alternative concept using large basins at the alluvial fan apices accompanied by leveed conveyance corridors in the down fan direction. It is the first of three alignments considered as part of the Alternative B4 series.

0 1 2

Miles

Sub-Area Key Map



Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs ($1000): Land Cost	Base Costs ($1000): Constr. Cost	Base Costs ($1000): Lndscp Cost	Base Costs ($1000): 50 Yr Maint. Cost	Base Costs ($1000): Total Cost	Base Cost Percentages: Land Cost %	Base Cost Percentages: Constr. Cost %	Base Cost Percentages: Lndscp Cost %	Base Cost Percentages: 50 Yr Maint. Cost %	Base Cost Percentages: % of Total Cost
RRL2BR	Online Basin	237	30	581	0	1650	800	11	$ 3,030	$ 5,044	$ 1,320	$ 1,260	$ 10,654	28%	47%	12%	12%	10%
L2A10	Excavated Chl.	322	17	85	0	0.7	111	4	$ 1,730	$ 1,978	$ 236	$ 265	$ 4,210	41%	47%	6%	6%	4%
RRCM1	Online Basin	424	42	877	0	2000	910	11	$ 4,180	$ 7,533	$ 1,820	$ 1,727	$ 15,260	27%	49%	12%	11%	14%
N110	Leveed Chl.	875	29	0	31	1	232	5	$ 2,900	$ 2,346	$ 457	$ 1,079	$ 6,782	43%	35%	7%	16%	6%
N120	Leveed Chl.	1264	23	0	24	0.8	242	5	$ 2,340	$ 1,730	$ 355	$ 916	$ 5,341	44%	32%	7%	17%	5%
RRCN1	Online Basin	419	9	126	0	850	460	11	$ 900	$ 1,232	$ 391	$ 388	$ 2,912	31%	42%	13%	13%	3%
N125	Leveed Chl.	1257	45	0	46	1.5	242	5	$ 4,500	$ 3,233	$ 680	$ 1,648	$ 10,061	45%	32%	7%	16%	9%
RRP1A	Online Basin	87	6	62	0	700	360	8	$ 580	$ 643	$ 252	$ 254	$ 1,730	34%	37%	15%	15%	2%
N130	Leveed Chl.	1519	80	0	62	2.1	322	5	$ 8,020	$ 4,723	$ 912	$ 2,333	$ 15,988	50%	30%	6%	15%	15%
N140	Leveed Chl.	1605	43	0	38	1.1	328	5	$ 4,260	$ 2,410	$ 521	$ 1,366	$ 8,558	50%	28%	6%	16%	8%
RRQ1A	Online Basin	106	10	146	0	1000	420	11	$ 960	$ 1,358	$ 420	$ 419	$ 3,156	30%	43%	13%	13%	3%
P1B10	Leveed Chl.	303	15	0	29	1	127	5	$ 1,500	$ 1,811	$ 430	$ 1,016	$ 4,757	32%	38%	9%	21%	4%
L30	Excavated Chl.	2162	24	97	0	1.2	204	7	$ 2,360	$ 2,835	$ 940	$ 1,768	$ 7,903	30%	36%	12%	22%	7%
L40	Excavated Chl.	2162	31	121	0	1.5	204	7	$ 3,110	$ 2,896	$ 1,240	$ 1,182	$ 8,429	37%	34%	15%	14%	8%
RRP1A10	Leveed Chl.	87	3	0	8	0.3	97	5	$ 320	$ 530	$ 123	$ 279	$ 1,252	26%	42%	10%	22%	1%
	TOTAL	407	2095	238					$40,690	$ 40,305	$10,099	$ 15,900	**$ 106,994**	38%	38%	9%	15%	100%
All Channels		310	303	238	11.2				$31,040	$ 24,494	$ 5,896	$ 11,852	$ 73,282	42%	33%	8%	16%	68%
All Online Basins		97	1792	0					$ 9,650	$ 15,810	$ 4,203	$ 4,048	$ 33,712	29%	47%	12%	12%	32%
All Offline Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)		$6,543		Basins Cost per ac. ft. (in $1000)					$2.35									

Cost Increase for Landscape Compatibility Enhancement over Base Costs

All Channels % increase	27%	23%	136%				27%	61%	74%	87%	52%	
All Online Basins % increase	44%	9%	0%				45%	9%	45%	44%	28%	
All Offline Basins % increase	0%	0%	0%				0%	0%	0%	0%	0%	
Total % increase	31%	11%	136%				31%	40%	62%	76%	44%	

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Costs Summary

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs (in $1000): Land Cost	Base Costs (in $1000): Constr. Cost	Base Costs (in $1000): Lndscp Cost	Base Costs (in $1000): 50 Yr Maint. Cost	Base Costs (in $1000): Total Cost	Base Cost Percentages: Land Cost %	Base Cost Percentages: Constr. Cost %	Base Cost Percentages: Lndscp Cost %	Base Cost Percentages: 50 Yr Maint. Cost %	Base Cost Percentages: % of Total Cost
RRL2BR	Online Basin	237	30	581	0	1650	800	11	$ 3,030	$ 5,044	$ 1,320	$ 1,260	$ 10,654	28%	47%	12%	12%	10%
L2A10	Excavated Chl.	322	17	85	0	0.7	111	4	$ 1,730	$ 1,978	$ 236	$ 265	$ 4,210	41%	47%	6%	6%	4%
RRCM1	Online Basin	424	42	877	0	2000	910	11	$ 4,180	$ 7,533	$ 1,820	$ 1,727	$ 15,260	27%	49%	12%	11%	14%
N110	Leveed Chl.	875	29	0	31	1	232	5	$ 2,900	$ 2,346	$ 457	$ 1,079	$ 6,782	43%	35%	7%	16%	6%
N120	Leveed Chl.	1264	23	0	24	0.8	242	5	$ 2,340	$ 1,730	$ 355	$ 916	$ 5,341	44%	32%	7%	17%	5%
RRCN1	Online Basin	419	9	126	0	850	460	11	$ 900	$ 1,232	$ 391	$ 388	$ 2,912	31%	42%	13%	13%	3%
N125	Leveed Chl.	1257	45	0	46	1.5	242	5	$ 4,500	$ 3,233	$ 680	$ 1,648	$ 10,061	45%	32%	7%	16%	9%
RRP1A	Online Basin	87	6	62	0	700	360	8	$ 580	$ 643	$ 252	$ 254	$ 1,730	34%	37%	15%	15%	2%
N130	Leveed Chl.	1519	80	0	62	2.1	322	5	$ 8,020	$ 4,723	$ 912	$ 2,333	$ 15,988	50%	30%	6%	15%	15%
N140	Leveed Chl.	1605	43	0	38	1.1	328	5	$ 4,260	$ 2,410	$ 521	$ 1,366	$ 8,558	50%	28%	6%	16%	8%
RRQ1A	Online Basin	106	10	146	0	1000	420	11	$ 960	$ 1,358	$ 420	$ 419	$ 3,156	30%	43%	13%	13%	3%
P1B10	Leveed Chl.	303	15	0	29	1	127	5	$ 1,500	$ 1,811	$ 430	$ 1,016	$ 4,757	32%	38%	9%	21%	4%
L30	Excavated Chl.	2162	24	97	0	1.2	204	7	$ 2,360	$ 2,835	$ 940	$ 1,768	$ 7,903	30%	36%	12%	22%	7%
L40	Excavated Chl.	2162	31	121	0	1.5	204	7	$ 3,110	$ 2,896	$ 1,240	$ 1,182	$ 8,429	37%	34%	15%	14%	8%
RRP1A10	Leveed Chl.	87	3	0	8	0.3	97	5	$ 320	$ 530	$ 123	$ 279	$ 1,252	26%	42%	10%	22%	1%
	TOTAL	407	2095	238					$ 40,690	$ 40,305	$ 10,099	$ 15,900	**$ 106,994**	38%	38%	9%	15%	100%
All Channels		310	303	238	11.2				$ 31,040	$ 24,494	$ 5,896	$ 11,852	$ 73,282	42%	33%	8%	16%	68%
All Online Basins		97	1792	0					$ 9,650	$ 15,810	$ 4,203	$ 4,048	$ 33,712	29%	47%	12%	12%	32%
All Offline Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)		$6,543		Basins Cost per ac. ft. (in $1000)					$2.35									

Cost Summary - Landscape Compatibility Enhanced (LCE)

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	LCE Design Geometry: Length (stor-ft; chl-mi)	LCE Design Geometry: ROW Width (ft)	LCE Design Geometry: Depth (ft)	LCE Costs (in $1000): Land Cost	LCE Costs (in $1000): Constr. Cost	LCE Costs (in $1000): Lndscp Cost	LCE Costs (in $1000): 50 Yr Maint. Cost	LCE Costs (in $1000): Total Cost	LCE Cost Percentages: Land Cost %	LCE Cost Percentages: Constr. Cost %	LCE Cost Percentages: Lndscp Cost %	LCE Cost Percentages: 50 Yr Maint. Cost %	LCE Cost Percentages: % of Total Cost
RRL2BR	Online Basin	237	42	632	0	2030	900	11	$ 4,190	$ 5,476	$ 1,827	$ 1,736	$ 13,229	32%	41%	14%	13%	9%
L2A10	Excavated Chl.	322	24	113	0	0.7	266	4	$ 2,360	$ 2,572	$ 318	$ 341	$ 5,591	42%	46%	6%	6%	4%
RRCM1	Online Basin	424	56	959	0	2430	1010	11	$ 5,640	$ 8,218	$ 2,454	$ 2,322	$ 18,634	30%	44%	13%	12%	12%
N110	Leveed Chl.	875	35	0	73	1	283	5	$ 3,540	$ 4,135	$ 947	$ 2,354	$ 10,976	32%	38%	9%	21%	7%
N120	Leveed Chl.	1264	28	0	57	0.8	293	5	$ 2,830	$ 3,103	$ 735	$ 1,903	$ 8,571	33%	36%	9%	22%	6%
RRCN1	Online Basin	419	15	136	0	1140	560	11	$ 1,470	$ 1,320	$ 638	$ 623	$ 4,051	36%	33%	16%	15%	3%
N125	Leveed Chl.	1257	55	0	109	1.5	293	5	$ 5,450	$ 5,864	$ 1,410	$ 3,541	$ 16,265	34%	36%	9%	22%	11%
RRP1A	Online Basin	87	10	68	0	960	460	8	$ 1,020	$ 694	$ 442	$ 434	$ 2,589	39%	27%	17%	17%	2%
N130	Leveed Chl.	1519	93	0	146	2.1	373	5	$ 9,290	$ 8,270	$ 1,888	$ 4,872	$ 24,321	38%	34%	8%	20%	16%
N140	Leveed Chl.	1605	50	0	87	1.1	382	5	$ 4,960	$ 4,388	$ 1,054	$ 2,829	$ 13,232	37%	33%	8%	21%	9%
RRQ1A	Online Basin	106	17	165	0	1390	520	11	$ 1,660	$ 1,514	$ 723	$ 705	$ 4,601	36%	33%	16%	15%	3%
P1B10	Leveed Chl.	303	21	0	69	1	178	5	$ 2,100	$ 3,452	$ 891	$ 2,211	$ 8,655	24%	40%	10%	26%	6%
L30	Excavated Chl.	2162	36	116	0	1.2	257	7	$ 3,610	$ 3,224	$ 1,178	$ 1,988	$ 10,000	36%	32%	12%	20%	6%
L40	Excavated Chl.	2162	48	144	0	1.5	257	7	$ 4,750	$ 3,371	$ 1,555	$ 1,473	$ 11,149	43%	30%	14%	13%	7%
RRP1A10	Leveed Chl.	87	5	0	20	0.3	148	5	$ 490	$ 1,000	$ 255	$ 621	$ 2,366	21%	42%	11%	26%	2%
	TOTAL	535	2333	561					$ 53,360	$ 56,602	$ 16,315	$ 27,953	**$ 154,230**	35%	37%	11%	18%	100%
All Channels		395	373	561	11.2				$ 39,380	$ 39,380	$ 10,231	$ 22,133	$ 111,125	35%	35%	9%	20%	72%
All Online Basins		140	1960	0					$ 13,980	$ 17,221	$ 6,084	$ 5,820	$ 43,105	32%	40%	14%	14%	28%
All Offline Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)		$9,922		Basins Cost per ac. ft. (in $1000)					$3.10									
All Channels % increase		27%	23%	136%					27%	61%	74%	87%	52%					
All Online Basins % increase		44%	9%	0%					45%	9%	45%	44%	28%					
All Offline Basins % increase		0%	0%	0%					0%	0%	0%	0%	0%					
Total % increase		31%	11%	136%					31%	40%	62%	76%	44%					

Hydrology - 6-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
R1	BASIN	506			4.2	0.28	47	12	4	2	1.525	1.527	1.527	1.527	23	23	23	23
Q1B	BASIN	851			4.5	0.94	155	39	13	6	1.533	1.544	1.544	1.544	77	77	77	77
DUMMY	COMBINE	1020			4.5	1.22	192	48	16	7	1.459	1.469	1.469	1.469	95	96	96	96
L1	BASIN	2128			4.7	3.55	543	139	46	20	1.424	1.453	1.453	1.453	269	275	275	275
L1-L2A	ROUTE	2066	14.4	40.14	4.9	3.55	543	139	46	20	1.423	1.453	1.453	1.453	269	275	275	275
L2A	BASIN	692			4.5	0.69	113	28	9	4	1.516	1.516	1.516	1.516	56	56	56	56
L2BR	COMBINE	2391			4.9	4.24	623	159	53	23	1.366	1.391	1.391	1.391	309	314	314	314
RRL2BR	STORAGE	237	9.6	250.16	7.1	4.24	225	149	53	23	0.494	1.309	1.391	1.391	112	296	314	314
L2A-M1	ROUTE	237	100.3	4.58	7.3	4.24	225	149	53	23	0.494	1.309	1.391	1.391	112	296	314	314
M1	BASIN	2809			4.8	5.69	790	203	68	29	1.291	1.327	1.327	1.327	392	402	402	402
CM1	COMBINE	2665			4.9	9.92	894	320	111	48	0.837	1.197	1.243	1.243	443	634	658	658
RRCM1	STORAGE	399	8.6	310.77	7.5	9.92	387	298	111	48	0.363	1.118	1.243	1.243	192	592	658	658
M1-N1	ROUTE	399	100.7	24.91	8	9.92	387	298	111	48	0.363	1.116	1.243	1.243	192	591	658	658
N1	BASIN	1253			4.5	1.52	210	53	18	8	1.281	1.286	1.286	1.286	104	105	105	105
CN1	COMBINE	812			4.5	11.45	447	323	121	52	0.363	1.051	1.177	1.177	221	642	719	719
RRCN1	STORAGE	380	7.8	56.24	10.5	11.45	376	319	121	52	0.306	1.036	1.177	1.177	187	633	719	719
N1-P1A	ROUTE	380	100.7	22.57	10.9	11.45	376	318	121	52	0.306	1.033	1.177	1.177	187	631	719	719
N2A	BASIN	1253			4.5	1.52	210	53	18	8	1.281	1.286	1.286	1.286	104	105	105	105
CN2AR	COMBINE	777			4.5	12.97	434	341	131	56	0.311	0.979	1.124	1.124	215	677	777	777
P1A	BASIN	575			4.4	0.5	89	22	7	3	1.655	1.663	1.663	1.663	44	44	44	44
RRP1A	STORAGE	87	6.6	31.21	5.5	0.5	70	22	7	3	1.305	1.663	1.663	1.663	35	44	44	44
CN2A	COMBINE	821			4.5	13.47	482	354	135	58	0.333	0.977	1.116	1.116	239	702	802	802
P1A-1B	ROUTE	672	100.9	79.7	5.6	13.47	461	348	135	58	0.318	0.962	1.116	1.116	229	691	802	802
P1B	BASIN	852			5	1.94	244	62	21	9	1.172	1.194	1.194	1.194	121	123	123	123
PR	COMBINE	990			5.5	15.41	559	375	146	63	0.337	0.905	1.055	1.055	277	744	867	867
Q1A	BASIN	990			4.5	1.3	193	49	16	7	1.385	1.396	1.396	1.396	96	97	97	97
RRQ1A	STORAGE	106	9.7	73.8	6.2	1.3	97	48	16	7	0.698	1.386	1.396	1.396	48	96	97	97
Q1A-P	ROUTE	106	100.8	4.28	6.5	1.3	97	48	16	7	0.697	1.386	1.396	1.396	48	96	97	97
P	COMBINE	1049			5.6	16.71	626	403	155	67	0.348	0.897	1.032	1.032	310	799	920	920
N2B	BASIN	1193			5.1	3.33	366	93	31	13	1.023	1.045	1.045	1.045	181	185	185	185
O1	BASIN	1057			5.3	3.09	343	88	29	13	1.033	1.059	1.059	1.059	170	174	174	174
M2	BASIN	1849			5.4	7.44	633	159	53	23	0.791	0.795	0.795	0.795	314	315	315	315
Z1	BASIN	694			4.5	0.66	100	25	8	4	1.405	1.406	1.406	1.406	50	50	50	50
L2B	BASIN	1532			5	4.08	418	104	35	15	0.952	0.952	0.952	0.952	207	207	207	207
L2B-L3	ROUTE	1196	12.8	208.54	6.9	4.08	416	104	35	15	0.948	0.952	0.952	0.952	206	207	207	207
L2C	BASIN	754			4.8	1.33	161	40	13	6	1.125	1.125	1.125	1.125	80	80	80	80
L2C-2D	ROUTE	712	13	29.17	5.2	1.33	161	40	13	6	1.125	1.125	1.125	1.125	80	80	80	80
L2D	BASIN	706			4.7	1.23	136	34	11	5	1.025	1.025	1.025	1.025	67	67	67	67
L3RB	COMBINE	1043			5	2.56	260	65	22	9	0.945	0.946	0.946	0.946	129	129	129	129
L2D-L3	ROUTE	650	12.5	187.08	8.3	2.56	258	65	22	9	0.936	0.946	0.946	0.946	128	129	129	129
L3	BASIN	1832			5.2	5.85	581	146	49	21	0.923	0.926	0.926	0.926	288	289	289	289
L	COMBINE	1638			5.3	12.49	963	250	83	36	0.717	0.745	0.745	0.745	478	496	496	496

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
R1	BASIN	387			12.2	0.28	37	10	3	1	1.223	1.322	1.322	1.322	19	20	20	20
Q1B	BASIN	740			12.5	0.94	134	38	13	5	1.325	1.498	1.5	1.5	66	75	75	75
DUMMY	COMBINE	902			12.5	1.22	170	48	16	7	1.294	1.448	1.45	1.45	84	94	94	94
L1	BASIN	2267			12.7	3.55	527	150	50	22	1.382	1.572	1.576	1.576	261	297	298	298
L1-L2A	ROUTE	2154	14.4	41.37	12.9	3.55	527	150	50	22	1.381	1.571	1.576	1.576	261	297	298	298
L2A	BASIN	570			12.5	0.69	92	23	8	3	1.236	1.236	1.236	1.236	46	46	46	46
L2BR	COMBINE	2519			12.9	4.24	616	172	57	25	1.351	1.509	1.513	1.513	305	341	342	342
RRL2BR	STORAGE	236	9.5	247.85	15.1	4.24	226	157	57	25	0.496	1.377	1.513	1.513	112	311	342	342
L2A-M1	ROUTE	236	100.3	4.56	15.3	4.24	226	157	57	25	0.496	1.376	1.513	1.513	112	311	342	342
M1	BASIN	3301			12.8	5.69	825	236	79	34	1.349	1.543	1.548	1.548	409	468	469	469
CM1	COMBINE	3400			12.8	9.92	1003	374	135	59	0.94	1.403	1.522	1.522	497	742	805	806
RRCM1	STORAGE	424	9.7	351.97	15.7	9.92	415	339	135	59	0.389	1.271	1.522	1.522	206	673	805	806
M1-N1	ROUTE	424	100.7	25.88	16.1	9.92	415	339	135	59	0.389	1.269	1.522	1.522	206	672	805	806
N1	BASIN	1211			12.5	1.52	192	52	17	7	1.172	1.269	1.27	1.27	95	103	103	103
CN1	COMBINE	1264			12.5	11.45	518	378	151	65	0.421	1.227	1.471	1.471	257	749	898	898
RRCN1	STORAGE	419	9.5	69.82	18.3	11.45	417	369	151	65	0.339	1.2	1.471	1.471	207	733	898	898
N1-P1A	ROUTE	419	100.8	23.89	18.7	11.45	417	369	151	65	0.339	1.198	1.47	1.471	207	731	898	898
N2A	BASIN	1211			12.5	1.52	192	52	17	7	1.172	1.269	1.27	1.27	95	103	103	103
CN2AR	COMBINE	1257			12.5	12.97	531	407	166	72	0.38	1.165	1.429	1.43	263	806	989	989
P1A	BASIN	441			12.4	0.5	73	21	7	3	1.351	1.542	1.545	1.545	36	41	41	41
RRP1A	STORAGE	77	5.1	23.93	13.5	0.5	61	21	7	3	1.136	1.535	1.545	1.545	30	41	41	41
CN2A	COMBINE	1309			12.5	13.47	588	424	172	74	0.406	1.17	1.427	1.427	292	841	1025	1026
P1A-1B	ROUTE	976	101.1	100.28	13.4	13.47	564	418	172	74	0.389	1.155	1.427	1.427	279	830	1025	1026
P1B	BASIN	842			13	1.94	231	61	20	9	1.108	1.174	1.175	1.175	114	121	121	121
PR	COMBINE	1540			13.2	15.41	726	463	190	82	0.438	1.118	1.376	1.376	360	919	1130	1131
Q1A	BASIN	915			12.5	1.3	173	48	16	7	1.242	1.372	1.374	1.374	86	95	95	95
RRQ1A	STORAGE	100	8.7	65.43	14.1	1.3	92	47	16	7	0.66	1.334	1.374	1.374	46	92	95	95
Q1A-P	ROUTE	100	100.7	4.14	14.5	1.3	92	47	16	7	0.659	1.334	1.374	1.374	46	92	95	95
P	COMBINE	1605			13.2	16.71	808	504	204	88	0.45	1.122	1.362	1.362	401	1000	1213	1213
N2B	BASIN	1331			13.1	3.33	378	99	33	14	1.057	1.102	1.103	1.103	187	195	196	196
O1	BASIN	1163			13.3	3.09	349	91	30	13	1.05	1.095	1.096	1.096	173	180	180	180
M2	BASIN	2347			13.4	7.44	786	198	66	29	0.983	0.989	0.99	0.99	390	392	392	392
Z1	BASIN	558			12.5	0.66	80	21	7	3	1.127	1.161	1.161	1.161	40	41	41	41
L2B	BASIN	1700			13	4.08	449	112	37	16	1.024	1.024	1.024	1.024	223	223	223	223
L2B-L3	ROUTE	1323	12.9	226.51	14.8	4.08	447	112	37	16	1.02	1.024	1.024	1.024	222	223	223	223
L2C	BASIN	692			12.8	1.33	145	36	12	5	1.013	1.013	1.013	1.013	72	72	72	72
L2C-2D	ROUTE	651	12.9	27.24	13.2	1.33	145	36	12	5	1.013	1.013	1.013	1.013	72	72	72	72
L2D	BASIN	655			12.7	1.23	124	31	10	4	0.934	0.934	0.934	0.934	61	61	61	61
L3RB	COMBINE	1104			13	2.56	266	66	22	10	0.965	0.965	0.965	0.965	132	132	132	132
L2D-L3	ROUTE	705	12.5	201.22	16.1	2.56	263	66	22	10	0.956	0.965	0.965	0.965	130	132	132	132
L3	BASIN	2129			13.2	5.85	658	166	56	24	1.045	1.058	1.058	1.058	326	330	330	330
L	COMBINE	2162			13.3	12.49	1287	335	112	48	0.958	0.997	0.997	0.997	638	664	664	664

Channels Hydraulics Summary

		Design Geometry						Hydraulics										
Structure ID	Type	Initial Slope (ft/ft)	Long-term Slope (ft/ft)	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Chnl Mannings n	Flow Rate (cfs)	Wetted Perimeter (ft)	Wetted XS Area (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flow Depth (ft)	Freeboard (ft)	Top Width (ft)	Velocity (ft/s)	Froude Number	Shear Stress (lb/sq. ft)
L2A10	Excavated	0.0128	0.0060	0.70	3	3.5	0.045	322	56.1	90.9	1.6	1.6	2.5	1.0	55	3.5	0.49	0.95
N110	Leveed	0.0234	0.0080	1.00	3	4.5	0.045	875	156.9	166.1	1.1	1.1	1.1	3.4	157	5.3	0.90	0.54
N120	Leveed	0.0129	0.0050	0.80	3	4.5	0.045	1264	169.8	255.6	1.5	1.5	1.6	2.9	169	4.9	0.71	0.48
N125	Leveed	0.0131	0.0050	1.50	3	4.5	0.045	1257	169.7	253.6	1.5	1.5	1.5	3.0	169	5.0	0.71	0.48
N130	Leveed	0.0132	0.0050	2.10	3	4.5	0.045	1519	248.6	330.2	1.3	1.3	1.4	3.1	248	4.6	0.70	0.42
N140	Leveed	0.0072	0.0040	1.10	3	5.0	0.045	1605	250.6	410.5	1.6	1.6	1.7	3.3	250	3.9	0.54	0.42
P1B10	Leveed	0.0112	0.0060	1.00	3	4.5	0.045	303	54.2	71.7	1.3	1.3	1.5	3.0	54	4.2	0.64	0.54
L30	Excavated	0.0048	0.0048	1.20	3	6.5	0.045	2162	146.5	447.6	3.1	3.1	5.0	1.5	145	4.8	0.48	1.49
L40	Excavated	0.0040	0.0040	1.50	3	6.5	0.045	2162	147.7	474.3	3.2	3.2	5.2	1.3	146	4.6	0.45	1.29
RRP1A10	Leveed	0.0196	0.0090	0.30	3	4.5	0.045	87	21.9	20.0	0.9	0.9	1.1	3.4	22	4.4	0.80	0.61

Basins Hydraulics Summary

			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac.	Peak Inflow into Basin (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Freeboard (ft)
RRL2BR	Online Basin	0.0240	1650	800	11.0	261.7	250.2	342.0	2519	237	9.6	1.4
RRCM1	Online Basin	0.0250	2000	910	11.0	363.5	352.0	806.0	3400	424	9.7	1.3
RRCN1	Online Basin	0.0210	850	460	11.0	73.9	69.8	898.0	1264	419	9.5	1.5
RRP1A	Online Basin	0.0222	700	360	8.0	33.4	31.2	44.0	575	87	6.6	1.4
RRQ1A	Online Basin	0.0300	1000	420	11.0	76.6	73.8	97.0	990	106	9.7	1.3

Online Basin

HEC1 ID	RRL2BR

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	4.2	sq. mi
Total Sediment Yield Volume	8.1	ac ft

Required Minimum Sediment Volume

Sediment Volume	8.1	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.024	0.024
Basin Length (ft)	1650	1930
Basin Width (ft)	800	800
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	11	11
Freeboard (ft)	1	1
Effective Basin Width (ft)	742	685
Top Area (acres)	30.3	35.4
U/S-D/S Height Difference (ft)	19.2	19.2
Excess Area on Upstream (acres)	2.3	5.2

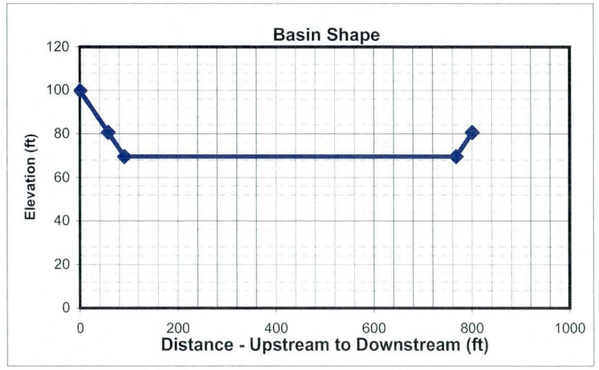
			Base	LC Enhanced
Bottom Length (ft)	1584	Allocated Storage Volume (ac. ft)	261.7	261.7
Bottom Width (ft)	676	Total Available Volume (ac. ft) (incl. Freeboard)	289.6	291.7
		Total Excavation Volume (ac. ft)	580.7	632.2

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	4.50	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	2	4	6	7	8	9	10	11	13
Volume	0.00	49.79	100.84	153.15	179.79	206.76	234.04	261.66	289.60	346.47
Outflow	0.0	108.3	153.2	187.6	202.6	216.6	229.7	242.2	254.0	276.1



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	314.0	342	342.0
Peak Inflow (cfs)	2391	2519	2519.0
Peak Outflow (cfs)	237	236	237.0
Stage at Peak Outflow (ft)	9.6	9.5	9.6
Volume at Peak Outflow (ac. ft)	250.2	247.85	250.2

Volume Check

Total Volume needed	258.3	ac. ft
Total Volume Provided	261.7	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	10.6	ft
Depth Provided	11	ft
Depth OK?	Yes	

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	507000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	1650	ft
Base Total ROW Width	800	ft
LC Enh. Total ROW Length	2030	ft
LC Enh. Total ROW Length	900	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	936863	1019949
Excavated Area (sq. Yd)	146667	203000

Inlet			***Outlet***		
Inlet Type	Riprap		Outlet Type	Pipe	
(Riprap, Concrete)			(None, Riprap Weir, Concrete Weir, Pipe)		
			Pipe Length	579	ft
Inlet Length	96	ft	Unit Cost	160	per ft
Inlet Width	100	ft	Cost per outlet	$92,640	
Material Thickness	1.5	ft	Other Cost	$ -	
Inlet Area	1061	sq. Yd	Total Cost	$92,640	
Material Volume	531	cu. Yd	Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		936,863	cu. Yd	$ 4.00	$ 3,747,452	146,667	sq. Yd	$ 9.00	$ 1,320,003	146,667	sq. Yd	$ 8.33	$ 1,222,225
Basin - LC Enhancement		83,086	cu. Yd	$ 4.00	$ 332,344	56,333	sq. Yd	$ 9.00	$ 506,997	56,333	sq. Yd	$ 8.33	$ 469,442
Inlet	Riprap	531	sq. Yd	$ 75.00	$ 39,825	1,061	sq. Yd	$ -	$ -	1,061	sq. Yd	$ 33.33	$ 35,367
Inlet - LC Enhancement (20%Inlet)					$ 7,965				$ -				$ 7,073
Outlet	Pipe	1	EA	$ 92,640	$ 92,640	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 4,632				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,320,003	Base Maintenance Cost			$ 1,259,808
						LC Enh. Landscape Cost			$ 506,997	LC Enh. Maintenance Cost			$ 476,626
						Total Landscape Cost			$ 1,827,000	Total Maintenance Cost			$ 1,736,434

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,879,917	$ 332,344	$ 4,212,261
Contingency Cost (25% of Construction Cost)	$ 969,979	$ 83,086	$ 1,053,065
Engineering Design Cost (5% of Construction Cost)	$ 193,996	$ 16,617	$ 210,613
Total Construction Cost	$ 5,043,892	$ 432,047	$ 5,475,939

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	11.6	$100,000	$ 1,160,000
Basin	30.3	$100,000	$ 3,030,000
Other		$100,000	$ -
Total	41.9	$100,000	$ 4,190,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	30.3	$100,000	$ 3,030,000
LC Enhancement Cost	acre	11.6	$100,000	$ 1,160,000
Total Land Cost	acre	41.9	$100,000	$ 4,190,000

Total Cost

Base Total Cost	$ 10,653,703
Total LC Enhancement Cost	$ 2,575,670
Total Cost Including LC Enh.	$ 13,229,373

Open Channel

Structure ID	L2A10

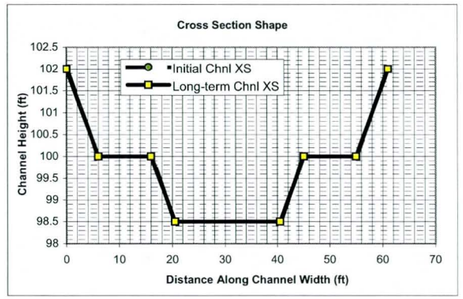
HEC1 ID	L2A-M1

Longitudinal Geometry

Length	3875.0	ft
U/S Elev	1616.0	ft
D/S Elev	1566.2	ft
Initial Channel Slope	0.0128	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	3



Initial Channel XS Geometry

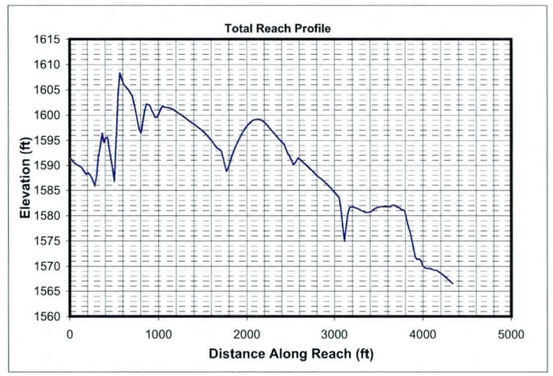
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	2	10	3	20	3.5	3	10	2	3

PT. ID	1	2	3	4	5	6	7	8
X	0	6	16	20.5	40.5	45	55	61
Y	102	100	100	98.5	98.5	100	100	102

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	2	10	3	20	3.5	3	10	2	3

PT. ID	1	2	3	4	5	6	7	8
X	0	6	16	20.5	40.5	45	55	61
Y	102	100	100	98.5	98.5	100	100	102



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RRL2BR	L2B							TOTAL
HEC1 Peak-Flow	237	1700							1937
Weighting Factor	1.00	0.05							
Flow into Channel	237	85							322

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	0.5	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	322	cfs	
Long-term Max. Chnl Capacity	667	cfs	
Q2 Channel	32	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	61	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
32	24.7	16.4	0.7	98.5	99.2	2.0	0.7	24.4	0.7	0.28	0.42
97	28.8	33.8	1.2	98.5	99.9	2.9	1.4	28.4	1.2	0.52	0.46
242	54.3	75.5	1.4	98.5	100.8	3.2	2.3	53.5	1.4	0.84	0.47
322	56.1	90.9	1.6	98.5	101.0	3.5	2.5	55.2	1.6	0.95	0.49

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
32	24.7	16.4	0.7	98.5	99.2	2.0	0.7	24.4	0.7	0.28	0.42
97	28.8	33.8	1.2	98.5	99.9	2.9	1.4	28.4	1.2	0.52	0.46
242	54.3	75.5	1.4	98.5	100.8	3.2	2.3	53.5	1.4	0.84	0.47
322	56.1	90.9	1.6	98.5	101.0	3.5	2.5	55.2	1.6	0.95	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
32										0
97										0
242										0
322										0

Allowable Velocity

Channel Lining: Natural - Coarse Gravel (noncolloidal)

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
32	1.74	1.2733	1.2097	Erosive	Erosive	Erosive	0.3	Stable	3.7	Stable	Stable
97	1.74	1.4496	1.3772	Erosive	Erosive	Erosive	0.3	Stable	5.6	Stable	Stable
242	1.74	1.5016	1.4265	Erosive	Erosive	Erosive	0.4	Stable	7.3	Stable	Stable
322	1.74	1.5492	1.4717	Erosive	Erosive	Erosive	0.4	Stable	7.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	6

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	32	97	242	322	32	97	242	322	32	97	242	322
Bray - Equation #1	15	26	43	50	0.8	1.2	1.7	1.8	2.6	3.0	3.4	3.5
Bray - Equation #2	19	35	56	65	0.9	1.3	1.8	2.0	1.8	2.1	2.3	2.4
Hey	4	8	13	15	2.4	3.7	5.2	5.8				
Ackers & Charlton/Lacey	15	25	36	41					1.4	1.7	2.0	2.1
Parker	39	68	107	123	0.6	0.9	1.4	1.5				
Chang	23	45	79	94	0.2	0.1	0.0	0.0				
Kellerhals	10	18	28	32	1.1	1.7	2.4	2.7	2.9	3.2	3.5	3.6
AMAFCA/Schumm	24	28	54	55								
Moody & Odem	9	9	9	9	0.9	0.9	0.9	0.9				
BUREC	9.4	14.3	20.1	22.4	3	4	5	6	2.1	2.8	3.5	3.8
Average	17	28	44	51	1.2	1.7	2.3	2.6	2.2	2.6	3.0	3.1
Values As Designed	24	28	54	55	0.7	1.4	2.3	2.5	2.0	2.9	3.2	3.5
Difference with Design	-8	-1	-9	-4	0.4	0.3	0.1	0.0	0.2	-0.3	-0.2	-0.4

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
32	105	73	156	530	551	27	19	19	838	53	238	237
97	521	291	574	3087	920	176	87	120	2598	237	1202	892
242	1527	763	1489	9407	1916	520	234	356	6528	670	3432	2440
322	2339	1074	2053	15005	2162	793	324	543	8735	997	5099	3557

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
32	1205	839	1793	6111	6351	312	214	214	9653	614	2746	2732
97	2003	1118	2206	11858	3531	676	335	461	9978	909	4616	3427
242	2347	1172	2287	14452	2943	799	359	547	10029	1029	5273	3749
322	2694	1237	2366	17289	2491	914	373	626	10064	1149	5875	4098

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
32	105	61	96	169	313	18	19	19	242	25	114	107
97	521	255	410	986	562	113	87	120	799	114	613	416
242	1527	675	1045	3003	1190	328	234	356	2027	327	1782	1136
322	2339	956	1434	4790	1360	492	324	543	2730	495	2687	1650

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
32	1205	701	1103	1951	3608	212	214	214	2784	284	1319	1236
97	2003	979	1574	3785	2160	434	335	461	3070	437	2356	1599
242	2347	1037	1605	4613	1829	503	359	547	3115	502	2737	1745
322	2694	1102	1652	5519	1567	567	373	626	3146	570	3096	1901

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
32	0.0014	0.0018	172	0.53	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0010	0.0110	0.0008	0.0028	0.0059	0.0047
97	0.0007	0.0010	229	0.70	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0110	0.0005	0.0012	0.0059	0.0045
242	0.0006	0.0009	249	0.76	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0110	0.0003	0.0006	0.0059	0.0044
322	0.0005	0.0007	269	0.82	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0110	0.0003	0.0005	0.0059	0.0044

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	26.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	431	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.21	sq. mi
Total Sediment Yield Volume	0.40	ac ft

Sedimentation Basins

Length	431 ft	Depth	3 ft
Width	61 ft	Side slope	3 ft/ft
Total Volume per Basin		1.51	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
32	1.1	-0.3	0.1	24.6	0.7	0.7	2.0	0.0060	0.1	0.0	1.5	2.1
97	1.1	-0.4	0.1	24.6	1.4	1.2	2.9	0.0060	0.1	0.0	1.5	2.2
242	1.1	-0.7	0.1	24.6	2.3	1.4	3.2	0.0060	0.2	0.0	1.5	2.4
322	1.1	-0.7	0.2	24.6	2.5	1.6	3.5	0.0060	0.3	0.0	1.5	2.4

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	237	cfs
Stage at Peak Flow	100.3	ft
Volume at Peak Flow	342.0	ac. ft

Freeboard

Max. Flow Depth	2.5	ft
Channel Depth as designed	3.5	ft
Available Freeboard	1.0	ft
Required Freeboard	1	ft

Sediment Volume

Inflowing Sediment Volume	0.40	ac. ft
Outflowing Sediment Volume	0.25	ac. ft
Deposited(+)/Eroded(-) Volume	0.16	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	3875	3875
Side Slope (?H:1V)	3	6
Channel Width (ft)	61	82
Channel XS Area (sq. ft)	146.8	183.55
Channel Perimeter (ft)	62	82

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	137182	182430
Excavated Area (sq. Yd)	26264	35306

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3875	ft
Thickness	1.5	ft
Protection Depth	3	ft
Tie-in Length/Depth	3.0	ft
Total Depth	6.0	ft
Area needed	646	sq. Yd
Volume	1292	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3875	3875
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	3875	3875
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	61	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.4	ft
Structure Height	9.4	ft
Number of Structures	9	
Volume per structure	64	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 4,800	
Area per structure	20	sq. Yd
Total Area	183	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	2436	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 9,744	
Other Cost	$ -	
Total cost per basin	$ 9,744	
Area per basin	2,918	sq. Yd
Total Area	2,918	sq. Yd

Structure Type	Structure Cost											
	Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	137,182	cu. Yd	$ 10.00	$ 1,371,820	26,264	sq. Yd	$ 9.00	$ 236,376	26,264	sq. Yd	$ 8.33	$ 218,867
Exc. Chl - LC Enhancement	Excavated	45,248	cu. Yd	$ 10.00	$ 452,480	9,042	sq. Yd	$ 9.00	$ 81,378	9,042	sq. Yd	$ 8.33	$ 75,350
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,292	cu. Yd	$ 75.00	$ 96,900	646	sq. Yd	$ -	$ -	646	sq. Yd	$ 25.00	$ 16,150
Drop Structures	Riprap	9	EA	$ 4,800.00	$ 43,200	183	sq. Yd	$ -	$ -	183	sq. Yd	$ 33.33	$ 6,100
Drop Str. - LC Enhancement	Riprap	9	EA	$ 480.00	$ 4,320	18	sq. Yd	$ -	$ -	18	sq. Yd	$ 33.33	$ 610
Sedimentation Basins		1	EA	$ 9,744.00	$ 9,744	2,918	sq. Yd	$ -	$ -	2,918	sq. Yd	$ 8.33	$ 24,317
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 236,376	Base Maintenance Cost			$ 265,433
						LC Enhancement Cost			$ 81,378	LC Enhancement Cost			$ 75,960
						Total Landscape Cost			$ 317,754	Total Maintenance Cost			$ 341,393

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,521,664	$ 456,800	$ 1,978,464
Contingency Cost (25% of Construction Cost)	$ 380,416	$ 114,200	$ 494,616
Engineering Design Cost (5% of Construction Cost)	$ 76,083	$ 22,840	$ 98,923
Total Construction Cost	$ 1,978,163	$ 593,840	$ 2,572,003

Land Cost

Channel Length	3875	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	11.9	$100,000	$ 1,190,000
LC Enhancement Buffer	50	4.4	$100,000	$ 440,000
Channel	61	5.4	$100,000	$ 540,000
Channel LC Enhancement	21	1.9	$100,000	$ 190,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	266	23.6		$ 2,360,000

Total Cost

Base Total Cost	$ 4,209,973
Total Landscape Enhancement Cost	$ 1,381,178
Total Cost Including LC Enh.	$ 5,591,151

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	17.3	$100,000	$ 1,730,000
LC Enhancement Cost	acre	6.3	$100,000	$ 630,000
Total Land Cost	acre	23.6	$100,000	$ 2,360,000

Online Basin

HEC1 ID	RRCM1

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID	L2A-M1						Total Volume (ac. ft)
Inflow Volume (ac. ft)	342						342
Volume Fraction	1						
Weighted Volume	342						342
Sediment Conc. (ppm)	1901						
Sediment Volume (ac. ft)	0.25						0.25
Weighting Factor	1						
Weighted Sed. Vol. (ac. ft)	0.25						0.25

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	5.7	sq. mi
Total Sediment Yield Volume	10.8	ac ft

Required Minimum Sediment Volume

Sediment Volume	11.0	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.025	0.025
Basin Length (ft)	2000	2330
Basin Width (ft)	910	910
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	11	11
Freeboard (ft)	1	1
Effective Basin Width (ft)	842	774
Top Area (acres)	41.8	48.7
U/S-D/S Height Difference (ft)	22.8	22.8
Excess Area on Upstream (acres)	3.3	7.4

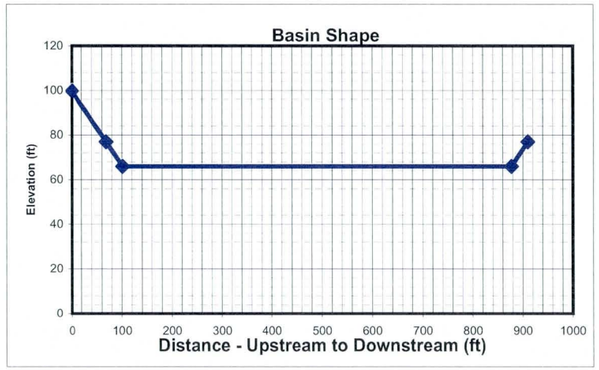
			Base	LC Enhanced
Bottom Length (ft)	1934	Allocated Storage Volume (ac. ft)	363.5	364.2
Bottom Width (ft)	776	Total Available Volume (ac. ft) (incl. Freeboard)	401.9	405.1
		Total Excavation Volume (ac. ft)	877.4	959

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	6.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	3	5	6	7	8	10	12	14
Volume	0.00	34.64	105.05	176.97	213.50	250.41	287.71	363.47	440.79	519.68
Outflow	0.0	136.1	235.8	304.4	333.5	360.2	385.1	430.5	471.6	509.4



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	658.0	806	806.0
Peak Inflow (cfs)	2665	3400	3400.0
Peak Outflow (cfs)	399	424	424.0
Stage at Peak Outflow (ft)	8.6	9.7	9.7
Volume at Peak Outflow (ac. ft)	310.8	351.97	352.0

Volume Check

Total Volume needed	363.0	ac. ft
Total Volume Provided	363.5	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	10.7	ft
Depth Provided	11	ft
Depth OK?	Yes	

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	634300	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	2000	ft
Base Total ROW Width	910	ft
LC Enh. Total ROW Length	2430	ft
LC Enh. Total ROW Length	1010	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	1415539	1547187
Excavated Area (sq. Yd)	202222	272700

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	107	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	1188	sq. Yd
Material Volume	594	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	550	ft
Unit Cost	160	per ft
Cost per outlet	$88,000	
Other Cost	$ -	
Total Cost	$88,000	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		1,415,539	cu. Yd	$ 4.00	$ 5,662,156	202,222	sq. Yd	$ 9.00	$ 1,819,998	202,222	sq. Yd	$ 8.33	$ 1,685,183
Basin - LC Enhancement		131,648	cu. Yd	$ 4.00	$ 526,592	70,478	sq. Yd	$ 9.00	$ 634,302	70,478	sq. Yd	$ 8.33	$ 587,317
Inlet	Riprap	594	sq. Yd	$ 75.00	$ 44,550	1,188	sq. Yd	$ -	$ -	1,188	sq. Yd	$ 33.33	$ 39,600
Inlet - LC Enhancement (20%Inlet)					$ 8,910				$ -				$ 7,920
Outlet	Pipe	1	EA	$ 88,000	$ 88,000	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 4,400				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,819,998	Base Maintenance Cost			$ 1,727,000
						LC Enh. Landscape Cost			$ 634,302	LC Enh. Maintenance Cost			$ 595,348
						Total Landscape Cost			$ 2,454,300	Total Maintenance Cost			$ 2,322,348

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 5,794,706	$ 526,592	$ 6,321,298
Contingency Cost (25% of Construction Cost)	$ 1,448,677	$ 131,648	$ 1,580,325
Engineering Design Cost (5% of Construction Cost)	$ 289,735	$ 26,330	$ 316,065
Total Construction Cost	$ 7,533,118	$ 684,570	$ 8,217,687

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	14.6	$100,000	$ 1,460,000
Basin	41.8	$100,000	$ 4,180,000
Other		$100,000	$ -
Total	56.4	$100,000	$ 5,640,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	41.8	$100,000	$ 4,180,000
LC Enhancement Cost	acre	14.6	$100,000	$ 1,460,000
Total Land Cost	acre	56.4	$100,000	$ 5,640,000

Total Cost

Base Total Cost	$ 15,260,116
Total LC Enhancement Cost	$ 3,374,219
Total Cost Including LC Enh.	$ 18,634,335

Open Channel

Structure ID	N110

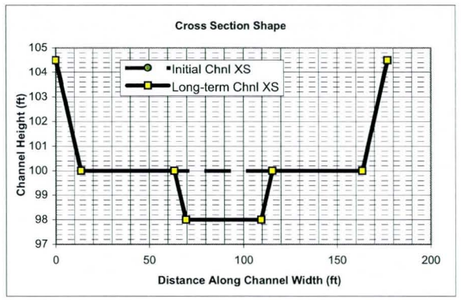
HEC1 ID	M1-N1

Longitudinal Geometry

Length	5444.1	ft
U/S Elev	1565.0	ft
D/S Elev	1437.4	ft
Initial Channel Slope	0.0234	ft/ft
Long-term Channel Slope	0.0080	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	4



Initial Channel XS Geometry

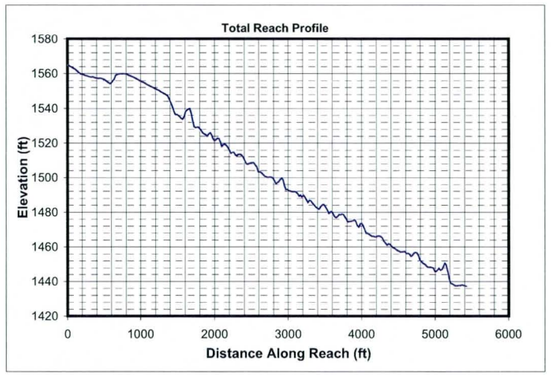
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	150	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	163.5	163.5	163.5	177
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	50	3	40	6.5	3	48	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	63.5	69.5	109.5	115.5	163.5	177
Y	104.5	100	100	98	98	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RRCM1	N1								TOTAL
HEC1 Peak-Flow	424	1253								1677
Weighting Factor	1.00	0.36								
Flow into Channel	424	451								875

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	11.45	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	875	cfs	
Long-term Max. Chnl Capacity	6802	cfs	
Q2 Channel	88	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	177	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
88	151.7	41.2	0.3	100.0	100.3	2.1	0.3	151.6	0.3	0.14	0.72
263	153.3	79.9	0.5	100.0	100.5	3.3	0.5	153.2	0.5	0.26	0.80
656	155.8	139.4	0.9	100.0	100.9	4.7	0.9	155.5	0.9	0.46	0.88
875	156.9	166.1	1.1	100.0	101.1	5.3	1.1	156.5	1.1	0.54	0.90

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
88	45.2	35.0	0.8	98.0	98.8	2.5	0.8	44.9	0.8	0.41	0.50
263	50.0	70.5	1.4	98.0	99.6	3.7	1.6	49.5	1.4	0.79	0.55
656	154.8	192.0	1.2	98.0	100.7	3.4	2.7	153.9	1.2	1.33	0.54
875	156.3	229.0	1.5	98.0	100.9	3.8	2.9	155.4	1.5	1.45	0.55

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
88										0
263										0
656										0
875										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
88	1.74	0.9937	0.9440	Erosive	Erosive	Erosive	0.2	Stable	4.6	Stable	Stable
263	1.74	1.1949	1.1351	Erosive	Erosive	Erosive	0.3	Stable	7.1	Stable	Stable
656	1.74	1.3618	1.2937	Erosive	Erosive	Erosive	0.3	Stable	9.0	Stable	Stable
875	1.74	1.4139	1.3432	Erosive	Erosive	Erosive	0.3	Stable	9.6	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	88	263	656	875	88	263	656	875	88	263	656	875
Bray - Equation #1	25	45	73	85	1.2	1.7	2.3	2.5	3.0	3.4	3.9	4.1
Bray - Equation #2	33	59	95	111	1.3	1.9	2.5	2.8	2.0	2.4	2.7	2.8
Hey	7	14	23	27	3.5	5.4	7.6	8.5				
Ackers & Charlton/Lacey	24	37	55	62					1.7	2.0	2.4	2.5
Parker	64	111	176	203	0.9	1.4	2.0	2.3				
Chang	46	91	158	188	0.1	-0.1	-0.4	-0.6				
Kellerhals	17	29	46	53	1.6	2.5	3.6	4.1	3.2	3.6	3.9	4.0
AMAFCA/Schumm	45	50	154	156								
Moody & Odem	31	31	31	31	1.4	1.4	1.4	1.4				
BUREC	13.0	19.6	27.7	30.8	3	5	7	8	3.0	4.0	5.0	5.4
Average	31	49	84	95	1.7	2.4	3.3	3.7	2.6	3.1	3.6	3.8
Values As Designed	45	49	154	155	0.8	1.6	2.7	2.9	2.5	3.7	3.4	3.8
Difference with Design	-14	-1	-70	-61	0.9	0.8	0.7	0.8	0.1	-0.6	0.2	-0.1

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
88	1210	764	1805	2448	2764	462	377	207	5601	395	1301	1576
263	6615	2932	6067	15739	4322	2350	1380	1271	17433	1694	6755	6051
656	27032	8310	14031	73927	6062	8387	3545	4662	44059	6122	23780	19992
875	42012	11418	18543	119993	6717	12460	4707	6861	58851	9215	34783	29597

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
88	5132	3238	7652	10378	11721	1958	1600	877	23747	1675	5514	6681
263	9350	4145	8574	22245	6108	3321	1950	1796	24639	2394	9547	8552
656	15282	4698	7932	41793	3427	4741	2004	2636	24908	3461	13444	11302
875	17813	4841	7862	50877	2848	5283	1996	2909	24953	3907	14748	12549

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
88	528	284	508	973	807	128	106	110	1102	123	609	480
263	2721	1081	1695	5884	1335	628	383	594	3455	590	3012	1944
656	6083	2489	4136	12629	3816	1436	941	1341	8586	1329	6859	4513
875	9441	3530	5724	20459	4286	2159	1293	2050	11534	2030	10371	6625

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
88	2239	1204	2155	4125	3421	543	448	466	4673	521	2582	2034
263	3845	1528	2395	8316	1887	887	541	840	4884	834	4257	2747
656	3439	1407	2338	7139	2157	812	532	758	4854	751	3877	2551
875	4003	1497	2427	8675	1817	915	548	869	4891	861	4397	2809

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
88	0.0026	0.0045	149	0.45	0.048	0.0010	30	0.036	0.0007	0.0159	0.0009	0.0022	0.0079	0.0005	0.0030	0.0234	0.0085
263	0.0012	0.0023	206	0.63	0.051	0.0005	31	0.036	0.0004	0.0159	0.0005	0.0011	0.0079	0.0003	0.0013	0.0234	0.0082
656	0.0006	0.0014	270	0.82	0.053	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0006	0.0079	0.0002	0.0007	0.0234	0.0080
875	0.0005	0.0011	293	0.89	0.054	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0079	0.0002	0.0005	0.0234	0.0080

Drop Structures

Design Slope	0.0080	ft/ft
Total Drop Needed	84.0	ft
Height of Drop Structure	3	ft
No . of Drop Structures	29	
Distance between structs.	188	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.54	sq. mi
Total Sediment Yield Volume	1.03	ac ft

Sedimentation Basins

Length	188 ft	Depth	3 ft
Width	177 ft	Side slope	3 ft/ft
Total Volume per Basin		2.07	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
88	1.1	-0.3	0.1	24.6	0.8	0.8	2.5	0.0080	0.1	1.5	2.0	4.7
263	1.1	-0.4	0.2	24.6	1.6	1.4	3.7	0.0080	0.2	1.5	2.0	4.9
656	1.1	-0.8	0.2	24.6	2.7	1.2	3.4	0.0080	0.3	1.5	2.0	5.0
875	1.1	-0.8	0.2	24.6	2.9	1.5	3.8	0.0080	0.3	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	424	cfs
Stage at Peak Flow	100.7	ft
Volume at Peak Flow	806.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.4	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.03	ac. ft
Outflowing Sediment Volume	0.85	ac. ft
Deposited(+)/Eroded(-) Volume	0.18	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5444	5444
Side Slope (?H:1V)	3	3
Channel Width (ft)	177	177
Channel XS Area (sq. ft)	827.8	827.8
Channel Perimeter (ft)	179	179

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5444	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1815	sq. Yd
Volume	5444	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5444	5444
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	25405	52625
Left Levee Volume (cu. Yd)	25002	58876
Right Levee Length (ft)	5444	5444
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	25405	52625
Right Levee Volume (cu. Yd)	25002	58876
Total Levee Surface Area (sq. Yd)	50810	105250
Total Levee Volume (cu. Yd)	50004	117752

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5444	5444
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	8468	19961
Left Levee Lining Volume (cu. Yd)	4234	9981
Right Levee Length (ft)	5444	5444
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	8468	19961
Right Levee Lining Volume (cu. Yd)	4234	9981
Total Lining Area (sq. Yd)	16937	39923
Total Lining Volume (cu. Yd)	8468	19962

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	177	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.3	ft
Structure Height	9.3	ft
Number of Structures	29	
Volume per structure	183	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 13,725	
Area per structure	59	sq. Yd
Total Area	1,711	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	3340	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 13,360	
Other Cost	$ -	
Total cost per basin	$ 13,360	
Area per basin	3,692	sq. Yd
Total Area	3,692	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	50,004	cu. Yd	$ 7.00	$ 350,028	50,810	sq. Yd	$ 9.00	$ 457,290	50,810	sq. Yd	$ 11.67	$ 592,783
Levee - LC Enhancement	Fill	67,748	cu. Yd	$ 7.00	$ 474,236	54,440	sq. Yd	$ 9.00	$ 489,960	67,748	sq. Yd	$ 11.67	$ 790,393
Levee Lining	Riprap	8,468	cu. Yd	$ 75.00	$ 635,100	16,937	sq. Yd	$ -	$ -	16,937	sq. Yd	$ 20.83	$ 352,852
Levee Lining -LC Enhancement	Riprap	11,494	cu. Yd	$ 75.00	$ 862,050	22,986	sq. Yd	$ -	$ -	22,986	sq. Yd	$ 20.83	$ 478,870
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	5,444	cu. Yd	$ 75.00	$ 408,300	1,815	sq. Yd	$ -	$ -	1,815	sq. Yd	$ 25.00	$ 45,375
Drop Structures	Riprap	29	EA	$ 13,725.00	$ 398,025	1,711	sq. Yd	$ -	$ -	1,711	sq. Yd	$ 33.33	$ 57,033
Drop Str. - LC Enhancement	Riprap	29	EA	$ 1,372.50	$ 39,803	171	sq. Yd	$ -	$ -	171	sq. Yd	$ 33.33	$ 5,703
Sedimentation Basins		1	EA	$ 13,360.00	$ 13,360	3,692	sq. Yd	$ -	$ -	3,692	sq. Yd	$ 8.33	$ 30,767
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 457,290	Base Maintenance Cost			$ 1,078,810
						LC Enhancement Cost			$ 489,960	LC Enhancement Cost			$ 1,274,967
						Total Landscape Cost			$ 947,250	Total Maintenance Cost			$ 2,353,777

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,804,813	$ 1,376,089	$ 3,180,902
Contingency Cost (25% of Construction Cost)	$ 451,203	$ 344,022	$ 795,225
Engineering Design Cost (5% of Construction Cost)	$ 90,241	$ 68,804	$ 159,045
Total Construction Cost	$ 2,346,257	$ 1,788,915	$ 4,135,172

Land Cost

Channel Length	5444	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	177	22.1	$100,000	$ 2,210,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	6.9	$100,000	$ 690,000
Levee LC Enhancement	51	6.4	$100,000	$ 640,000
Other	0	0	$100,000	$ -
Total	283	35.4		$ 3,540,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	29	$100,000	$ 2,900,000
LC Enhancement Cost	acre	6.4	$100,000	$ 640,000
Total Land Cost	acre	35.4	$100,000	$ 3,540,000

Total Cost

Base Total Cost	$ 6,782,357
Total Landscape Enhancement Cost	$ 4,193,842
Total Cost Including LC Enh.	$ 10,976,199

Open Channel

Structure ID	N120

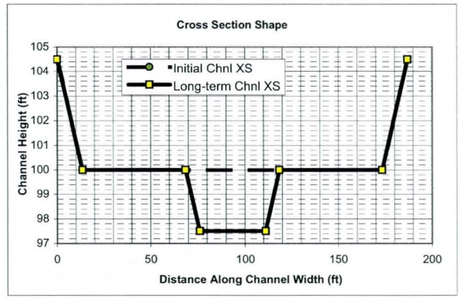
HEC1 ID	M1-N1

Longitudal Geometry

Length	4224.1	ft
U/S Elev	1437.4	ft
D/S Elev	1382.8	ft
Initial Channel Slope	0.0129	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	4



Initial Channel XS Geometry

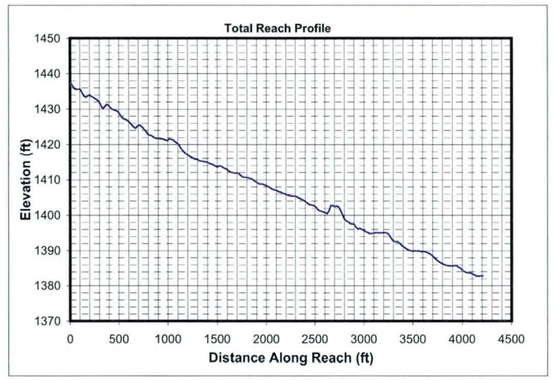
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	160	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	173.5	173.5	173.5	187
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	55	3	35	7	3	55	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	68.5	76	111	118.5	173.5	187
Y	104.5	100	100	97.5	97.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	CN1								TOTAL
HEC1 Peak-Flow	1264								1264
Weighting Factor	1.00								
Flow into Channel	1264								1264

Reach Sediment Inflow Characteristics

U/S Contributing ID	M1-N1_N110								TOTAL
Flow Volume (ac. ft)	806.00								806
Sediment Conc. (ppm)	2809								
Sediment Volume (ac. ft)	0.85								0.85
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.85								0.85

Hydrology

Drainage Area	11.45	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	1264	cfs	
Long-term Max. Chnl Capacity	5816	cfs	
Q2 Channel	126	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	187	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
126	162.5	63.1	0.4	100.0	100.4	2.0	0.4	162.3	0.4	0.12	0.57
379	164.8	122.6	0.7	100.0	100.8	3.1	0.8	164.5	0.7	0.24	0.63
948	168.3	214.3	1.3	100.0	101.3	4.4	1.3	167.8	1.3	0.41	0.69
1264	169.8	255.6	1.5	100.0	101.6	4.9	1.6	169.3	1.5	0.48	0.71

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
126	43.0	49.3	1.1	97.5	98.8	2.6	1.3	42.6	1.2	0.40	0.42
379	50.2	101.4	2.0	97.5	99.9	3.7	2.4	49.4	2.1	0.75	0.46
948	167.7	284.6	1.7	97.5	101.1	3.3	3.6	166.6	1.7	1.12	0.45
1264	169.8	339.9	2.0	97.5	101.4	3.7	3.9	168.5	2.0	1.22	0.46

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)								TOTAL
	M1-N1_N110								
126	480								480
379	1944								1944
948	4513								4513
1264	6625								6625

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
126	1.74	1.1041	1.0489	Erosive	Erosive	Erosive	0.2	Stable	4.8	Stable	Stable
379	1.74	1.3047	1.2395	Erosive	Erosive	Erosive	0.3	Stable	7.3	Stable	Stable
948	1.74	1.4708	1.3972	Erosive	Erosive	Erosive	0.3	Stable	8.7	Stable	Stable
1264	1.74	1.5225	1.4463	Erosive	Erosive	Erosive	0.4	Stable	9.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	126	379	948	1264	126	379	948	1264	126	379	948	1264
Bray - Equation #1	30	54	88	103	1.3	1.9	2.6	2.9	3.1	3.6	4.1	4.3
Bray - Equation #2	40	71	116	135	1.5	2.1	2.9	3.1	2.1	2.5	2.8	3.0
Hey	9	17	28	33	4.1	6.2	8.7	9.7				
Ackers & Charlton/Lacey	27	44	64	72					1.8	2.2	2.5	2.6
Parker	77	134	212	244	1.0	1.6	2.4	2.7				
Chang	50	97	170	202	0.2	0.0	-0.2	-0.4				
Kellerhals	20	35	55	64	1.9	2.9	4.2	4.7	3.3	3.7	4.0	4.2
AMAFCA/Schumm	43	49	167	169								
Moody & Odem	31	31	31	31	1.4	1.4	1.4	1.4				
BUREC	16.3	24.6	34.7	38.7	4	7	9	10	2.8	3.7	4.6	5.0
Average	34	56	97	109	2.0	2.8	3.9	4.3	2.6	3.1	3.6	3.8
Values As Designed	43	49	167	169	1.3	2.4	3.6	3.9	2.6	3.7	3.3	3.7
Difference with Design	-8	6	-70	-59	0.7	0.4	0.3	0.4	0.1	-0.6	0.3	0.1

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
126	904	562	1120	1635	2480	255	232	148	3198	254	985	1070
379	4926	2298	4170	10489	3987	1428	954	1009	10202	1172	5422	4187
948	20063	6707	10497	49092	5685	5171	2545	3854	25966	4405	19820	13982
1264	31143	9279	13687	79563	6328	7684	3405	5722	34725	6697	29302	20685

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
126	2653	1650	3288	4799	7278	750	681	436	9385	744	2891	3141
379	4820	2249	4080	10262	3901	1397	933	987	9982	1147	5305	4096
948	7852	2625	4108	19212	2225	2023	996	1508	10162	1724	7757	5472
1264	9141	2724	4017	23353	1857	2255	999	1680	10192	1966	8601	6071

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
126	497	259	402	868	724	98	83	114	774	106	586	410
379	2484	991	1375	5061	1247	481	311	594	2448	511	2865	1670
948	5354	2265	3348	10282	3727	1061	753	1292	6052	1100	6278	3774
1264	8296	3230	4611	16628	4207	1606	1047	1982	8155	1690	9560	5546

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
126	1459	761	1179	2548	2125	287	245	336	2272	311	1719	1204
379	2430	970	1345	4952	1220	471	304	581	2395	500	2803	1634
948	2095	887	1310	4024	1458	415	295	506	2368	431	2457	1477
1264	2435	948	1353	4880	1235	471	307	582	2394	496	2806	1628

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Sif (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
126	0.0021	0.0031	132	0.40	0.047	0.0007	30	0.035	0.0005	0.0159	0.0007	0.0016	0.0069	0.0004	0.0023	0.0129	0.0055
379	0.0009	0.0016	183	0.56	0.050	0.0004	31	0.036	0.0003	0.0159	0.0003	0.0008	0.0069	0.0003	0.0010	0.0129	0.0052
948	0.0005	0.0010	239	0.73	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0069	0.0002	0.0005	0.0129	0.0051
1264	0.0004	0.0008	260	0.79	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0069	0.0001	0.0004	0.0129	0.0051

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	33.5	ft
Height of Drop Structure	3	ft
No . of Drop Structures	12	
Distance between structs.	352	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.98	sq. mi
Total Sediment Yield Volume	1.87	ac ft

Sedimentation Basins

Length	352 ft	Depth	3 ft
Width	187 ft	Side slope	3 ft/ft
Total Volume per Basin		4.21	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
126	1.1	-0.4	0.1	24.6	1.3	1.2	2.6	0.0050	0.1	1.5	2.5	5.4
379	1.1	-0.7	0.2	24.6	2.4	2.1	3.7	0.0050	0.3	1.5	2.5	5.7
948	1.1	-1.0	0.2	24.6	3.6	1.7	3.3	0.0050	0.4	1.5	2.5	5.8
1264	1.1	-1.1	0.2	24.6	3.9	2.0	3.7	0.0050	0.4	1.5	2.5	5.9

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	424	cfs
Stage at Peak Flow	100.7	ft
Volume at Peak Flow	806.0	ac. ft

Freeboard

Max. Flow Depth	1.6	ft
Channel Depth as designed	4.5	ft
Available Freeboard	2.9	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	2.72	ac. ft
Outflowing Sediment Volume	0.50	ac. ft
Deposited(+)/Eroded(-) Volume	2.22	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	4224	4224
Side Slope (?H:1V)	3	3
Channel Width (ft)	187	187
Channel XS Area (sq. ft)	887	887
Channel Perimeter (ft)	189	189

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	4224	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1408	sq. Yd
Volume	4224	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	4224	4224
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	19712	40832
Left Levee Volume (cu. Yd)	19399	45682
Right Levee Length (ft)	4224	4224
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	19712	40832
Right Levee Volume (cu. Yd)	19399	45682
Total Levee Surface Area (sq. Yd)	39424	81664
Total Levee Volume (cu. Yd)	38798	91364

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	4224	4224
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	6571	15488
Left Levee Lining Volume (cu. Yd)	3285	7744
Right Levee Length (ft)	4224	4224
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	6571	15488
Right Levee Lining Volume (cu. Yd)	3285	7744
Total Lining Area (sq. Yd)	13141	30976
Total Lining Volume (cu. Yd)	6570	15488

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	187	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	7.4	ft
Structure Height	10.4	ft
Number of Structures	12	
Volume per structure	217	cu. Yd
Other Cost	$ 75.00	cu. Yd
Cost per structure	$ 16,275	
Area per structure	62	sq. Yd
Total Area	748	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	6792	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 27,168	
Other Cost	$ -	
Total cost per basin	$ 27,168	
Area per basin	7,314	sq. Yd
Total Area	14,628	sq. Yd

Structure Type	Structure Cost											
	Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	38,798	cu. Yd	$ 7.00	$ 271,586	39,424	sq. Yd	$ 9.00	$ 354,816	39,424	sq. Yd	$ 11.67	$ 459,947
Levee - LC Enhancement	Fill	52,566	cu. Yd	$ 7.00	$ 367,962	42,240	sq. Yd	$ 9.00	$ 380,160	52,566	sq. Yd	$ 11.67	$ 613,270
Levee Lining	Riprap	6,570	cu. Yd	$ 75.00	$ 492,750	13,141	sq. Yd	$ -	$ -	13,141	sq. Yd	$ 20.83	$ 273,778
Levee Lining -LC Enhancement	Riprap	8,918	cu. Yd	$ 75.00	$ 668,850	17,835	sq. Yd	$ -	$ -	17,835	sq. Yd	$ 20.83	$ 371,556
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	4,224	cu. Yd	$ 75.00	$ 316,800	1,408	sq. Yd	$ -	$ -	1,408	sq. Yd	$ 25.00	$ 35,200
Drop Structures	Riprap	12	EA	$ 16,275.00	$ 195,300	748	sq. Yd	$ -	$ -	748	sq. Yd	$ 33.33	$ 24,933
Drop Str. - LC Enhancement	Riprap	12	EA	$ 1,627.50	$ 19,530	75	sq. Yd	$ -	$ -	75	sq. Yd	$ 33.33	$ 2,493
Sedimentation Basins		2	EA	$ 27,168.00	$ 54,336	14,628	sq. Yd	$ -	$ -	14,628	sq. Yd	$ 8.33	$ 121,900
Other					$ -				$ -				$ -

Base Landscape Cost	$ 354,816	Base Maintenance Cost	$ 915,758
LC Enhancement Cost	$ 380,160	LC Enhancement Cost	$ 987,319
Total Landscape Cost	$ 734,976	Total Maintenance Cost	$ 1,903,077

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 1,330,772	$ 1,056,342	$ 2,387,114
Contingency Cost (25% of Construction Cost)	$ 332,693	$ 264,086	$ 596,779
Engineering Design Cost (5% of Construction Cost)	$ 66,539	$ 52,817	$ 119,356
Total Construction Cost	$ 1,730,004	$ 1,373,245	$ 3,103,248

Land Cost

Channel Length	4224 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	187	18.1	$100,000	$ 1,810,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	5.3	$100,000	$ 530,000
Levee LC Enhancement	51	4.9	$100,000	$ 490,000
Other	0	0	$100,000	$ -
Total	293	28.3		$ 2,830,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	23.4	$100,000	$ 2,340,000
LC Enhancement Cost	acre	4.9	$100,000	$ 490,000
Total Land Cost	acre	28.3	$100,000	$ 2,830,000

Total Cost

Base Total Cost	$ 5,340,577
Total Landscape Enhancement Cost	$ 3,230,723
Total Cost Including LC Enh.	$ 8,571,301

Online Basin

HEC1 ID	RRCN1

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID	M1-N1						Total Volume (ac. ft)
Inflow Volume (ac. ft)	806						806
Volume Fraction	1						
Weighted Volume	806						806
Sediment Conc. (ppm)	1634						
Sediment Volume (ac. ft)	0.50						0.50
Weighting Factor	1						
Weighted Sed. Vol. (ac. ft)	0.50						0.50

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.5	sq. mi
Total Sediment Yield Volume	2.9	ac ft

Required Minimum Sediment Volume

Sediment Volume	3.4	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.021	0.021
Basin Length (ft)	850	1040
Basin Width (ft)	460	460
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	11	11
Freeboard (ft)	1	1
Effective Basin Width (ft)	431	402
Top Area (acres)	9.0	11.0
U/S-D/S Height Difference (ft)	9.7	9.7
Excess Area on Upstream (acres)	0.6	1.4

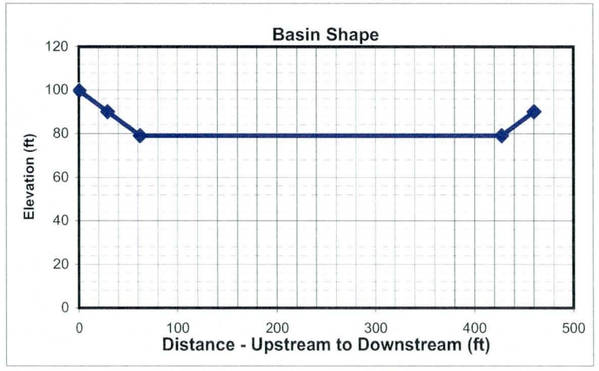
			Base	LC Enhanced
Bottom Length (ft)	784	Allocated Storage Volume (ac. ft)	73.9	73.6
Bottom Width (ft)	365	Total Available Volume (ac. ft) (incl. Freeboard)	82.2	83
		Total Excavation Volume (ac. ft)	125.6	136.1

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	6.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	3	5	6	7	8	9	11	13
Volume	0.00	6.65	20.43	34.86	42.32	49.96	57.76	65.73	82.20	99.38
Outflow	0.0	136.1	235.8	304.4	333.5	360.2	385.1	408.4	451.5	490.9



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	719.0	898	898.0
Peak Inflow (cfs)	812	1264	1264.0
Peak Outflow (cfs)	380	419	419.0
Stage at Peak Outflow (ft)	7.8	9.5	9.5
Volume at Peak Outflow (ac. ft)	56.2	69.82	69.8

Volume Check

Total Volume needed	73.2	ac. ft
Total Volume Provided	73.9	ac. ft

Volume OK?	Yes

Stage Check

Depth Needed	10.5	ft
Depth Provided	11	ft

Depth OK?	Yes

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	247400	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	850	ft
Base Total ROW Width	460	ft
LC Enh. Total ROW Length	1140	ft
LC Enh. Total ROW Length	560	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	202635	219575
Excavated Area (sq. Yd)	43444	70933

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	65	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	727	sq. Yd
Material Volume	364	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	688	ft
Unit Cost	160	per ft
Cost per outlet	$110,080	
Other Cost	$ -	
Total Cost	$110,080	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost	
Basin		202,635	cu. Yd	$ 4.00	$ 810,540	43,444	sq. Yd	$ 9.00	$ 390,996	43,444	sq. Yd	$ 8.33	$ 362,033	
Basin - LC Enhancement		16,940	cu. Yd	$ 4.00	$ 67,760	27,489	sq. Yd	$ 9.00	$ 247,401	27,489	sq. Yd	$ 8.33	$ 229,075	
Inlet	Riprap	364	sq. Yd	$ 75.00	$ 27,300	727	sq. Yd	$ -	$ -	727	sq. Yd	$ 33.33	$ 24,233	
Inlet - LC Enhancement (20%Inlet)					$ 5,460				$ -				$ 4,847	
Outlet	Pipe	1	EA	$ 110,080	$ 110,080	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217	
Outlet - LC Enhancement (5% Outlet)					$ 5,504				$ -				$ 111	
Other					$ -				$ -				$ -	
						Base Landscape Cost			$ 390,996	Base Maintenance Cost			$ 388,483	
						LC Enh. Landscape Cost			$ 247,401	LC Enh. Maintenance Cost			$ 234,033	
						Total Landscape Cost			$ 638,397	Total Maintenance Cost			$ 622,516	

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 947,920	$ 67,760	$ 1,015,680
Contingency Cost (25% of Construction Cost)	$ 236,980	$ 16,940	$ 253,920
Engineering Design Cost (5% of Construction Cost)	$ 47,396	$ 3,388	$ 50,784
Total Construction Cost	$ 1,232,296	$ 88,088	$ 1,320,384

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	5.7	$100,000	$ 570,000
Basin	9.0	$100,000	$ 900,000
Other		$100,000	$ -
Total	14.7	$100,000	$ 1,470,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	9.0	$100,000	$ 900,000
LC Enhancement Cost	acre	5.7	$100,000	$ 570,000
Total Land Cost	acre	14.7	$100,000	$ 1,470,000

Total Cost

Base Total Cost	$ 2,911,775
Total LC Enhancement Cost	$ 1,139,522
Total Cost Including LC Enh.	$ 4,051,297

Open Channel

Structure ID	N125

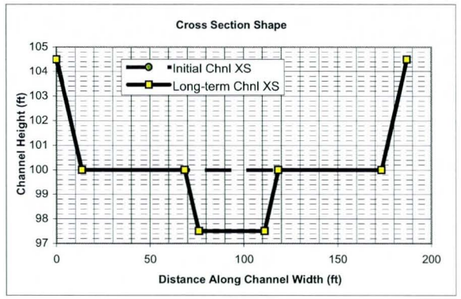
HEC1 ID	N1-P1A

Longitudal Geometry

Length	8101.2	ft
U/S Elev	1382.8	ft
D/S Elev	1276.4	ft
Initial Channel Slope	0.0131	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	4



Initial Channel XS Geometry

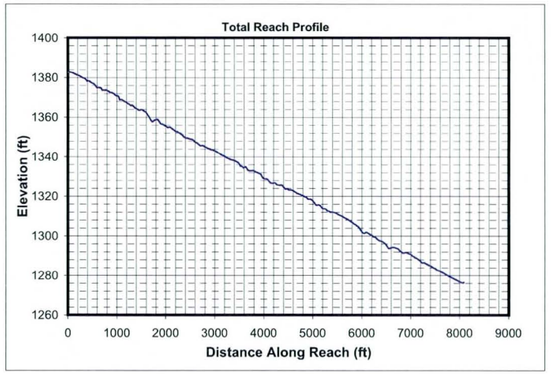
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	160	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	173.5	173.5	173.5	187
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	55	3	35	7	3	55	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	68.5	76	111	118.5	173.5	187
Y	104.5	100	100	97.5	97.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	CN2AR									TOTAL
HEC1 Peak-Flow	1257									1257
Weighting Factor	1.00									
Flow into Channel	1257									1257

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)	0.00									0.00
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	12.97	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	1257	cfs	
Long-term Max. Chnl Capacity	5816	cfs	
Q2 Channel	126	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	187	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
126	162.5	62.6	0.4	100.0	100.4	2.0	0.4	162.3	0.4	0.12	0.57
377	164.7	121.6	0.7	100.0	100.7	3.1	0.7	164.5	0.7	0.23	0.64
943	168.2	212.6	1.3	100.0	101.3	4.4	1.3	167.8	1.3	0.40	0.69
1257	169.7	253.6	1.5	100.0	101.5	5.0	1.5	169.2	1.5	0.48	0.71

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
126	43.0	49.1	1.1	97.5	98.8	2.6	1.3	42.6	1.2	0.39	0.42
377	50.1	101.0	2.0	97.5	99.9	3.7	2.4	49.4	2.0	0.75	0.46
943	167.7	283.6	1.7	97.5	101.1	3.3	3.6	166.5	1.7	1.12	0.45
1257	169.8	338.7	2.0	97.5	101.4	3.7	3.9	168.5	2.0	1.22	0.46

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
126										0
377										0
943										0
1257										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
126	1.74	1.1017	1.0466	Erosive	Erosive	Erosive	0.2	Stable	4.8	Stable	Stable
377	1.74	1.3024	1.2373	Erosive	Erosive	Erosive	0.3	Stable	7.3	Stable	Stable
943	1.74	1.4684	1.3950	Erosive	Erosive	Erosive	0.3	Stable	8.7	Stable	Stable
1257	1.74	1.5201	1.4441	Erosive	Erosive	Erosive	0.4	Stable	9.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	126	377	943	1257	126	377	943	1257	126	377	943	1257
Bray - Equation #1	30	54	88	102	1.3	1.9	2.6	2.9	3.1	3.6	4.1	4.3
Bray - Equation #2	40	71	115	134	1.5	2.1	2.9	3.1	2.1	2.5	2.8	2.9
Hey	9	17	28	33	4.0	6.1	8.7	9.7				
Ackers & Charlton/Lacey	27	43	64	72					1.8	2.2	2.5	2.6
Parker	77	133	211	244	1.0	1.6	2.4	2.7				
Chang	49	97	169	202	0.2	0.0	-0.2	-0.4				
Kellerhals	20	35	55	64	1.9	2.9	4.2	4.7	3.3	3.7	4.0	4.2
AMAFCA/Schumm	43	49	167	169								
Moody & Odem	32	32	32	32	1.4	1.4	1.4	1.4				
BUREC	16.3	24.6	34.6	38.6	4	7	9	10	2.8	3.7	4.6	5.0
Average	34	56	96	109	2.0	2.8	3.9	4.3	2.6	3.1	3.6	3.8
Values As Designed	43	49	167	168	1.3	2.4	3.6	3.9	2.6	3.7	3.3	3.7
Difference with Design	-8	6	-70	-59	0.7	0.4	0.3	0.4	0.1	-0.6	0.3	0.1

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
126	915	569	1139	1661	2493	261	236	151	3257	258	997	1085
377	4985	2322	4225	10653	4006	1452	966	1019	10383	1188	5480	4243
943	20316	6772	10611	49869	5708	5259	2577	3890	26419	4465	20010	14172
1257	31537	9366	13840	80827	6352	7815	3446	5774	35328	6786	29574	20968

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
126	2701	1680	3362	4902	7359	770	697	444	9614	760	2944	3203
377	4904	2284	4157	10481	3941	1429	951	1002	10215	1169	5391	4175
943	7995	2665	4176	19625	2246	2070	1014	1531	10397	1757	7875	5577
1257	9308	2764	4085	23856	1875	2306	1017	1704	10427	2003	8729	6189

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
126	493	257	399	860	722	97	83	113	769	105	581	407
377	2464	985	1367	5017	1244	477	309	589	2434	507	2843	1658
943	5309	2250	3328	10187	3718	1052	748	1282	6017	1091	6226	3746
1257	8226	3208	4582	16474	4197	1593	1040	1966	8109	1676	9484	5505

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
126	1455	759	1177	2539	2131	286	244	335	2271	311	1714	1202
377	2424	969	1345	4936	1223	470	304	580	2395	499	2797	1631
943	2089	885	1310	4009	1463	414	294	504	2368	429	2450	1474
1257	2428	947	1352	4862	1239	470	307	580	2393	495	2799	1625

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
126	0.0021	0.0031	132	0.40	0.047	0.0007	30	0.035	0.0005	0.0159	0.0007	0.0016	0.0070	0.0004	0.0023	0.0131	0.0055
377	0.0009	0.0016	183	0.56	0.050	0.0004	31	0.036	0.0003	0.0159	0.0003	0.0008	0.0070	0.0003	0.0010	0.0131	0.0053
943	0.0005	0.0010	240	0.73	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0070	0.0002	0.0005	0.0131	0.0052
1257	0.0004	0.0008	261	0.79	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0070	0.0001	0.0004	0.0131	0.0051

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	65.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	22	
Distance between structs.	368	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.48	sq. mi
Total Sediment Yield Volume	2.81	ac ft

Sedimentation Basins

Length	368 ft	Depth	3 ft
Width	187 ft	Side slope	3 ft/ft
Total Volume per Basin		4.41	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
126	1.1	-0.4	0.1	24.6	1.3	1.2	2.6	0.0050	0.1	1.5	2.5	5.4
377	1.1	-0.7	0.2	24.6	2.4	2.0	3.7	0.0050	0.3	1.5	2.5	5.7
943	1.1	-1.0	0.2	24.6	3.6	1.7	3.3	0.0050	0.4	1.5	2.5	5.8
1257	1.1	-1.1	0.2	24.6	3.9	2.0	3.7	0.0050	0.4	1.5	2.5	5.9

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	419	cfs
Stage at Peak Flow	100.8	ft
Volume at Peak Flow	898.0	ac. ft

Freeboard

Max. Flow Depth	1.5	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	2.81	ac. ft
Outflowing Sediment Volume	0.55	ac. ft
Deposited(+)/Eroded(-) Volume	2.26	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	8101	8101
Side Slope (?H:1V)	3	3
Channel Width (ft)	187	187
Channel XS Area (sq. ft)	887	887
Channel Perimeter (ft)	189	189

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	8101	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	2700	sq. Yd
Volume	8101	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	8101	8101
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	37805	78310
Left Levee Volume (cu. Yd)	37205	87611
Right Levee Length (ft)	8101	8101
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	37805	78310
Right Levee Volume (cu. Yd)	37205	87611
Total Levee Surface Area (sq. Yd)	75610	156620
Total Levee Volume (cu. Yd)	74410	175222

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	8101	8101
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	12602	29704
Left Levee Lining Volume (cu. Yd)	6301	14852
Right Levee Length (ft)	8101	8101
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	12602	29704
Right Levee Lining Volume (cu. Yd)	6301	14852
Total Lining Area (sq. Yd)	25203	59407
Total Lining Volume (cu. Yd)	12602	29704

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	187	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	7.4	ft	
Structure Height	10.4	ft	
Number of Structures	22		
Volume per structure	216	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 16,200		
Area per structure	62	sq. Yd	
Total Area	1,371	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	7115	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 28,460	
Other Cost	$ -	
Total cost per basin	$ 28,460	
Area per basin	7,651	sq. Yd
Total Area	15,302	sq. Yd

Structure Type	Structure Cost											
	Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	74,410	cu. Yd	$ 7.00	$ 520,870	75,610	sq. Yd	$ 9.00	$ 680,490	75,610	sq. Yd	$ 11.67	$ 882,117
Levee - LC Enhancement	Fill	100,812	cu. Yd	$ 7.00	$ 705,684	81,010	sq. Yd	$ 9.00	$ 729,090	100,812	sq. Yd	$ 11.67	$ 1,176,140
Levee Lining	Riprap	12,602	cu. Yd	$ 75.00	$ 945,150	25,203	sq. Yd	$ -	$ -	25,203	sq. Yd	$ 20.83	$ 525,065
Levee Lining -LC Enhancement	Riprap	17,102	cu. Yd	$ 75.00	$ 1,282,650	34,204	sq. Yd	$ -	$ -	34,204	sq. Yd	$ 20.83	$ 712,588
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	8,101	cu. Yd	$ 75.00	$ 607,575	2,700	sq. Yd	$ -	$ -	2,700	sq. Yd	$ 25.00	$ 67,500
Drop Structures	Riprap	22	EA	$ 16,200.00	$ 356,400	1,371	sq. Yd	$ -	$ -	1,371	sq. Yd	$ 33.33	$ 45,700
Drop Str. - LC Enhancement	Riprap	22	EA	$ 1,620.00	$ 35,640	137	sq. Yd	$ -	$ -	137	sq. Yd	$ 33.33	$ 4,570
Sedimentation Basins		2	EA	$ 28,460.00	$ 56,920	15,302	sq. Yd	$ -	$ -	15,302	sq. Yd	$ 8.33	$ 127,517
Other					$ -				$ -				$ -

Base Landscape Cost	$ 680,490	Base Maintenance Cost	$ 1,647,898
LC Enhancement Cost	$ 729,090	LC Enhancement Cost	$ 1,893,298
Total Landscape Cost	$ 1,409,580	Total Maintenance Cost	$ 3,541,196

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 2,486,915	$ 2,023,974	$ 4,510,889
Contingency Cost (25% of Construction Cost)	$ 621,729	$ 505,994	$ 1,127,722
Engineering Design Cost (5% of Construction Cost)	$ 124,346	$ 101,199	$ 225,544
Total Construction Cost	$ 3,232,990	$ 2,631,166	$ 5,864,156

Land Cost

Channel Length	8101 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	187	34.8	$100,000	$ 3,480,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	10.2	$100,000	$ 1,020,000
Levee LC Enhancement	51	9.5	$100,000	$ 950,000
Other	0	0	$100,000	$ -
Total	293	54.5		$ 5,450,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	45	$100,000	$ 4,500,000
LC Enhancement Cost	acre	9.5	$100,000	$ 950,000
Total Land Cost	acre	54.5	$100,000	$ 5,450,000

Total Cost

Base Total Cost	$ 10,061,378
Total Landscape Enhancement Cost	$ 6,203,554
Total Cost Including LC Enh.	$ 16,264,932

Online Basin

HEC1 ID	RRP1A

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.5	sq. mi
Total Sediment Yield Volume	1.0	ac ft

Required Minimum Sediment Volume

Sediment Volume	1.0	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.0222	0.0222
Basin Length (ft)	700	860
Basin Width (ft)	360	360
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	8	8
Freeboard (ft)	1	1
Effective Basin Width (ft)	336	312
Top Area (acres)	5.8	7.1
U/S-D/S Height Difference (ft)	8.0	8.0
Excess Area on Upstream (acres)	0.4	1.0

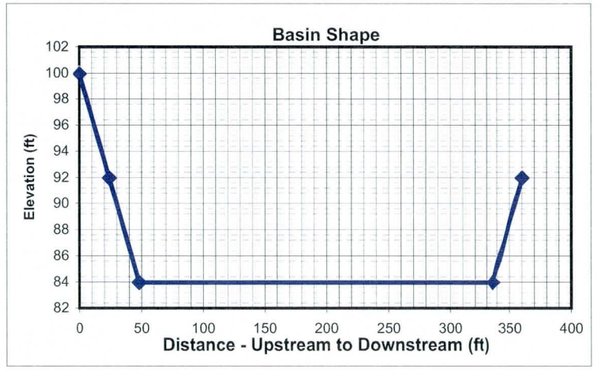
			Base	LC Enhanced
Bottom Length (ft)	652	Allocated Storage Volume (ac. ft)	33.4	33.5
Bottom Width (ft)	288	Total Available Volume (ac. ft) (incl. Freeboard)	38.8	39.5
		Total Excavation Volume (ac. ft)	61.9	67.9

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	3.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	2	3	4	5	6	7	8.5	10
Volume	0.00	4.38	8.88	13.52	18.30	23.21	28.25	33.44	41.49	49.86
Outflow	0.0	34.0	48.1	59.0	68.1	76.1	83.4	90.0	99.2	107.6



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	44.0	41	44.0
Peak Inflow (cfs)	575	441	575.0
Peak Outflow (cfs)	87	77	87.0
Stage at Peak Outflow (ft)	6.6	5.1	6.6
Volume at Peak Outflow (ac. ft)	31.2	23.93	31.2

Volume Check

Total Volume needed	32.2	ac. ft
Total Volume Provided	33.4	ac. ft

Volume OK?	Yes

Stage Check

Depth Needed	7.6	ft
Depth Provided	8	ft

Depth OK?	Yes

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	189600	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	700	ft
Base Total ROW Width	360	ft
LC Enh. Total ROW Length	960	ft
LC Enh. Total ROW Length	460	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	99865	109545
Excavated Area (sq. Yd)	28000	49067

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	51	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	562	sq. Yd
Material Volume	281	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	465	ft
Unit Cost	160	per ft
Cost per outlet	$74,400	
Other Cost	$ -	
Total Cost	$74,400	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		99,865	cu. Yd	$ 4.00	$ 399,460	28,000	sq. Yd	$ 9.00	$ 252,000	28,000	sq. Yd	$ 8.33	$ 233,333
Basin - LC Enhancement		9,680	cu. Yd	$ 4.00	$ 38,720	21,067	sq. Yd	$ 9.00	$ 189,603	21,067	sq. Yd	$ 8.33	$ 175,558
Inlet	Riprap	281	sq. Yd	$ 75.00	$ 21,075	562	sq. Yd	$ -	$ -	562	sq. Yd	$ 33.33	$ 18,733
Inlet - LC Enhancement (20%Inlet)					$ 4,215				$ -				$ 3,747
Outlet	Pipe	1	EA	$ 74,400	$ 74,400	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 3,720				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 252,000	Base Maintenance Cost			$ 254,283
						LC Enh. Landscape Cost			$ 189,603	LC Enh. Maintenance Cost			$ 179,416
						Total Landscape Cost			$ 441,699	Total Maintenance Cost			$ 433,699

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 494,935	$ 38,720	$ 533,655
Contingency Cost (25% of Construction Cost)	$ 123,734	$ 9,680	$ 133,414
Engineering Design Cost (5% of Construction Cost)	$ 24,747	$ 1,936	$ 26,683
Total Construction Cost	$ 643,416	$ 50,336	$ 693,752

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	4.4	$100,000	$ 440,000
Basin	5.8	$100,000	$ 580,000
Other		$100,000	$ -
Total	10.2	$100,000	$ 1,020,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	5.8	$100,000	$ 580,000
LC Enhancement Cost	acre	4.4	$100,000	$ 440,000
Total Land Cost	acre	10.2	$100,000	$ 1,020,000

Total Cost

Base Total Cost	$ 1,729,699
Total LC Enhancement Cost	$ 859,355
Total Cost Including LC Enh.	$ 2,589,054

Open Channel

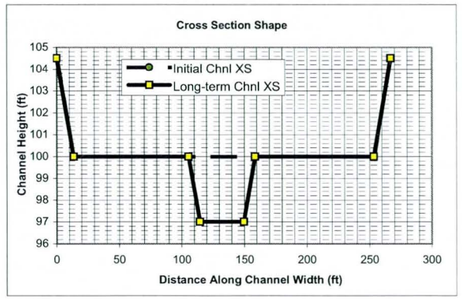
Structure ID	N130	HEC1 ID	P1A-1B

Longitudinal Geometry

Length	10853.3	ft
U/S Elev	1276.4	ft
D/S Elev	1133.0	ft
Initial Channel Slope	0.0132	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	11



Initial Channel XS Geometry

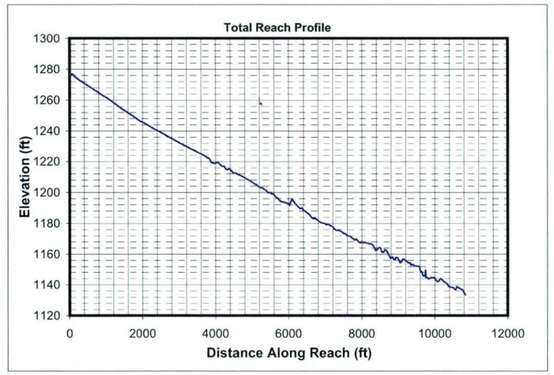
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	240	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	253.5	253.5	253.5	267
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	92	3	35	7.5	3	95	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	105.5	114.5	149.5	158.5	253.5	267
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	P1A-1B	P1B							TOTAL
HEC1 Peak-Flow	976	852							1828
Weighting Factor	1.00	0.64							
Flow into Channel	976	543							1519

Reach Sediment Inflow Characteristics

U/S Contributing ID	N1-P1A_N125	P1A-1B_RRP1A10							TOTAL
Flow Volume (ac. ft)	898.00	1026.00							1924
Sediment Conc. (ppm)	1631	2874							
Sediment Volume (ac. ft)	0.55	1.11							1.67
Weighting Factor	1	1							
Weighted Sed. Vol. (ac. ft)	0.55	1.11							1.67

Hydrology

Drainage Area	15.41	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	1519	cfs	
Long-term Max. Chnl Capacity	8389	cfs	
Q2 Channel	152	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	267	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (ib/sq. ft)	Froude Number
152	242.2	82.1	0.3	100.0	100.3	1.8	0.3	242.0	0.3	0.11	0.56
456	244.2	159.2	0.7	100.0	100.7	2.9	0.7	243.9	0.7	0.21	0.62
1139	247.2	277.2	1.1	100.0	101.1	4.1	1.1	246.8	1.1	0.36	0.68
1519	248.6	330.2	1.3	100.0	101.4	4.6	1.4	248.1	1.3	0.42	0.70

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
152	43.9	55.5	1.3	97.0	98.4	2.7	1.4	43.5	1.3	0.44	0.43
456	51.9	114.7	2.2	97.0	99.7	4.0	2.7	51.0	2.2	0.83	0.47
1139	247.2	371.1	1.5	97.0	101.0	3.1	4.0	245.9	1.5	1.24	0.44
1519	249.0	442.3	1.8	97.0	101.3	3.4	4.3	247.6	1.8	1.33	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)								TOTAL
	N1-P1A_N125	P1A-1B_RRP1A10							
152	407	41							448
456	1658	154							1811
1139	3746	471							4217
1519	5505	674							6179

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
152	1.74	1.0621	1.0090	Erosive	Erosive	Erosive	0.2	Stable	5.2	Stable	Stable
456	1.74	1.2638	1.2006	Erosive	Erosive	Erosive	0.3	Stable	7.8	Stable	Stable
1139	1.74	1.4313	1.3597	Erosive	Erosive	Erosive	0.3	Stable	9.0	Stable	Stable
1519	1.74	1.4836	1.4094	Erosive	Erosive	Erosive	0.3	Stable	9.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	152	456	1139	1519	152	456	1139	1519	152	456	1139	1519
Bray - Equation #1	34	60	97	113	1.4	2.0	2.8	3.1	3.2	3.7	4.2	4.4
Bray - Equation #2	44	79	128	149	1.6	2.2	3.0	3.3	2.2	2.6	2.9	3.0
Hey	10	19	31	37	4.3	6.6	9.3	10.4				
Ackers & Charlton/Lacey	30	47	69	78					1.9	2.2	2.6	2.7
Parker	85	147	232	268	1.1	1.8	2.6	2.9				
Chang	55	109	190	226	0.1	0.0	-0.3	-0.5				
Kellerhals	22	38	61	70	2.0	3.1	4.5	5.1	3.4	3.8	4.1	4.2
AMAFCA/Schumm	44	51	246	248								
Moody & Odem	34	34	34	34	1.4	1.4	1.4	1.4				
BUREC	17.5	26.4	37.2	41.4	5	7	10	11	2.9	3.9	4.8	5.2
Average	37	61	113	126	2.1	3.0	4.2	4.6	2.7	3.2	3.7	3.9
Values As Designed	43	51	246	248	1.4	2.7	4.0	4.3	2.7	4.0	3.1	3.4
Difference with Design	-6	10	-133	-121	0.7	0.4	0.2	0.3	0.0	-0.8	0.7	0.5

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
152	996	640	1284	1752	3379	268	257	147	3893	294	1053	1269
456	5443	2706	5032	11283	5493	1617	1143	1102	12594	1329	6053	4890
1139	22294	8021	13190	53117	7846	5952	3124	4372	32174	4973	22600	16151
1519	34683	11137	17102	86303	8725	8870	4198	6542	43052	7564	33595	23797

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
152	2432	1562	3136	4279	8253	655	627	359	9508	717	2571	3100
456	4432	2203	4097	9185	4472	1316	930	897	10253	1082	4928	3981
1139	7260	2612	4295	17298	2555	1938	1017	1424	10477	1620	7360	5260
1519	8471	2720	4177	21079	2131	2166	1025	1598	10515	1848	8205	5812

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
152	653	328	515	1170	794	130	106	154	943	138	772	518
456	3234	1226	1683	6763	1365	616	379	765	2956	662	3686	2121
1139	5766	2558	3971	10702	5055	1153	870	1388	7199	1192	6808	4242
1519	8960	3680	5419	17365	5708	1765	1225	2159	9728	1833	10460	6209

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
152	1594	801	1257	2857	1940	318	259	376	2302	337	1886	1266
456	2633	998	1370	5506	1111	502	308	622	2406	539	3001	1727
1139	1878	833	1293	3485	1646	375	283	452	2344	388	2217	1381
1519	2188	899	1324	4241	1394	431	299	527	2376	448	2555	1517

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Sif (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
152	0.0025	0.0036	125	0.38	0.046	0.0007	29	0.035	0.0005	0.0159	0.0008	0.0018	0.0065	0.0004	0.0027	0.0132	0.0055
456	0.0011	0.0019	173	0.53	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0009	0.0065	0.0002	0.0012	0.0132	0.0052
1139	0.0006	0.0011	227	0.69	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0065	0.0002	0.0006	0.0132	0.0051
1519	0.0004	0.0009	247	0.75	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0065	0.0001	0.0005	0.0132	0.0051

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	89.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	30	
Distance between structs.	362	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.83	sq. mi
Total Sediment Yield Volume	3.47	ac ft

Sedimentation Basins

Length	362 ft	Depth	3 ft
Width	267 ft	Side slope	3 ft/ft
Total Volume per Basin		6.27	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		3	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
152	1.1	-0.5	0.1	24.6	1.4	1.3	2.7	0.0050	0.1	1.5	3.0	6.1
456	1.1	-0.7	0.2	24.6	2.7	2.2	4.0	0.0050	0.3	1.5	3.0	6.4
1139	1.1	-1.2	0.1	24.6	4.0	1.5	3.1	0.0050	0.4	1.5	3.0	6.5
1519	1.1	-1.2	0.2	24.6	4.3	1.8	3.4	0.0050	0.5	1.5	3.0	6.6

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	976	cfs
Stage at Peak Flow	101.1	ft
Volume at Peak Flow	1026.0	ac. ft

Freeboard

Max. Flow Depth	1.4	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.1	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	5.13	ac. ft
Outflowing Sediment Volume	0.67	ac. ft
Deposited(+)/Eroded(-) Volume	4.46	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	10853	10853
Side Slope (?H:1V)	3	3
Channel Width (ft)	267	267
Channel XS Area (sq. ft)	1272.8	1272.8
Channel Perimeter (ft)	269	269

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	10853	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	3618	sq. Yd
Volume	12059	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	10853	10853
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	50647	104912
Left Levee Volume (cu. Yd)	49843	117373
Right Levee Length (ft)	10853	10853
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	50647	104912
Right Levee Volume (cu. Yd)	49843	117373
Total Levee Surface Area (sq. Yd)	101294	209824
Total Levee Volume (cu. Yd)	99686	234746

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	10853	10853
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	16882	39794
Left Levee Lining Volume (cu. Yd)	8441	19897
Right Levee Length (ft)	10853	10853
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	16882	39794
Right Levee Lining Volume (cu. Yd)	8441	19897
Total Lining Area (sq. Yd)	33765	79589
Total Lining Volume (cu. Yd)	16882	39794

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	267	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.6	ft
Structure Height	9.6	ft
Number of Structures	30	
Volume per structure	286	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 21,450	
Area per structure	89	sq. Yd
Total Area	2,670	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	3	
Total Volume per Basin	10116	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 40,464	
Other Cost	$ -	
Total cost per basin	$ 40,464	
Area per basin	10,733	sq. Yd
Total Area	32,199	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	99,686	cu. Yd	$ 7.00	$ 697,802	101,294	sq. Yd	$ 9.00	$ 911,646	101,294	sq. Yd	$ 11.67	$ 1,181,763
Levee - LC Enhancement	Fill	135,060	cu. Yd	$ 7.00	$ 945,420	108,530	sq. Yd	$ 9.00	$ 976,770	135,060	sq. Yd	$ 11.67	$ 1,575,700
Levee Lining	Riprap	16,882	cu. Yd	$ 75.00	$ 1,266,150	33,765	sq. Yd	$ -	$ -	33,765	sq. Yd	$ 20.83	$ 703,435
Levee Lining -LC Enhancement	Riprap	22,912	cu. Yd	$ 75.00	$ 1,718,400	45,824	sq. Yd	$ -	$ -	45,824	sq. Yd	$ 20.83	$ 954,662
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	12,059	cu. Yd	$ 75.00	$ 904,425	3,618	sq. Yd	$ -	$ -	3,618	sq. Yd	$ 25.00	$ 90,450
Drop Structures	Riprap	30	EA	$ 21,450.00	$ 643,500	2,670	sq. Yd	$ -	$ -	2,670	sq. Yd	$ 33.33	$ 89,000
Drop Str. - LC Enhancement	Riprap	30	EA	$ 2,145.00	$ 64,350	267	sq. Yd	$ -	$ -	267	sq. Yd	$ 33.33	$ 8,900
Sedimentation Basins		3	EA	$ 40,464.00	$ 121,392	32,199	sq. Yd	$ -	$ -	32,199	sq. Yd	$ 8.33	$ 268,325
Other					$ -				$ -				$ -

Base Landscape Cost	$ 911,646	Base Maintenance Cost	$ 2,332,974
LC Enhancement Cost	$ 976,770	LC Enhancement Cost	$ 2,539,262
Total Landscape Cost	$ 1,888,416	Total Maintenance Cost	$ 4,872,236

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,633,269	$ 2,728,170	$ 6,361,439
Contingency Cost (25% of Construction Cost)	$ 908,317	$ 682,043	$ 1,590,360
Engineering Design Cost (5% of Construction Cost)	$ 181,663	$ 136,409	$ 318,072
Total Construction Cost	$ 4,723,250	$ 3,546,621	$ 8,269,871

Land Cost

Channel Length	10853 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	267	66.5	$100,000	$ 6,650,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	13.7	$100,000	$ 1,370,000
Levee LC Enhancement	51	12.7	$100,000	$ 1,270,000
Other	0	0	$100,000	$ -
Total	373	92.9		$ 9,290,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	80.2	$100,000	$ 8,020,000
LC Enhancement Cost	acre	12.7	$100,000	$ 1,270,000
Total Land Cost	acre	92.9	$100,000	$ 9,290,000

Total Cost

Base Total Cost	$ 15,987,869
Total Landscape Enhancement Cost	$ 8,332,653
Total Cost Including LC Enh.	$ 24,320,522

Open Channel

Structure ID	N140

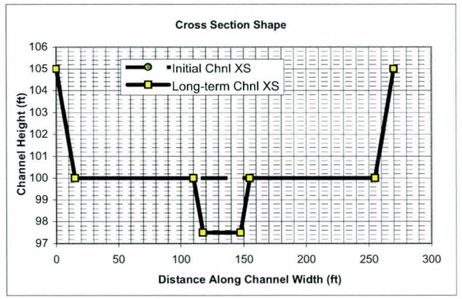
HEC1 ID	P1A-1B

Longitudinal Geometry

Length	5668.0	ft
U/S Elev	1133.0	ft
D/S Elev	1092.0	ft
Initial Channel Slope	0.0072	ft/ft
Long-term Channel Slope	0.0040	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	11



Initial Channel XS Geometry

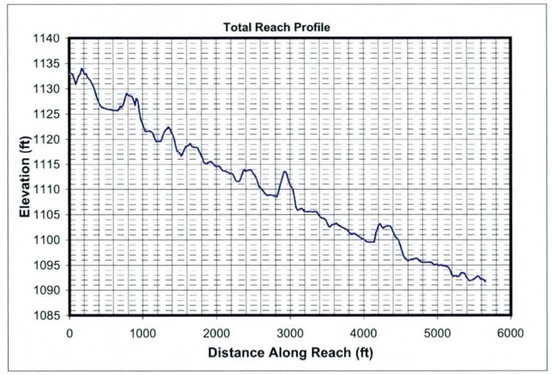
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	240	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	255	255	255	270
Y	105	100	100	100	100	100	100	105

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	95	3	30	7.5	3	100	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	110	117.5	147.5	155	255	270
Y	105	100	100	97.5	97.5	100	100	105



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	P									TOTAL
HEC1 Peak-Flow	1605									1605
Weighting Factor	1.00									
Flow into Channel	1605									1605

Reach Sediment Inflow Characteristics

U/S Contributing ID	P1A-1B_N130	Q1A-P_P1B10							TOTAL
Flow Volume (ac. ft)	1026.00	97.00							1123
Sediment Conc. (ppm)	1727	1891							
Sediment Volume (ac. ft)	0.67	0.07							0.74
Weighting Factor	1	1							
Weighted Sed. Vol. (ac. ft)	0.67	0.07							0.74

Hydrology

Drainage Area	16.71	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	1605	cfs	
Long-term Max. Chnl Capacity	8408	cfs	
Q2 Channel	161	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	270	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (ib/sq. ft)	Froude Number
161	242.7	101.8	0.4	100.0	100.4	1.6	0.4	242.5	0.4	0.11	0.43
482	245.2	197.5	0.8	100.0	100.8	2.4	0.8	244.9	0.8	0.20	0.48
1204	248.9	344.5	1.4	100.0	101.4	3.5	1.4	248.5	1.4	0.35	0.52
1605	250.6	410.5	1.6	100.0	101.7	3.9	1.7	250.1	1.6	0.42	0.54

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
161	40.7	59.5	1.5	97.5	99.2	2.7	1.7	40.2	1.5	0.42	0.39
482	244.5	235.7	1.0	97.5	100.6	2.0	3.1	243.5	1.0	0.77	0.37
1204	249.0	411.4	1.7	97.5	101.3	2.9	3.8	247.8	1.7	0.95	0.40
1605	251.1	490.4	2.0	97.5	101.6	3.3	4.1	249.7	2.0	1.03	0.41

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
	P1A-1B_N130	Q1A-P_P1B10								
161	518	112								630
482	2121	333								2455
1204	4242	1064								5306
1605	6209	1544								7753

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
161	1.74	1.1279	1.0715	Erosive	Erosive	Erosive	0.2	Stable	5.2	Stable	Stable
482	1.74	1.3292	1.2627	Erosive	Erosive	Erosive	0.3	Stable	6.5	Stable	Stable
1204	1.74	1.4962	1.4214	Erosive	Erosive	Erosive	0.4	Stable	8.0	Stable	Stable
1605	1.74	1.5483	1.4709	Erosive	Erosive	Erosive	0.4	Stable	8.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	161	482	1204	1605	161	482	1204	1605	161	482	1204	1605
Bray - Equation #1	35	62	100	116	1.4	2.1	2.8	3.1	3.2	3.8	4.3	4.4
Bray - Equation #2	45	81	131	153	1.6	2.3	3.1	3.4	2.2	2.6	2.9	3.1
Hey	10	19	32	38	4.4	6.7	9.5	10.6				
Ackers & Charlton/Lacey	30	48	71	80					1.9	2.2	2.6	2.7
Parker	87	151	238	275	1.1	1.8	2.6	3.0				
Chang	53	104	183	218	0.2	0.1	-0.2	-0.3				
Kellerhals	23	39	62	72	2.1	3.2	4.6	5.2	3.4	3.8	4.1	4.3
AMAFCA/Schumm	40	244	248	250								
Moody & Odem	35	35	35	35	1.4	1.4	1.4	1.4				
BUREC	18.6	28.1	39.6	44.1	5	8	11	12	2.7	3.6	4.5	4.9
Average	38	81	114	128	2.2	3.1	4.3	4.8	2.7	3.2	3.7	3.9
Values As Designed	40	244	248	250	1.7	3.1	3.8	4.1	2.7	2.0	2.9	3.3
Difference with Design	-2	-162	-134	-122	0.5	0.1	0.5	0.7	0.0	1.1	0.8	0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
161	469	280	391	709	2420	51	67	53	1442	126	445	587
482	2558	1394	2393	4558	4183	589	501	534	5153	583	2951	2309
1204	10460	4417	6772	21417	6174	2360	1544	2342	13505	2235	11828	7550
1605	16260	6224	9379	34768	6921	3551	2121	3577	18146	3426	17908	11116

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
161	1083	647	904	1638	5593	117	155	123	3333	290	1028	1356
482	1971	1074	1844	3512	3223	454	386	412	3970	450	2274	1779
1204	3224	1361	2087	6601	1903	727	476	722	4162	689	3645	2327
1605	3759	1439	2168	8037	1600	821	490	827	4194	792	4139	2570

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
161	541	273	397	939	695	97	82	133	703	111	646	420
482	1124	591	847	1725	3012	160	166	229	1920	227	1251	1023
1204	4592	2122	3204	8089	4656	836	670	1151	5358	921	5485	3371
1605	7134	3073	4329	13120	5278	1296	959	1804	7269	1417	8486	4924

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
161	1252	631	918	2170	1606	225	190	308	1626	257	1493	971
482	866	456	653	1329	2321	124	128	176	1479	175	964	788
1204	1415	654	987	2493	1435	258	206	355	1651	284	1690	1039
1605	1649	710	1001	3033	1220	300	222	417	1680	328	1962	1138

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
161	0.0024	0.0029	102	0.31	0.045	0.0006	29	0.035	0.0004	0.0159	0.0006	0.0016	0.0064	0.0004	0.0026	0.0072	0.0039
482	0.0010	0.0015	142	0.43	0.047	0.0003	30	0.036	0.0002	0.0159	0.0003	0.0008	0.0064	0.0002	0.0011	0.0072	0.0037
1204	0.0005	0.0009	186	0.57	0.050	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0064	0.0001	0.0006	0.0072	0.0036
1605	0.0004	0.0007	202	0.62	0.051	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0064	0.0001	0.0005	0.0072	0.0035

Drop Structures

Design Slope	0.0040	ft/ft
Total Drop Needed	18.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	7	
Distance between structs.	810	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.70	sq. mi
Total Sediment Yield Volume	1.34	ac ft

Sedimentation Basins

Length	810 ft	Depth	3 ft
Width	270 ft	Side slope	3 ft/ft
Total Volume per Basin		14.39	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
161	1.1	-0.5	0.1	24.6	1.7	1.5	2.7	0.0040	0.2	1.5	2.5	5.5
482	1.1	-1.1	0.1	24.6	3.1	1.0	2.0	0.0040	0.3	1.5	2.5	5.6
1204	1.1	-1.2	0.1	24.6	3.8	1.7	2.9	0.0040	0.4	1.5	2.5	5.8
1605	1.1	-1.2	0.1	24.6	4.1	2.0	3.3	0.0040	0.4	1.5	2.5	5.9

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	976	cfs
Stage at Peak Flow	101.1	ft
Volume at Peak Flow	1026.0	ac. ft

Freeboard

Max. Flow Depth	1.7	ft
Channel Depth as designed	5.0	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	2.08	ac. ft
Outflowing Sediment Volume	0.44	ac. ft
Deposited(+)/Eroded(-) Volume	1.63	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5668	5668
Side Slope (?H:1V)	3	3
Channel Width (ft)	270	270
Channel XS Area (sq. ft)	1368.8	1368.8
Channel Perimeter (ft)	272	272

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5668	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1889	sq. Yd
Volume	5668	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5668	5668
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	5	6
Left Levee Surface Area (sq. Yd)	28970	58569
Left Levee Volume (cu. Yd)	30439	70535
Right Levee Length (ft)	5668	5668
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5	6
Right Levee Surface Area (sq. Yd)	28970	58569
Right Levee Volume (cu. Yd)	30439	70535
Total Levee Surface Area (sq. Yd)	57940	117138
Total Levee Volume (cu. Yd)	60878	141070

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5668	5668
Left Levee Lining Width (ft)	16	36
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	10076	22672
Left Levee Lining Volume (cu. Yd)	5038	11336
Right Levee Length (ft)	5668	5668
Right Levee Lining Width (ft)	16	36
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	10076	22672
Right Levee Lining Volume (cu. Yd)	5038	11336
Total Lining Area (sq. Yd)	20153	45344
Total Lining Volume (cu. Yd)	10076	22672

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	270	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	6.8	ft	
Structure Height	9.8	ft	
Number of Structures	7		
Volume per structure	294	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 22,050		
Area per structure	90	sq. Yd	
Total Area	630	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	23216	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 92,864	
Other Cost	$ -	
Total cost per basin	$ 92,864	
Area per basin	24,291	sq. Yd
Total Area	24,291	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	60,878	cu. Yd	$ 7.00	$ 426,146	57,940	sq. Yd	$ 9.00	$ 521,460	57,940	sq. Yd	$ 11.67	$ 675,967
Levee - LC Enhancement	Fill	80,192	cu. Yd	$ 7.00	$ 561,344	59,198	sq. Yd	$ 9.00	$ 532,782	80,192	sq. Yd	$ 11.67	$ 935,573
Levee Lining	Riprap	10,076	cu. Yd	$ 75.00	$ 755,700	20,153	sq. Yd	$ -	$ -	20,153	sq. Yd	$ 20.83	$ 419,852
Levee Lining -LC Enhancement	Riprap	12,596	cu. Yd	$ 75.00	$ 944,700	25,191	sq. Yd	$ -	$ -	25,191	sq. Yd	$ 20.83	$ 524,815
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	5,668	cu. Yd	$ 75.00	$ 425,100	1,889	sq. Yd	$ -	$ -	1,889	sq. Yd	$ 25.00	$ 47,225
Drop Structures	Riprap	7	EA	$ 22,050.00	$ 154,350	630	sq. Yd	$ -	$ -	630	sq. Yd	$ 33.33	$ 21,000
Drop Str. - LC Enhancement	Riprap	7	EA	$ 2,205.00	$ 15,435	63	sq. Yd	$ -	$ -	63	sq. Yd	$ 33.33	$ 2,100
Sedimentation Basins		1	EA	$ 92,864.00	$ 92,864	24,291	sq. Yd	$ -	$ -	24,291	sq. Yd	$ 8.33	$ 202,425
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 521,460	Base Maintenance Cost			$ 1,366,469
						LC Enhancement Cost			$ 532,782	LC Enhancement Cost			$ 1,462,488
						Total Landscape Cost			$ 1,054,242	Total Maintenance Cost			$ 2,828,957

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,854,160	$ 1,521,479	$ 3,375,639
Contingency Cost (25% of Construction Cost)	$ 463,540	$ 380,370	$ 843,910
Engineering Design Cost (5% of Construction Cost)	$ 92,708	$ 76,074	$ 168,782
Total Construction Cost	$ 2,410,408	$ 1,977,923	$ 4,388,331

Land Cost

Channel Length	5668 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	270	35.1	$100,000	$ 3,510,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	58	7.5	$100,000	$ 750,000
Levee LC Enhancement	54	7	$100,000	$ 700,000
Other	0	0	$100,000	$ -
Total	382	49.6		$ 4,960,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	42.6	$100,000	$ 4,260,000
LC Enhancement Cost	acre	7	$100,000	$ 700,000
Total Land Cost	acre	49.6	$100,000	$ 4,960,000

Total Cost

Base Total Cost	$ 8,558,337
Total Landscape Enhancement Cost	$ 4,673,193
Total Cost Including LC Enh.	$ 13,231,529

Online Basin

HEC1 ID	RRQ1A

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.3	sq. mi
Total Sediment Yield Volume	2.5	ac ft

Required Minimum Sediment Volume

Sediment Volume	2.5	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.03	0.03
Basin Length (ft)	1000	1290
Basin Width (ft)	420	420
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	11	11
Freeboard (ft)	1	1
Effective Basin Width (ft)	382	344
Top Area (acres)	9.6	12.4
U/S-D/S Height Difference (ft)	12.6	12.6
Excess Area on Upstream (acres)	0.9	2.3

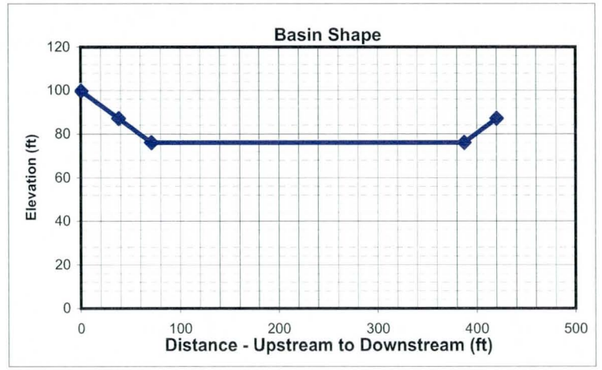
			Base	LC Enhanced
Bottom Length (ft)	934	Allocated Storage Volume (ac. ft)	76.6	76.3
Bottom Width (ft)	316	Total Available Volume (ac. ft) (incl. Freeboard)	85.3	86.3
		Total Excavation Volume (ac. ft)	146.1	164.7

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	3.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1.5	3	4.5	6	7	8	9	10	12
Volume	0.00	10.36	21.11	32.26	43.81	51.74	59.86	68.15	76.64	94.18
Outflow	0.0	41.7	59.0	72.2	83.4	90.0	96.3	102.1	107.6	117.9



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	97.0	95	97.0
Peak Inflow (cfs)	990	915	990.0
Peak Outflow (cfs)	106	100	106.0
Stage at Peak Outflow (ft)	9.7	8.7	9.7
Volume at Peak Outflow (ac. ft)	73.8	65.43	73.8

Volume Check

Total Volume needed	76.3	ac. ft
Total Volume Provided	76.6	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	10.7	ft
Depth Provided	11	ft
Depth OK?	Yes	

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	302800	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	1000	ft
Base Total ROW Width	420	ft
LC Enh. Total ROW Length	1390	ft
LC Enh. Total ROW Length	520	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	235708	265716
Excavated Area (sq. Yd)	46667	80311

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	75	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	829	sq. Yd
Material Volume	415	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	440	ft
Unit Cost	160	per ft
Cost per outlet	$70,400	
Other Cost	$ -	
Total Cost	$70,400	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		235,708	cu. Yd	$ 4.00	$ 942,832	46,667	sq. Yd	$ 9.00	$ 420,003	46,667	sq. Yd	$ 8.33	$ 388,892
Basin - LC Enhancement		30,008	cu. Yd	$ 4.00	$ 120,032	33,644	sq. Yd	$ 9.00	$ 302,796	33,644	sq. Yd	$ 8.33	$ 280,367
Inlet	Riprap	415	sq. Yd	$ 75.00	$ 31,125	829	sq. Yd	$ -	$ -	829	sq. Yd	$ 33.33	$ 27,633
Inlet - LC Enhancement (20%Inlet)					$ 6,225				$ -				$ 5,527
Outlet	Pipe	1	EA	$ 70,400	$ 70,400	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 3,520				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 420,003	Base Maintenance Cost			$ 418,742
						LC Enh. Landscape Cost			$ 302,796	LC Enh. Maintenance Cost			$ 286,004
						Total Landscape Cost			$ 722,799	Total Maintenance Cost			$ 704,746

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,044,357	$ 120,032	$ 1,164,389
Contingency Cost (25% of Construction Cost)	$ 261,089	$ 30,008	$ 291,097
Engineering Design Cost (5% of Construction Cost)	$ 52,218	$ 6,002	$ 58,219
Total Construction Cost	$ 1,357,664	$ 156,042	$ 1,513,706

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	7.0	$100,000	$ 700,000
Basin	9.6	$100,000	$ 960,000
Other		$100,000	$ -
Total	16.6	$100,000	$ 1,660,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	9.6	$100,000	$ 960,000
LC Enhancement Cost	acre	7.0	$100,000	$ 700,000
Total Land Cost	acre	16.6	$100,000	$ 1,660,000

Total Cost

Base Total Cost	$ 3,156,409
Total LC Enhancement Cost	$ 1,444,842
Total Cost Including LC Enh.	$ 4,601,251

Open Channel

Structure ID	P1B10

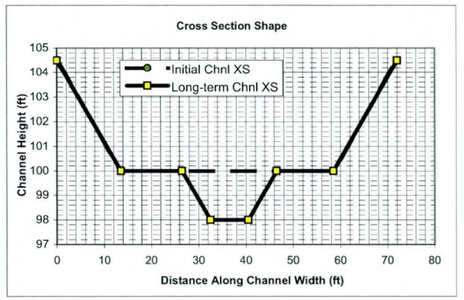
HEC1 ID	Q1A-P

Longitudnal Geometry

Length	5122.9	ft
U/S Elev	1190.4	ft
D/S Elev	1133.0	ft
Initial Channel Slope	0.0112	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	7



Initial Channel XS Geometry

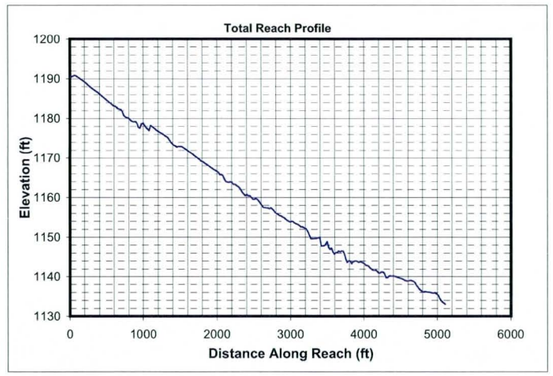
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	45	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	58.5	58.5	58.5	72
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	13	3	8	6.5	3	12	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	26.5	32.5	40.5	46.5	58.5	72
Y	104.5	100	100	98	98	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RRQ1A	P1B							TOTAL
HEC1 Peak-Flow	106	852							958
Weighting Factor	1.00	0.23							
Flow into Channel	106	197							303

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	1.384	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	303	cfs	
Long-term Max. Chnl Capacity	1860	cfs	
Q2 Channel	30	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	72	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (ib/sq. ft)	Froude Number
30	47.3	17.1	0.4	100.0	100.4	1.8	0.4	47.2	0.4	0.14	0.52
91	49.5	33.6	0.7	100.0	100.7	2.7	0.7	49.3	0.7	0.27	0.58
227	52.8	59.7	1.1	100.0	101.2	3.8	1.2	52.4	1.1	0.46	0.63
303	54.2	71.7	1.3	100.0	101.5	4.2	1.5	53.7	1.3	0.54	0.64

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
30	15.2	13.1	0.9	98.0	99.1	2.3	1.1	14.9	0.9	0.43	0.44
91	47.3	39.8	0.8	98.0	100.3	2.3	2.3	46.5	0.9	0.84	0.44
227	51.4	71.2	1.4	98.0	100.9	3.2	2.9	50.4	1.4	1.09	0.47
303	53.2	85.8	1.6	98.0	101.2	3.5	3.2	52.1	1.6	1.19	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
30										0
91										0
227										0
303										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
30	1.74	1.0818	1.0277	Erosive	Erosive	Erosive	0.2	Stable	4.8	Stable	Stable
91	1.74	1.2772	1.2133	Erosive	Erosive	Erosive	0.3	Stable	6.7	Stable	Stable
227	1.74	1.4359	1.3641	Erosive	Erosive	Erosive	0.3	Stable	8.3	Stable	Stable
303	1.74	1.4845	1.4103	Erosive	Erosive	Erosive	0.3	Stable	8.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	30	91	227	303	30	91	227	303	30	91	227	303
Bray - Equation #1	14	26	42	48	0.8	1.2	1.6	1.8	2.5	3.0	3.4	3.5
Bray - Equation #2	19	34	54	63	0.9	1.3	1.8	2.0	1.8	2.0	2.3	2.4
Hey	4	7	12	15	2.4	3.6	5.1	5.7				
Ackers & Charlton/Lacey	15	24	35	40					1.4	1.7	2.0	2.1
Parker	38	65	104	120	0.6	0.9	1.3	1.5				
Chang	22	43	76	90	0.2	0.1	0.0	0.0				
Kellerhals	10	17	27	31	1.1	1.7	2.4	2.7	2.9	3.2	3.5	3.6
AMAFCA/Schumm	15	47	51	52								
Moody & Odem	14	14	14	14	1.0	1.0	1.0	1.0				
BUREC	9.2	13.9	19.6	21.9	2	4	5	6	2.1	2.8	3.5	3.7
Average	16	29	43	50	1.2	1.7	2.3	2.6	2.1	2.5	2.9	3.1
Values As Designed	15	47	50	52	1.1	2.3	2.9	3.2	2.3	2.3	3.2	3.5
Difference with Design	1	-17	-7	-3	0.0	-0.6	-0.6	-0.6	-0.2	0.2	-0.3	-0.5

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
30	159	101	190	270	607	37	37	22	591	46	166	202
91	852	439	812	1698	1021	239	179	174	1942	206	965	775
227	3383	1310	2230	7720	1518	876	502	695	4987	758	3594	2507
303	5195	1820	2876	12364	1715	1298	678	1038	6679	1144	5330	3649

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
30	1951	1241	2323	3309	7431	451	454	272	7232	560	2026	2477
91	3478	1792	3314	6930	4169	975	731	710	7928	841	3937	3164
227	5523	2139	3641	12604	2479	1431	819	1134	8141	1238	5868	4092
303	6361	2229	3521	15138	2100	1589	830	1271	8177	1401	6527	4468

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
30	122	66	109	216	236	25	22	26	241	28	141	112
91	362	190	327	629	722	74	67	75	719	82	418	333
227	1423	622	978	2821	1123	306	218	332	1908	307	1663	1064
303	2177	882	1341	4493	1284	459	302	507	2569	464	2507	1544

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
30	1489	813	1340	2640	2886	308	273	313	2949	342	1726	1371
91	1479	775	1335	2567	2945	303	273	308	2936	337	1705	1360
227	2324	1016	1596	4605	1833	499	355	543	3114	501	2715	1736
303	2666	1080	1642	5501	1573	562	370	620	3145	568	3070	1891

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
30	0.0024	0.0034	118	0.36	0.046	0.0007	29	0.035	0.0005	0.0159	0.0007	0.0018	0.0112	0.0008	0.0033	0.0111	0.0062
91	0.0011	0.0018	162	0.49	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0009	0.0112	0.0005	0.0015	0.0111	0.0059
227	0.0006	0.0011	210	0.64	0.051	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0112	0.0003	0.0007	0.0111	0.0058
303	0.0005	0.0009	227	0.69	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0112	0.0003	0.0006	0.0111	0.0057

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	26.7	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	569	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.45	sq. mi
Total Sediment Yield Volume	0.85	ac ft

Sedimentation Basins

Length	569 ft	Depth	3 ft
Width	72 ft	Side slope	3 ft/ft
Total Volume per Basin		2.43	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
30	1.1	-0.4	0.1	24.6	1.1	0.9	2.3	0.0060	0.1	1.5	2.0	4.7
91	1.1	-0.8	0.1	24.6	2.3	0.9	2.3	0.0060	0.2	1.5	2.0	4.9
227	1.1	-0.9	0.1	24.6	2.9	1.4	3.2	0.0060	0.3	1.5	2.0	5.0
303	1.1	-0.9	0.2	24.6	3.2	1.6	3.5	0.0060	0.3	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	106	cfs
Stage at Peak Flow	100.8	ft
Volume at Peak Flow	97.0	ac. ft

Freeboard

Max. Flow Depth	1.5	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.85	ac. ft
Outflowing Sediment Volume	0.07	ac. ft
Deposited(+)/Eroded(-) Volume	0.78	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5123	5123
Side Slope (?H:1V)	3	3
Channel Width (ft)	72	72
Channel XS Area (sq. ft)	291.2	291.2
Channel Perimeter (ft)	74	74

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5123	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1708	sq. Yd
Volume	5123	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5123	5123
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	23907	49522
Left Levee Volume (cu. Yd)	23528	55404
Right Levee Length (ft)	5123	5123
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	23907	49522
Right Levee Volume (cu. Yd)	23528	55404
Total Levee Surface Area (sq. Yd)	47814	99044
Total Levee Volume (cu. Yd)	47056	110808

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5123	5123
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	7969	18784
Left Levee Lining Volume (cu. Yd)	3985	9392
Right Levee Length (ft)	5123	5123
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	7969	18784
Right Levee Lining Volume (cu. Yd)	3985	9392
Total Lining Area (sq. Yd)	15938	37569
Total Lining Volume (cu. Yd)	7970	18784

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	72	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	6.4	ft	
Structure Height	9.4	ft	
Number of Structures	9		
Volume per structure	75	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 5,625		
Area per structure	24	sq. Yd	
Total Area	216	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	3920	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 15,680	
Other Cost	$ -	
Total cost per basin	$ 15,680	
Area per basin	4,554	sq. Yd
Total Area	9,108	sq. Yd

Structure Type	Structure Cost											
	Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	47,056	cu. Yd	$ 7.00	$ 329,392	47,814	sq. Yd	$ 9.00	$ 430,326	47,814	sq. Yd	$ 11.67	$ 557,830
Levee - LC Enhancement	Fill	63,752	cu. Yd	$ 7.00	$ 446,264	51,230	sq. Yd	$ 9.00	$ 461,070	63,752	sq. Yd	$ 11.67	$ 743,773
Levee Lining	Riprap	7,970	cu. Yd	$ 75.00	$ 597,750	15,938	sq. Yd	$ -	$ -	15,938	sq. Yd	$ 20.83	$ 332,046
Levee Lining -LC Enhancement	Riprap	10,814	cu. Yd	$ 75.00	$ 811,050	21,630	sq. Yd	$ -	$ -	21,630	sq. Yd	$ 20.83	$ 450,634
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	5,123	cu. Yd	$ 75.00	$ 384,225	1,708	sq. Yd	$ -	$ -	1,708	sq. Yd	$ 25.00	$ 42,700
Drop Structures	Riprap	9	EA	$ 5,625.00	$ 50,625	216	sq. Yd	$ -	$ -	216	sq. Yd	$ 33.33	$ 7,200
Drop Str. - LC Enhancement	Riprap	9	EA	$ 562.50	$ 5,063	22	sq. Yd	$ -	$ -	22	sq. Yd	$ 33.33	$ 720
Sedimentation Basins		2	EA	$ 15,680.00	$ 31,360	9,108	sq. Yd	$ -	$ -	9,108	sq. Yd	$ 8.33	$ 75,900
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 430,326	Base Maintenance Cost			$ 1,015,676
						LC Enhancement Cost			$ 461,070	LC Enhancement Cost			$ 1,195,128
						Total Landscape Cost			$ 891,396	Total Maintenance Cost			$ 2,210,804

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,393,352	$ 1,262,377	$ 2,655,729
Contingency Cost (25% of Construction Cost)	$ 348,338	$ 315,594	$ 663,932
Engineering Design Cost (5% of Construction Cost)	$ 69,668	$ 63,119	$ 132,786
Total Construction Cost	$ 1,811,358	$ 1,641,089	$ 3,452,447

Land Cost

Channel Length	5123 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	72	8.5	$100,000	$ 850,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	6.5	$100,000	$ 650,000
Levee LC Enhancement	51	6	$100,000	$ 600,000
Other	0	0	$100,000	$ -
Total	178	21		$ 2,100,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	15	$100,000	$ 1,500,000
LC Enhancement Cost	acre	6	$100,000	$ 600,000
Total Land Cost	acre	21	$100,000	$ 2,100,000

Total Cost

Base Total Cost	$ 4,757,360
Total Landscape Enhancement Cost	$ 3,897,287
Total Cost Including LC Enh.	$ 8,654,647

Open Channel

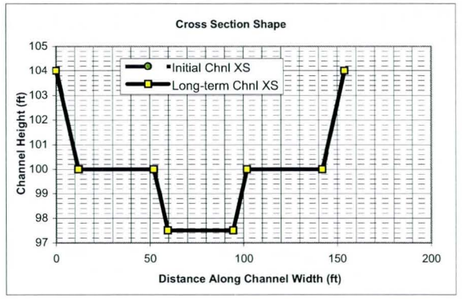
Structure ID	L30	HEC1 ID	L30

Longitudnal Geometry

Length	6103.1	ft
U/S Elev	1119.1	ft
D/S Elev	1148.6	ft
Initial Channel Slope	0.0048	ft/ft
Long-term Channel Slope	0.0048	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	



Initial Channel XS Geometry

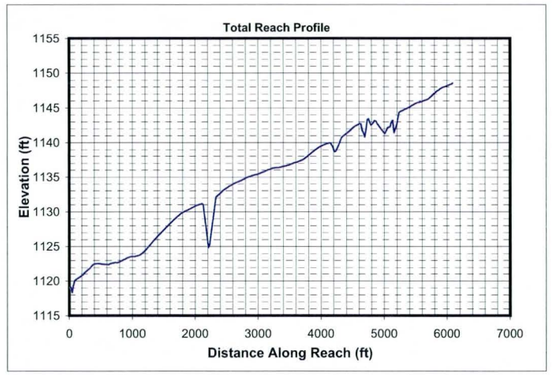
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	40	3	35	6.5	3	40	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	52	59.5	94.5	102	142	154
Y	104	100	100	97.5	97.5	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	40	3	35	6.5	3	40	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	52	59.5	94.5	102	142	154
Y	104	100	100	97.5	97.5	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	L									TOTAL
HEC1 Peak-Flow	2162									2162
Weighting Factor	1.00									
Flow into Channel	2162									2162

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	12.5	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	2162	cfs	
Long-term Max. Chnl Capacity	4102	cfs	
Q2 Channel	216	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	154	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (ib/sq. ft)	Froude Number
216	46.1	70.8	1.5	97.5	99.3	3.1	1.8	45.5	1.6	0.53	0.43
649	135.8	210.9	1.6	97.5	100.8	3.1	3.3	134.7	1.6	0.99	0.43
1622	143.2	373.3	2.6	97.5	102.0	4.3	4.5	141.8	2.6	1.34	0.47
2162	146.5	447.6	3.1	97.5	102.5	4.8	5.0	144.9	3.1	1.49	0.48

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
216	46.1	70.8	1.5	97.5	99.3	3.1	1.8	45.5	1.6	0.53	0.43
649	135.8	210.9	1.6	97.5	100.8	3.1	3.3	134.7	1.6	0.99	0.43
1622	143.2	373.3	2.6	97.5	102.0	4.3	4.5	141.8	2.6	1.34	0.47
2162	146.5	447.6	3.1	97.5	102.5	4.8	5.0	144.9	3.1	1.49	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
216										0
649										0
1622										0
2162										0

Allowable Velocity

Channel Lining: Natural - Coarse Gravel (noncolloidal)

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
216	1.74	1.5315	1.4549	Erosive	Erosive	Erosive	0.4	Stable	5.9	Stable	Stable
649	1.74	1.5335	1.4569	Erosive	Erosive	Erosive	0.4	Stable	8.0	Stable	Stable
1622	1.74	1.6939	1.6092	Erosive	Erosive	Erosive	0.4	Stable	10.2	Stable	Stable
2162	1.74	1.7432	1.6561	Erosive	Erosive	Erosive	0.5	Stable	11.1	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	6

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	216	649	1622	2162	216	649	1622	2162	216	649	1622	2162
Bray - Equation #1	40	72	117	136	1.6	2.3	3.1	3.4	3.4	3.9	4.4	4.6
Bray - Equation #2	53	95	154	179	1.8	2.5	3.4	3.8	2.3	2.7	3.1	3.2
Hey	12	23	38	44	5.0	7.5	10.7	11.9				
Ackers & Charlton/Lacey	34	55	80	91					2.0	2.4	2.7	2.9
Parker	101	175	277	319	1.3	2.0	3.0	3.4				
Chang	68	133	232	276	0.1	-0.1	-0.5	-0.7				
Kellerhals	26	46	72	84	2.3	3.6	5.2	5.9	3.5	3.9	4.3	4.4
AMAFCA/Schumm	46	135	142	145								
Moody & Odem	32	32	32	32	1.4	1.4	1.4	1.4				
BUREC	20.1	30.3	42.8	47.7	5	8	11	13	3.1	4.1	5.2	5.6
Average	43	80	119	135	2.4	3.4	4.7	5.2	2.9	3.4	4.0	4.1
Values As Designed	46	135	142	145	1.8	3.3	4.5	5.0	3.1	3.1	4.3	4.8
Difference with Design	-2	-55	-23	-10	0.6	0.1	0.3	0.2	-0.2	0.3	-0.4	-0.7

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	1035	484	715	1953	935	205	154	251	1300	217	1236	771
649	3153	1416	2157	5922	2777	623	469	766	3903	657	3762	2328
1622	12611	4333	5950	27117	4105	2309	1323	2928	10069	1834	14170	7886
2162	19419	6058	7681	43546	4626	3427	1789	4343	13497	1982	21125	11590

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	1775	831	1227	3351	1604	351	265	431	2231	372	2122	1324
649	1803	810	1234	3387	1589	356	268	438	2233	376	2152	1331
1622	2885	991	1361	6204	939	528	303	670	2304	420	3242	1804
2162	3332	1040	1318	7473	794	588	307	745	2316	340	3625	1989

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	1035	484	713	1928	929	204	154	251	1283	215	1227	766
649	3153	1414	2149	5847	2761	620	469	766	3852	650	3733	2310
1622	12611	4328	5926	26777	4084	2297	1323	2928	9941	1797	14066	7825
2162	19419	6052	7658	43001	4602	3409	1789	4343	13325	1943	20974	11501

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	1775	830	1223	3309	1594	350	265	431	2201	369	2105	1314
649	1803	809	1229	3345	1579	355	268	438	2203	372	2135	1321
1622	2885	990	1356	6127	934	526	303	670	2274	411	3218	1790
2162	3332	1038	1314	7379	790	585	307	745	2287	333	3599	1974

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
216	0.0005	0.0008	160	0.49	0.049	0.0002	30	0.036	0.0001	0.0159	0.0002	0.0004	0.0058	0.0003	0.0014	0.0047	0.0028
649	0.0005	0.0008	161	0.49	0.049	0.0002	30	0.036	0.0001	0.0159	0.0002	0.0004	0.0058	0.0002	0.0006	0.0048	0.0028
1622	0.0003	0.0005	209	0.64	0.051	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0002	0.0058	0.0001	0.0003	0.0047	0.0027
2162	0.0002	0.0004	226	0.69	0.052	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0002	0.0058	0.0001	0.0002	0.0047	0.0027

Drop Structures

Design Slope	0.0048	ft/ft
Total Drop Needed	0.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	1	
Distance between structs.	6103	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	5.85	sq. mi
Total Sediment Yield Volume	11.12	ac ft

Sedimentation Basins

Length	6103 ft	Depth	3 ft
Width	154 ft	Side slope	3 ft/ft
Total Volume per Basin		60.86	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
216	1.1	-0.5	0.1	24.6	1.8	1.6	3.1	0.0048	0.2	0.0	2.5	3.6
649	1.1	-1.0	0.1	24.6	3.3	1.6	3.1	0.0048	0.4	0.0	2.5	3.8
1622	1.1	-1.1	0.3	24.6	4.5	2.6	4.3	0.0048	0.5	0.0	2.5	4.1
2162	1.1	-1.2	0.3	24.6	5.0	3.1	4.8	0.0048	0.6	0.0	2.5	4.2

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	237	cfs
Stage at Peak Flow	100.3	ft
Volume at Peak Flow	342.0	ac. ft

Freeboard

Max. Flow Depth	5.0	ft
Channel Depth as designed	6.5	ft
Available Freeboard	1.5	ft
Required Freeboard	1.3	ft

Sediment Volume

Inflowing Sediment Volume	11.12	ac. ft
Outflowing Sediment Volume	0.25	ac. ft
Deposited(+)/Eroded(-) Volume	10.86	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	6103	6103
Side Slope (?H:1V)	3	6
Channel Width (ft)	154	193
Channel XS Area (sq. ft)	674.2	800.95
Channel Perimeter (ft)	156	194

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	156694	186433
Excavated Area (sq. Yd)	104429	130875

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	6103	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	1017	sq. Yd
Volume	2712	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	6103	6103
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	6103	6103
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	154	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	11.0	ft
Structure Height	14.0	ft
Number of Structures	1	
Volume per structure	240	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 18,000	
Area per structure	51	sq. Yd
Total Area	51	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	98187	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 392,748	
Other Cost	$ -	
Total cost per basin	$ 392,748	
Area per basin	104,430	sq. Yd
Total Area	104,430	sq. Yd

Structure Type	Structure Cost											
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	156,694	cu. Yd	$ 10.00	$ 1,566,940	104,429	sq. Yd	$ 9.00	$ 939,861	104,429	sq. Yd	$ 8.33	$ 870,242
Exc. Chl - LC Enhancement	Excavated	29,739	cu. Yd	$ 10.00	$ 297,390	26,446	sq. Yd	$ 9.00	$ 238,014	26,446	sq. Yd	$ 8.33	$ 220,383
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	2,712	cu. Yd	$ 75.00	$ 203,400	1,017	sq. Yd	$ -	$ -	1,017	sq. Yd	$ 25.00	$ 25,425
Drop Structures	Riprap	1	EA	$ 18,000.00	$ 18,000	51	sq. Yd	$ -	$ -	51	sq. Yd	$ 33.33	$ 1,700
Drop Str. - LC Enhancement	Riprap	1	EA	$ 1,800.00	$ 1,800	5	sq. Yd	$ -	$ -	5	sq. Yd	$ 33.33	$ 170
Sedimentation Basins		1	EA	$ 392,748.00	$ 392,748	104,430	sq. Yd	$ -	$ -	104,430	sq. Yd	$ 8.33	$ 870,250
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 939,861	Base Maintenance Cost			$ 1,767,617
						LC Enhancement Cost			$ 238,014	LC Enhancement Cost			$ 220,553
						Total Landscape Cost			$ 1,177,875	Total Maintenance Cost			$ 1,988,170

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,181,088	$ 299,190	$ 2,480,278
Contingency Cost (25% of Construction Cost)	$ 545,272	$ 74,798	$ 620,070
Engineering Design Cost (5% of Construction Cost)	$ 109,054	$ 14,960	$ 124,014
Total Construction Cost	$ 2,835,414	$ 388,947	$ 3,224,361

Land Cost

Channel Length	6103 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	14	2	$100,000	$ 200,000
LC Enhancement Buffer	50	7	$100,000	$ 700,000
Channel	154	21.6	$100,000	$ 2,160,000
Channel LC Enhancement	39	5.5	$100,000	$ 550,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	257	36.1		$ 3,610,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	23.6	$100,000	$ 2,360,000
LC Enhancement Cost	acre	12.5	$100,000	$ 1,250,000
Total Land Cost	acre	36.1	$100,000	$ 3,610,000

Total Cost

Base Total Cost	$ 7,902,892
Total Landscape Enhancement Cost	$ 2,097,514
Total Cost Including LC Enh.	$ 10,000,406

Open Channel

Structure ID	L40

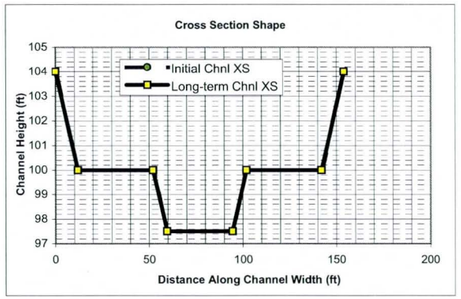
HEC1 ID	L40

Longitudinal Geometry

Length	8055.0	ft
U/S Elev	1119.1	ft
D/S Elev	1087.1	ft
Initial Channel Slope	0.0040	ft/ft
Long-term Channel Slope	0.0040	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	



Initial Channel XS Geometry

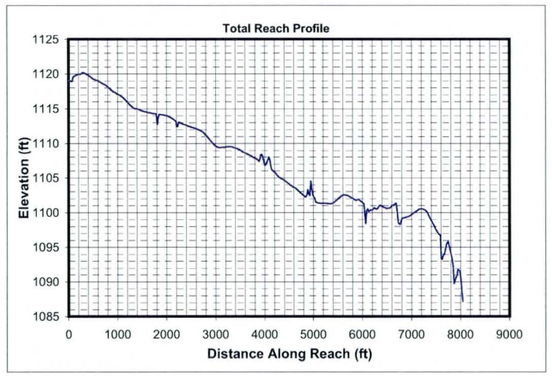
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	40	3	35	6.5	3	40	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	52	59.5	94.5	102	142	154
Y	104	100	100	97.5	97.5	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	40	3	35	6.5	3	40	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	52	59.5	94.5	102	142	154
Y	104	100	100	97.5	97.5	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	L								TOTAL
HEC1 Peak-Flow	2162								2162
Weighting Factor	1.00								
Flow into Channel	2162								2162

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	12.5	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	2162	cfs	
Long-term Max. Chnl Capacity	3745	cfs	
Q2 Channel	216	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	154	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
216	46.7	75.2	1.6	97.5	99.4	2.9	1.9	46.1	1.6	0.46	0.40
649	136.4	223.1	1.6	97.5	100.9	2.9	3.4	135.3	1.6	0.84	0.40
1622	144.2	395.3	2.7	97.5	102.1	4.1	4.6	142.7	2.8	1.15	0.43
2162	147.7	474.3	3.2	97.5	102.7	4.6	5.2	146.0	3.2	1.29	0.45

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
216	46.7	75.2	1.6	97.5	99.4	2.9	1.9	46.1	1.6	0.46	0.40
649	136.4	223.1	1.6	97.5	100.9	2.9	3.4	135.3	1.6	0.84	0.40
1622	144.2	395.3	2.7	97.5	102.1	4.1	4.6	142.7	2.8	1.15	0.43
2162	147.7	474.3	3.2	97.5	102.7	4.6	5.2	146.0	3.2	1.29	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
216										0
649										0
1622										0
2162										0

Allowable Velocity

Channel Lining: Natural - Coarse Gravel (noncolloidal)

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
216	1.74	1.5461	1.4688	Erosive	Erosive	Erosive	0.4	Stable	5.5	Stable	Stable
649	1.74	1.5497	1.4722	Erosive	Erosive	Erosive	0.4	Stable	7.5	Stable	Stable
1622	1.74	1.7096	1.6241	Erosive	Erosive	Erosive	0.4	Stable	9.5	Stable	Stable
2162	1.74	1.7518	1.6642	Erosive	Erosive	Erosive	0.5	Stable	10.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	6

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	216	649	1622	2162	216	649	1622	2162	216	649	1622	2162
Bray - Equation #1	40	72	117	136	1.6	2.3	3.1	3.4	3.4	3.9	4.4	4.6
Bray - Equation #2	53	95	154	179	1.8	2.5	3.4	3.8	2.3	2.7	3.1	3.2
Hey	12	23	38	44	5.0	7.5	10.7	11.9				
Ackers & Charlton/Lacey	34	55	80	91					2.0	2.4	2.7	2.9
Parker	101	175	277	319	1.3	2.0	3.0	3.4				
Chang	64	125	219	261	0.2	0.0	-0.3	-0.5				
Kellerhals	26	46	72	84	2.3	3.6	5.2	5.9	3.5	3.9	4.3	4.4
AMAFCA/Schumm	46	135	143	146								
Moody & Odem	32	32	32	32	1.4	1.4	1.4	1.4				
BUREC	20.8	31.4	44.3	49.3	6	8	12	13	2.9	3.9	4.9	5.2
Average	43	79	118	134	2.4	3.5	4.8	5.3	2.8	3.3	3.9	4.1
Values As Designed	46	135	143	146	1.9	3.4	4.6	5.2	2.9	2.9	4.1	4.6
Difference with Design	-3	-56	-25	-12	0.5	0.1	0.2	0.1	-0.1	0.4	-0.2	-0.5

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	797	387	568	1400	851	145	117	200	949	161	948	593
649	2442	1139	1714	4271	2517	443	357	612	2852	488	2900	1794
1622	9754	3551	4625	19522	3768	1685	1048	2392	7433	1291	11150	6020
2162	15011	4986	6343	31327	4260	2508	1428	3565	9979	1398	16713	8865

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	1368	664	975	2402	1460	248	201	342	1629	276	1626	1017
649	1397	651	981	2443	1440	253	204	350	1631	279	1659	1026
1622	2232	813	1058	4467	862	386	240	547	1701	295	2551	1377
2162	2576	856	1088	5376	731	430	245	612	1712	240	2868	1521

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	797	387	570	1415	855	145	117	200	960	162	954	597
649	2442	1140	1720	4316	2530	445	357	612	2884	493	2920	1805
1622	9754	3555	4641	19729	3785	1692	1048	2392	7514	1313	11221	6059
2162	15011	4990	6359	31659	4278	2519	1428	3565	10087	1422	16817	8921

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	1368	664	978	2428	1468	249	201	342	1647	278	1637	1024
649	1397	652	984	2469	1447	254	204	350	1650	282	1670	1033
1622	2232	813	1062	4514	866	387	240	547	1719	300	2567	1386
2162	2576	856	1091	5433	734	432	245	612	1731	244	2886	1531

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
216	0.0005	0.0007	149	0.45	0.048	0.0002	30	0.036	0.0001	0.0159	0.0002	0.0004	0.0058	0.0003	0.0014	0.0039	0.0026
649	0.0005	0.0007	150	0.46	0.048	0.0002	30	0.036	0.0001	0.0159	0.0002	0.0004	0.0058	0.0002	0.0006	0.0040	0.0026
1622	0.0003	0.0004	194	0.59	0.050	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0002	0.0058	0.0001	0.0003	0.0040	0.0025
2162	0.0002	0.0004	210	0.64	0.051	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0002	0.0058	0.0001	0.0002	0.0039	0.0025

Drop Structures

Design Slope	0.0040	ft/ft
Total Drop Needed	0.0	ft
Height of Drop Structure	3	ft
No . of Drop Structures	0	
Distance between structs.	N/A	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	5.85	sq. mi
Total Sediment Yield Volume	11.12	ac ft

Sedimentation Basins

Length	0 ft	Depth	3 ft
Width	154 ft	Side slope	3 ft/ft
Total Volume per Basin		0.00	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		0	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
216	1.1	-0.6	0.1	24.6	1.9	1.6	2.9	0.0040	0.2	0.0	2.5	3.6
649	1.1	-1.0	0.1	24.6	3.4	1.6	2.9	0.0040	0.4	0.0	2.5	3.8
1622	1.1	-1.2	0.2	24.6	4.6	2.8	4.1	0.0040	0.5	0.0	2.5	4.1
2162	1.1	-1.3	0.3	24.6	5.2	3.2	4.6	0.0040	0.6	0.0	2.5	4.2

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	237	cfs
Stage at Peak Flow	100.3	ft
Volume at Peak Flow	342.0	ac. ft

Freeboard

Max. Flow Depth	5.2	ft
Channel Depth as designed	6.5	ft
Available Freeboard	1.3	ft
Required Freeboard	1.4	ft

Sediment Volume

Inflowing Sediment Volume	11.12	ac. ft
Outflowing Sediment Volume	0.20	ac. ft
Deposited(+)/Eroded(-) Volume	10.92	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	8055	8055
Side Slope (?H:1V)	3	6
Channel Width (ft)	154	193
Channel XS Area (sq. ft)	674.2	800.95
Channel Perimeter (ft)	156	194

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	195952	232453
Excavated Area (sq. Yd)	137830	172735

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	8055	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	1343	sq. Yd
Volume	3580	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	8055	8055
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	8055	8055
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	154	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	11.0	ft	
Structure Height	14.0	ft	
Number of Structures	0		
Volume per structure	239	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 17,925		
Area per structure	51	sq. Yd	
Total Area	0	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	0	
Total Volume per Basin	0	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ -	
Other Cost	$ -	
Total cost per basin	$ -	
Area per basin	0	sq. Yd
Total Area	0	sq. Yd

Structure Type	Structure Cost											
	Excavation/Construction					Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	195,952	cu. Yd	$ 10.00	$ 1,959,520	137,830	sq. Yd	$ 9.00	$ 1,240,470	137,830	sq. Yd	$ 8.33	$ 1,148,583
Exc. Chl - LC Enhancement	Excavated	36,501	cu. Yd	$ 10.00	$ 365,010	34,905	sq. Yd	$ 9.00	$ 314,145	34,905	sq. Yd	$ 8.33	$ 290,875
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	3,580	cu. Yd	$ 75.00	$ 268,500	1,343	sq. Yd	$ -	$ -	1,343	sq. Yd	$ 25.00	$ 33,575
Drop Structures	Riprap	0	EA	$ 17,925.00	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 33.33	$ -
Drop Str. - LC Enhancement	Riprap	0	EA	$ 1,792.50	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 33.33	$ -
Sedimentation Basins		0	EA	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ 8.33	$ -
Other					$ -				$ -				$ -
Base Landscape Cost									$ 1,240,470	Base Maintenance Cost			$ 1,182,158
LC Enhancement Cost									$ 314,145	LC Enhancement Cost			$ 290,875
Total Landscape Cost									$ 1,554,615	Total Maintenance Cost			$ 1,473,033

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,228,020	$ 365,010	$ 2,593,030
Contingency Cost (25% of Construction Cost)	$ 557,005	$ 91,253	$ 648,258
Engineering Design Cost (5% of Construction Cost)	$ 111,401	$ 18,251	$ 129,652
Total Construction Cost	$ 2,896,426	$ 474,513	$ 3,370,939

Land Cost

Channel Length	8055 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	14	2.6	$100,000	$ 260,000
LC Enhancement Buffer	50	9.2	$100,000	$ 920,000
Channel	154	28.5	$100,000	$ 2,850,000
Channel LC Enhancement	39	7.2	$100,000	$ 720,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	257	47.5		$ 4,750,000

Total Cost

Base Total Cost	$ 8,429,054
Total Landscape Enhancement Cost	$ 2,719,533
Total Cost Including LC Enh.	$ 11,148,587

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	31.1	$100,000	$ 3,110,000
LC Enhancement Cost	acre	16.4	$100,000	$ 1,640,000
Total Land Cost	acre	47.5	$100,000	$ 4,750,000

Open Channel

Structure ID	RRP1A10

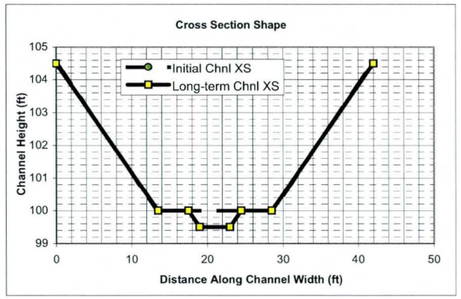
HEC1 ID	RRP1A10

Longitundal Geometry

Length	1465.1	ft
U/S Elev	1276.4	ft
D/S Elev	1305.2	ft
Initial Channel Slope	0.0196	ft/ft
Long-term Channel Slope	0.0090	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	



Initial Channel XS Geometry

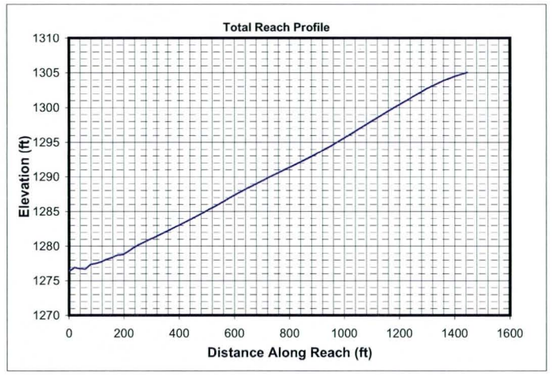
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	15	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	28.5	28.5	28.5	42
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	4	3	4	5	3	4	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	17.5	19	23	24.5	28.5	42
Y	104.5	100	100	99.5	99.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RRP1A								TOTAL
HEC1 Peak-Flow	87								87
Weighting Factor	1.00								
Flow into Channel	87								87

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	0.5	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	87	cfs	
Long-term Max. Chnl Capacity	857	cfs	
Q2 Channel	9	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	42	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
9	16.8	4.5	0.3	100.0	100.3	1.9	0.3	16.7	0.3	0.16	0.65
26	18.4	9.0	0.5	100.0	100.5	2.9	0.5	18.3	0.5	0.31	0.72
65	20.9	16.5	0.8	100.0	100.9	4.0	0.9	20.6	0.8	0.52	0.78
87	21.9	20.0	0.9	100.0	101.1	4.4	1.1	21.6	0.9	0.61	0.80

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
9	16.3	5.6	0.3	99.5	100.2	1.5	0.7	16.1	0.3	0.38	0.46
26	18.5	11.4	0.6	99.5	100.5	2.3	1.0	18.1	0.6	0.57	0.51
65	21.6	21.1	1.0	99.5	101.0	3.1	1.5	21.1	1.0	0.85	0.55
87	22.9	25.7	1.1	99.5	101.2	3.4	1.7	22.4	1.1	0.97	0.56

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)								TOTAL
9									0
26									0
65									0
87									0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
9	1.74	0.9917	0.9421	Erosive	Erosive	Erosive	0.2	Stable	3.9	Stable	Stable
26	1.74	1.1787	1.1198	Erosive	Erosive	Erosive	0.2	Stable	5.3	Stable	Stable
65	1.74	1.3270	1.2607	Erosive	Erosive	Erosive	0.3	Stable	6.9	Stable	Stable
87	1.74	1.3717	1.3031	Erosive	Erosive	Erosive	0.3	Stable	7.6	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	9	26	65	87	9	26	65	87	9	26	65	87
Bray - Equation #1	7	13	22	25	0.5	0.8	1.1	1.2	2.1	2.5	2.8	3.0
Bray - Equation #2	10	17	28	33	0.6	0.9	1.2	1.3	1.5	1.7	1.9	2.0
Hey	2	3	6	7	1.5	2.2	3.2	3.5				
Ackers & Charlton/Lacey	9	14	21	23					1.1	1.4	1.6	1.7
Parker	20	35	55	64	0.3	0.5	0.8	0.9				
Chang	12	23	40	48	0.1	0.1	0.0	0.0				
Kellerhals	5	9	15	17	0.6	1.0	1.4	1.6	2.5	2.8	3.1	3.2
AMAFCA/Schumm	16	18	21	22								
Moody & Odem	9	9	9	9	0.9	0.9	0.9	0.9				
BUREC	5.4	8.1	11.4	12.7	1	2	3	3	1.8	2.3	3.0	3.2
Average	10	15	23	26	0.8	1.1	1.5	1.6	1.8	2.2	2.5	2.6
Values As Designed	16	18	21	22	0.7	1.0	1.5	1.7	1.5	2.3	3.1	3.4
Difference with Design	-7	-3	2	4	0.1	0.0	-0.1	-0.1	0.3	-0.1	-0.6	-0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
9	88	58	128	169	266	30	27	14	417	29	94	120
26	458	226	462	1026	445	159	105	89	1315	121	493	445
65	1757	644	1169	4479	676	550	279	331	3339	417	1723	1397
87	2663	884	1521	7065	772	805	373	486	4463	617	2508	2014

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
9	3758	2455	5473	7197	11329	1286	1140	582	17774	1241	3994	5112
26	6515	3214	6564	14585	6324	2254	1498	1271	18693	1719	7010	6332
65	9987	3659	6647	25470	3844	3128	1585	1881	18983	2374	9795	7941
87	11355	3771	6487	30127	3293	3431	1591	2072	19033	2631	10696	8590

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
9	30	17	28	48	166	4	5	3	111	9	28	41
26	154	84	160	284	304	39	33	30	388	38	175	154
65	579	263	453	1214	489	147	101	126	1013	134	661	471
87	873	368	619	1900	567	217	139	189	1361	199	981	674

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
9	1289	744	1201	2039	7086	166	210	134	4751	377	1207	1746
26	2185	1198	2277	4044	4318	547	471	424	5514	541	2489	2183
65	3291	1494	2574	6903	2779	834	576	714	5759	760	3756	2676
87	3721	1571	2641	8103	2418	925	594	808	5803	847	4182	2874

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
9	0.0028	0.0045	135	0.41	0.047	0.0009	30	0.036	0.0007	0.0159	0.0009	0.0022	0.0170	0.0014	0.0057	0.0194	0.0100
26	0.0013	0.0024	183	0.56	0.050	0.0005	31	0.036	0.0004	0.0159	0.0005	0.0012	0.0170	0.0009	0.0025	0.0194	0.0096
65	0.0007	0.0015	232	0.71	0.052	0.0004	31	0.036	0.0002	0.0159	0.0003	0.0007	0.0170	0.0006	0.0013	0.0193	0.0094
87	0.0006	0.0013	249	0.76	0.053	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0170	0.0005	0.0010	0.0192	0.0093

Drop Structures

Design Slope	0.0090	ft/ft
Total Drop Needed	15.6	ft
Height of Drop Structure	3	ft
No . of Drop Structures	6	
Distance between structs.	244	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.00	sq. mi
Total Sediment Yield Volume	0.00	ac ft

Sedimentation Basins

Length	244 ft	Depth	3 ft
Width	42 ft	Side slope	3 ft/ft
Total Volume per Basin		0.54	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
9	1.1	-0.3	0.0	24.6	0.7	0.3	1.5	0.0090	0.1	1.5	3.0	6.0
26	1.1	-0.4	0.1	24.6	1.0	0.6	2.3	0.0090	0.1	1.5	3.0	6.0
65	1.1	-0.5	0.1	24.6	1.5	1.0	3.1	0.0090	0.2	1.5	3.0	6.1
87	1.1	-0.5	0.2	24.6	1.7	1.1	3.4	0.0090	0.2	1.5	3.0	6.2

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	976	cfs
Stage at Peak Flow	101.1	ft
Volume at Peak Flow	1026.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.4	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.00	ac. ft
Outflowing Sediment Volume	1.11	ac. ft
Deposited(+)/Eroded(-) Volume	-1.11	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1465	1465
Side Slope (?H:1V)	3	3
Channel Width (ft)	42	42
Channel XS Area (sq. ft)	131	131
Channel Perimeter (ft)	44	44

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1465	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	488	sq. Yd
Volume	1628	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1465	1465
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	6837	14162
Left Levee Volume (cu. Yd)	6728	15844
Right Levee Length (ft)	1465	1465
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	6837	14162
Right Levee Volume (cu. Yd)	6728	15844
Total Levee Surface Area (sq. Yd)	13674	28324
Total Levee Volume (cu. Yd)	13456	31688

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1465	1465
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	2279	5372
Left Levee Lining Volume (cu. Yd)	1139	2686
Right Levee Length (ft)	1465	1465
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	2279	5372
Right Levee Lining Volume (cu. Yd)	1139	2686
Total Lining Area (sq. Yd)	4558	10743
Total Lining Volume (cu. Yd)	2278	5372

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	42	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	5.1	ft	
Structure Height	8.1	ft	
Number of Structures	6		
Volume per structure	38	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 2,850		
Area per structure	14	sq. Yd	
Total Area	84	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	871	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 3,484	
Other Cost	$ -	
Total cost per basin	$ 3,484	
Area per basin	1,140	sq. Yd
Total Area	1,140	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	13,456	cu. Yd	$ 7.00	$ 94,192	13,674	sq. Yd	$ 9.00	$ 123,066	13,674	sq. Yd	$ 11.67	$ 159,530
Levee - LC Enhancement	Fill	18,232	cu. Yd	$ 7.00	$ 127,624	14,650	sq. Yd	$ 9.00	$ 131,850	18,232	sq. Yd	$ 11.67	$ 212,707
Levee Lining	Riprap	2,278	cu. Yd	$ 75.00	$ 170,850	4,558	sq. Yd	$ -	$ -	4,558	sq. Yd	$ 20.83	$ 94,954
Levee Lining -LC Enhancement	Riprap	3,094	cu. Yd	$ 75.00	$ 232,050	6,186	sq. Yd	$ -	$ -	6,186	sq. Yd	$ 20.83	$ 128,866
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	1,628	cu. Yd	$ 75.00	$ 122,100	488	sq. Yd	$ -	$ -	488	sq. Yd	$ 25.00	$ 12,200
Drop Structures	Riprap	6	EA	$ 2,850.00	$ 17,100	84	sq. Yd	$ -	$ -	84	sq. Yd	$ 33.33	$ 2,800
Drop Str. - LC Enhancement	Riprap	6	EA	$ 285.00	$ 1,710	8	sq. Yd	$ -	$ -	8	sq. Yd	$ 33.33	$ 280
Sedimentation Basins		1	EA	$ 3,484.00	$ 3,484	1,140	sq. Yd	$ -	$ -	1,140	sq. Yd	$ 8.33	$ 9,500
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 123,066	Base Maintenance Cost			$ 278,984
						LC Enhancement Cost			$ 131,850	LC Enhancement Cost			$ 341,852
						Total Landscape Cost			$ 254,916	Total Maintenance Cost			$ 620,836

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 407,726	$ 361,384	$ 769,110
Contingency Cost (25% of Construction Cost)	$ 101,932	$ 90,346	$ 192,278
Engineering Design Cost (5% of Construction Cost)	$ 20,386	$ 18,069	$ 38,456
Total Construction Cost	$ 530,044	$ 469,799	$ 999,843

Land Cost

Channel Length	1465 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	42	1.4	$100,000	$ 140,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	1.8	$100,000	$ 180,000
Levee LC Enhancement	51	1.7	$100,000	$ 170,000
Other	0	0	$100,000	$ -
Total	148	4.9		$ 490,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	3.2	$100,000	$ 320,000
LC Enhancement Cost	acre	1.7	$100,000	$ 170,000
Total Land Cost	acre	4.9	$100,000	$ 490,000

Total Cost

Base Total Cost	$ 1,252,094
Total Landscape Enhancement Cost	$ 1,113,502
Total Cost Including LC Enh.	$ 2,365,595

SUN VALLEY ADMP
Step 2 - Alt. B4-2
FRS No. 1

FRS No. 1 Sub-area

FEMA Floodplains

Floodplain

Floodway

Alluvial Fan Apices

Concentration Point

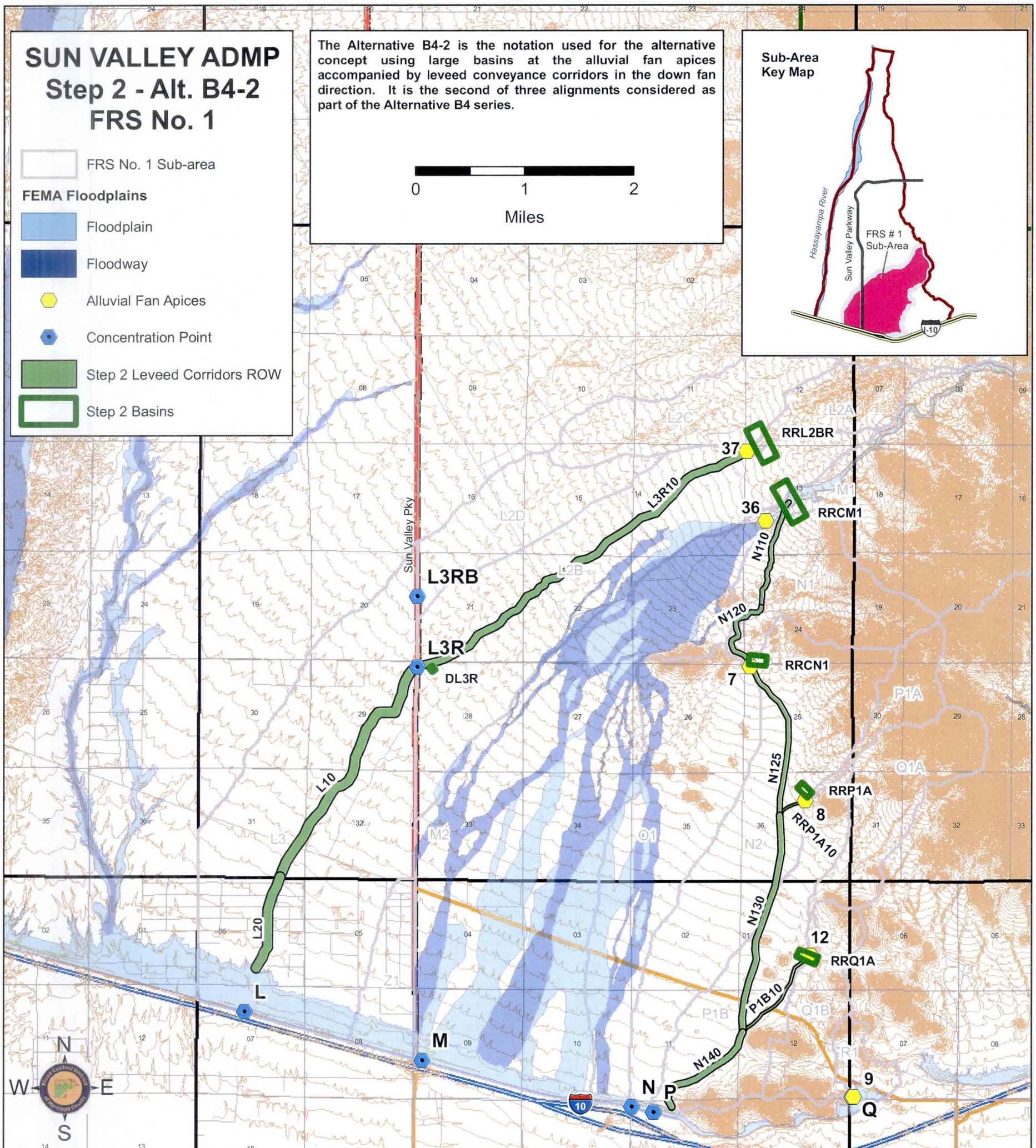
Step 2 Leveed Corridors ROW

Step 2 Basins

The Alternative B4-2 is the notation used for the alternative concept using large basins at the alluvial fan apices accompanied by leveed conveyance corridors in the down fan direction. It is the second of three alignments considered as part of the Alternative B4 series.

0 1 2

Miles



Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs (in $1000): Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Base Cost Percentages: Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RRL2BR	Online Basin	278	32	584	0	1800	780	10	$ 3,220	$ 5,057	$ 1,404	$ 1,336	$ 11,017	29%	46%	13%	12%	7%
L3R10	Leveed Chl.	1703	176	0	114	3.8	382	5	$17,620	$ 8,978	$ 1,688	$ 4,273	$ 32,558	54%	28%	5%	13%	22%
DL3R	Offline Basin	1585	1	6	0	260	200	4	$ 119	$ 153	$ 52	$ 58	$ 382	31%	40%	14%	15%	0%
L10	Leveed Chl.	3270	144	0	86	2.4	488	5	$14,420	$ 6,158	$ 1,184	$ 3,151	$ 24,913	58%	25%	5%	13%	17%
RRCM1	Online Basin	422	36	712	0	1980	800	11	$ 3,640	$ 6,137	$ 1,584	$ 1,505	$ 12,866	28%	48%	12%	12%	9%
N110	Leveed Chl.	873	28	0	26	1	226	4	$ 2,820	$ 2,219	$ 425	$ 1,040	$ 6,504	43%	34%	7%	16%	4%
N120	Leveed Chl.	1264	18	0	18	0.6	242	5	$ 1,760	$ 1,312	$ 265	$ 716	$ 4,053	43%	32%	7%	18%	3%
RRCN1	Online Basin	420	10	135	0	860	480	11	$ 950	$ 1,312	$ 413	$ 409	$ 3,084	31%	43%	13%	13%	2%
N125	Leveed Chl.	1276	45	0	46	1.5	242	5	$ 4,500	$ 3,237	$ 680	$ 1,648	$ 10,066	45%	32%	7%	16%	7%
RRP1A	Online Basin	87	6	62	0	700	360	8	$ 580	$ 643	$ 252	$ 254	$ 1,730	34%	37%	15%	15%	1%
N130	Leveed Chl.	1537	80	0	62	2.1	322	5	$ 8,020	$ 4,674	$ 912	$ 2,244	$ 15,849	51%	29%	6%	14%	11%
N140	Leveed Chl.	1645	43	0	38	1.1	328	5	$ 4,260	$ 2,412	$ 521	$ 1,366	$ 8,560	50%	28%	6%	16%	6%
RRQ1A	Online Basin	106	10	146	0	1000	420	11	$ 960	$ 1,358	$ 420	$ 419	$ 3,156	30%	43%	13%	13%	2%
P1B10	Leveed Chl.	303	15	0	29	1	127	5	$ 1,500	$ 1,811	$ 430	$ 1,016	$ 4,757	32%	38%	9%	21%	3%
L20	Leveed Chl.	3021	53	0	31	0.9	488	5	$ 5,250	$ 2,228	$ 432	$ 1,246	$ 9,156	57%	24%	5%	14%	6%
RRP1A10	Leveed Chl.	87	3	0	8	0.3	97	5	$ 320	$ 467	$ 123	$ 279	$ 1,189	27%	39%	10%	23%	1%
	TOTAL	700	1645	458					$69,939	$ 48,156	$10,785	$ 20,960	**$ 149,840**	47%	32%	7%	14%	100%
All Channels		605	0	458	14.7				$60,470	$ 33,496	$ 6,661	$ 16,978	$ 117,605	51%	28%	6%	14%	78%
All Online Basins		94	1639	0					$ 9,350	$ 14,507	$ 4,073	$ 3,923	$ 31,853	29%	46%	13%	12%	21%
All Offline Basins		1	6	0					$ 119	$ 153	$ 52	$ 58	$ 382	31%	40%	14%	15%	0%

Channel Cost per mile (in $1000)	$8,000	Basins Cost per ac. ft. (in $1000)	$2.51

Cost Increase for Landscape Compatibility Enhancement over Base Costs

All Channels % increase	15%	0%	135%				15%	77%	106%	109%	51%
All Online Basins % increase	45%	9%	0%				46%	9%	46%	45%	29%
All Offline Basins % increase	200%	0%	0%				135%	2%	137%	116%	79%
Total % increase	19%	9%	135%				19%	56%	83%	97%	47%

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Costs Summary

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs ($1000): Land Cost	Base Costs ($1000): Constr. Cost	Base Costs ($1000): Lndscp Cost	Base Costs ($1000): 50 Yr Maint. Cost	Base Costs ($1000): Total Cost	Base Cost Percentages: Land Cost %	Base Cost Percentages: Constr. Cost %	Base Cost Percentages: Lndscp Cost %	Base Cost Percentages: 50 Yr Maint. Cost %	Base Cost Percentages: % of Total Cost
RRL2BR	Online Basin	278	32	584	0	1800	780	10	$ 3,220	$ 5,057	$ 1,404	$ 1,336	$ 11,017	29%	46%	13%	12%	7%
L3R10	Leveed Chl.	1703	176	0	114	3.8	382	5	$ 17,620	$ 8,978	$ 1,688	$ 4,273	$ 32,558	54%	28%	5%	13%	22%
DL3R	Offline Basin	1585	1	6	0	260	200	4	$ 119	$ 153	$ 52	$ 58	$ 382	31%	40%	14%	15%	0%
L10	Leveed Chl.	3270	144	0	86	2.4	488	5	$ 14,420	$ 6,158	$ 1,184	$ 3,151	$ 24,913	58%	25%	5%	13%	17%
RRCM1	Online Basin	422	36	712	0	1980	800	11	$ 3,640	$ 6,137	$ 1,584	$ 1,505	$ 12,866	28%	48%	12%	12%	9%
N110	Leveed Chl.	873	28	0	26	1	226	4	$ 2,820	$ 2,219	$ 425	$ 1,040	$ 6,504	43%	34%	7%	16%	4%
N120	Leveed Chl.	1264	18	0	18	0.6	242	5	$ 1,760	$ 1,312	$ 265	$ 716	$ 4,053	43%	32%	7%	18%	3%
RRCN1	Online Basin	420	10	135	0	860	480	11	$ 950	$ 1,312	$ 413	$ 409	$ 3,084	31%	43%	13%	13%	2%
N125	Leveed Chl.	1276	45	0	46	1.5	242	5	$ 4,500	$ 3,237	$ 680	$ 1,648	$ 10,066	45%	32%	7%	16%	7%
RRP1A	Online Basin	87	6	62	0	700	360	8	$ 580	$ 643	$ 252	$ 254	$ 1,730	34%	37%	15%	15%	1%
N130	Leveed Chl.	1537	80	0	62	2.1	322	5	$ 8,020	$ 4,674	$ 912	$ 2,244	$ 15,849	51%	29%	6%	14%	11%
N140	Leveed Chl.	1645	43	0	38	1.1	328	5	$ 4,260	$ 2,412	$ 521	$ 1,366	$ 8,560	50%	28%	6%	16%	6%
RRQ1A	Online Basin	106	10	146	0	1000	420	11	$ 960	$ 1,358	$ 420	$ 419	$ 3,156	30%	43%	13%	13%	2%
P1B10	Leveed Chl.	303	15	0	29	1	127	5	$ 1,500	$ 1,811	$ 430	$ 1,016	$ 4,757	32%	38%	9%	21%	3%
L20	Leveed Chl.	3021	53	0	31	0.9	488	5	$ 5,250	$ 2,228	$ 432	$ 1,246	$ 9,156	57%	24%	5%	14%	6%
RRP1A10	Leveed Chl.	87	3	0	8	0.3	97	5	$ 320	$ 467	$ 123	$ 279	$ 1,189	27%	39%	10%	23%	1%
	TOTAL	700	1645	458					$ 69,939	$ 48,156	$ 10,785	$ 20,960	**$ 149,840**	47%	32%	7%	14%	100%
All Channels		605	0	458	14.7				$ 60,470	$ 33,496	$ 6,661	$ 16,978	$ 117,605	51%	28%	6%	14%	78%
All Online Basins		94	1639	0					$ 9,350	$ 14,507	$ 4,073	$ 3,923	$ 31,853	29%	46%	13%	12%	21%
All Offline Basins		1	6	0					$ 119	$ 153	$ 52	$ 58	$ 382	31%	40%	14%	15%	0%
Channel Cost per mile (in $1000)		$8,000		Basins Cost per ac. ft. (in $1000)					$2.51									

Cost Summary - Landscape Compatibility Enhanced (LCE)

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	LCE Design Geometry: Length (stor-ft; chl-mi)	LCE Design Geometry: ROW Width (ft)	LCE Design Geometry: Depth (ft)	LCE Costs ($1000): Land Cost	LCE Costs ($1000): Constr. Cost	LCE Costs ($1000): Lndscp Cost	LCE Costs ($1000): 50 Yr Maint. Cost	LCE Costs ($1000): Total Cost	LCE Cost Percentages: Land Cost %	LCE Cost Percentages: Constr. Cost %	LCE Cost Percentages: Lndscp Cost %	LCE Cost Percentages: 50 Yr Maint. Cost %	LCE Cost Percentages: % of Total Cost
RRL2BR	Online Basin	278	44	634	0	2190	880	10	$ 4,420	$ 5,478	$ 1,927	$ 1,827	$ 13,653	32%	40%	14%	13%	6%
L3R10	Leveed Chl.	1703	200	0	269	3.8	433	5	$ 19,970	$ 15,595	$ 3,496	$ 8,980	$ 48,042	42%	32%	7%	19%	22%
DL3R	Offline Basin	1585	3	6	0	410	300	4	$ 280	$ 156	$ 123	$ 126	$ 685	41%	23%	18%	18%	0%
L10	Leveed Chl.	3270	160	0	199	2.4	542	5	$ 16,020	$ 10,718	$ 2,394	$ 6,478	$ 35,611	45%	30%	7%	18%	16%
RRCM1	Online Basin	422	50	776	0	2420	900	11	$ 5,000	$ 6,678	$ 2,178	$ 2,063	$ 15,919	31%	42%	14%	13%	7%
N110	Leveed Chl.	873	34	0	62	1	274	4	$ 3,420	$ 3,808	$ 882	$ 2,161	$ 10,271	33%	37%	9%	21%	5%
N120	Leveed Chl.	1264	21	0	42	0.6	293	5	$ 2,130	$ 2,340	$ 550	$ 1,454	$ 6,474	33%	36%	8%	22%	3%
RRCN1	Online Basin	420	15	147	0	1150	580	11	$ 1,530	$ 1,410	$ 667	$ 650	$ 4,257	36%	33%	16%	15%	2%
N125	Leveed Chl.	1276	55	0	109	1.5	293	5	$ 5,450	$ 5,869	$ 1,410	$ 3,541	$ 16,270	33%	36%	9%	22%	7%
RRP1A	Online Basin	87	10	68	0	960	460	8	$ 1,020	$ 694	$ 442	$ 434	$ 2,589	39%	27%	17%	17%	1%
N130	Leveed Chl.	1537	93	0	146	2.1	373	5	$ 9,290	$ 8,220	$ 1,888	$ 4,783	$ 24,182	38%	34%	8%	20%	11%
N140	Leveed Chl.	1645	50	0	87	1.1	382	5	$ 4,960	$ 4,391	$ 1,054	$ 2,829	$ 13,234	37%	33%	8%	21%	6%
RRQ1A	Online Basin	106	17	165	0	1390	520	11	$ 1,660	$ 1,514	$ 723	$ 705	$ 4,601	36%	33%	16%	15%	2%
P1B10	Leveed Chl.	303	21	0	69	1	178	5	$ 2,100	$ 3,452	$ 891	$ 2,211	$ 8,655	24%	40%	10%	26%	4%
L20	Leveed Chl.	3021	58	0	72	0.9	542	5	$ 5,830	$ 3,882	$ 873	$ 2,458	$ 13,043	45%	30%	7%	19%	6%
RRP1A10	Leveed Chl.	87	5	0	20	0.3	148	5	$ 490	$ 936	$ 255	$ 621	$ 2,302	21%	41%	11%	27%	1%
	TOTAL	836	1796	1075					$ 83,570	$ 75,142	$ 19,753	$ 41,320	**$ 219,785**	38%	34%	9%	19%	100%
All Channels		697	0	1075	14.7				$ 69,660	$ 59,212	$ 13,693	$ 35,517	$ 178,082	39%	33%	8%	20%	81%
All Online Basins		136	1790	0					$ 13,630	$ 15,774	$ 5,937	$ 5,678	$ 41,018	33%	38%	14%	14%	19%
All Offline Basins		3	6	0					$ 280	$ 156	$ 123	$ 126	$ 685	41%	23%	18%	18%	0%
Channel Cost per mile (in $1000)		$12,114		Basins Cost per ac. ft. (in $1000)					$3.37									
All Channels % increase		15%	0%	135%					15%	77%	106%	109%	51%					
All Online Basins % increase		45%	9%	0%					46%	9%	46%	45%	29%					
All Offline Basins % increase		200%	0%	0%					135%	2%	137%	116%	79%					
Total % increase		19%	9%	135%					19%	56%	83%	97%	47%					

JE FULLER HYDROLOGY & GEOMORPHOLOGY, INC.

Hydrology - 6-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
R1	BASIN	506			4.2	0.28	47	12	4	2	1.525	1.527	1.527	1.527	23	23	23	23
Q1B	BASIN	851			4.5	0.94	155	39	13	6	1.533	1.544	1.544	1.544	77	77	77	77
DUMMY	COMBINE	1020			4.5	1.22	192	48	16	7	1.459	1.469	1.469	1.469	95	96	96	96
L1	BASIN	2128			4.7	3.55	543	139	46	20	1.424	1.453	1.453	1.453	269	275	275	275
L1-L2A	ROUTE	2066	14.4	40.14	4.9	3.55	543	139	46	20	1.423	1.453	1.453	1.453	269	275	275	275
L2A	BASIN	692			4.5	0.69	113	28	9	4	1.516	1.516	1.516	1.516	56	56	56	56
L2BR	COMBINE	2391			4.9	4.24	623	159	53	23	1.366	1.391	1.391	1.391	309	314	314	314
RRL2BR	STORAGE	278	8.6	241.92	7	4.24	261	153	53	23	0.573	1.347	1.391	1.391	130	304	314	314
L2AL2B	ROUTE	275	100.4	54.91	8.9	4.24	256	152	53	23	0.562	1.337	1.391	1.391	127	302	314	314
L2B	BASIN	1532			5	4.08	418	104	35	15	0.952	0.952	0.952	0.952	207	207	207	207
L3R	COMBINE	1321			5	8.32	486	228	79	34	0.543	1.022	1.057	1.057	241	453	469	469
DL3R	DIVERT	1321			5	8.32	486	228	79	34	0.543	1.022	1.057	1.057	241	453	469	469
L2BL3	ROUTE	1127	100.9	109.47	5.9	8.32	451	225	79	34	0.504	1.008	1.057	1.057	224	447	469	469
L2C	BASIN	754			4.8	1.33	161	40	13	6	1.125	1.125	1.125	1.125	80	80	80	80
L2C-2D	ROUTE	712	13	29.17	5.2	1.33	161	40	13	6	1.125	1.125	1.125	1.125	80	80	80	80
L2D	BASIN	706			4.7	1.23	136	34	11	5	1.025	1.025	1.025	1.025	67	67	67	67
L3RB	COMBINE	1043			5	2.56	260	65	22	9	0.945	0.946	0.946	0.946	129	129	129	129
L2D-L3	ROUTE	650	12.5	187.08	8.3	2.56	258	65	22	9	0.936	0.946	0.946	0.946	128	129	129	129
L3	BASIN	1832			5.2	5.85	581	146	49	21	0.923	0.926	0.926	0.926	288	289	289	289
L	COMBINE	1916			5.7	16.73	932	350	120	52	0.518	0.777	0.803	0.803	462	694	717	717
M1	BASIN	2809			4.8	5.69	790	203	68	29	1.291	1.327	1.327	1.327	392	402	402	402
RRCM1	STORAGE	414	9.3	289.98	6.8	5.69	384	201	68	29	0.628	1.317	1.327	1.327	191	399	402	402
M1-N1	ROUTE	414	100.6	18.85	7.2	5.69	384	201	68	29	0.628	1.316	1.327	1.327	190	399	402	402
N1	BASIN	1253			4.5	1.52	210	53	18	8	1.281	1.286	1.286	1.286	104	105	105	105
CN1	COMBINE	914			4.5	7.21	479	236	79	34	0.617	1.219	1.23	1.23	237	469	473	473
RRCN1	STORAGE	395	8.4	65	8.4	7.21	388	236	79	34	0.501	1.218	1.23	1.23	193	468	473	473
N1-P1A	ROUTE	395	100.8	23.07	8.8	7.21	388	236	79	34	0.5	1.217	1.23	1.23	192	468	473	473
N2A	BASIN	1253			4.5	1.52	210	53	18	8	1.281	1.286	1.286	1.286	104	105	105	105
CN2AR	COMBINE	856			4.5	8.73	465	269	91	39	0.495	1.144	1.16	1.16	231	533	540	540
P1A	BASIN	575			4.4	0.5	89	22	7	3	1.655	1.663	1.663	1.663	44	44	44	44
RRP1A	STORAGE	87	6.6	31.21	5.5	0.5	70	22	7	3	1.305	1.663	1.663	1.663	35	44	44	44
CN2A	COMBINE	900			4.5	9.23	516	282	95	41	0.519	1.137	1.152	1.152	256	560	568	568
P1A-1B	ROUTE	748	100.9	84.99	5.6	9.23	493	281	95	41	0.496	1.134	1.152	1.152	244	558	568	568
P1B	BASIN	852			5	1.94	244	62	21	9	1.172	1.194	1.194	1.194	121	123	123	123
PR	COMBINE	1106			5.5	11.17	600	317	108	47	0.499	1.055	1.077	1.077	298	629	641	641
Q1A	BASIN	990			4.5	1.3	193	49	16	7	1.385	1.396	1.396	1.396	96	97	97	97
RRQ1A	STORAGE	106	9.7	73.8	6.2	1.3	97	48	16	7	0.697	1.39	1.396	1.396	48	96	97	97
Q1A-P	ROUTE	106	100.8	4.28	6.5	1.3	97	48	16	7	0.696	1.389	1.396	1.396	48	96	97	97
P	COMBINE	1153			5.5	12.47	667	346	117	51	0.497	1.031	1.05	1.05	331	685	698	698
N2B	BASIN	1193			5.1	3.33	366	93	31	13	1.023	1.045	1.045	1.045	181	185	185	185
O1	BASIN	1057			5.3	3.09	343	88	29	13	1.033	1.059	1.059	1.059	170	174	174	174
M2	BASIN	1849			5.4	7.44	633	159	53	23	0.791	0.795	0.795	0.795	314	315	315	315
Z1	BASIN	694			4.5	0.66	100	25	8	4	1.405	1.406	1.406	1.406	50	50	50	50

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
R1	BASIN	387			12.2	0.28	37	10	3	1	1.223	1.322	1.322	1.322	19	20	20	20
Q1B	BASIN	740			12.5	0.94	134	38	13	5	1.325	1.498	1.5	1.5	66	75	75	75
DUMMY	COMBINE	902			12.5	1.22	170	48	16	7	1.294	1.448	1.45	1.45	84	94	94	94
L1	BASIN	2267			12.7	3.55	527	150	50	22	1.382	1.572	1.576	1.576	261	297	298	298
L1-L2A	ROUTE	2154	14.4	41.37	12.9	3.55	527	150	50	22	1.381	1.571	1.576	1.576	261	297	298	298
L2A	BASIN	570			12.5	0.69	92	23	8	3	1.236	1.236	1.236	1.236	46	46	46	46
L2BR	COMBINE	2519			12.9	4.24	616	172	57	25	1.351	1.509	1.513	1.513	305	341	342	342
RRL2BR	STORAGE	276	8.5	238.46	15	4.24	262	162	57	25	0.574	1.42	1.513	1.513	130	321	342	342
L2AL2B	ROUTE	274	100.4	54.78	16.9	4.24	258	161	57	25	0.565	1.414	1.513	1.513	128	320	342	342
L2B	BASIN	1700			13	4.08	449	112	37	16	1.024	1.024	1.024	1.024	223	223	223	223
L3R	COMBINE	1703			13	8.32	585	269	94	41	0.654	1.202	1.263	1.263	290	533	560	560
DL3R	DIVERT	1585			12.9	8.32	580	267	94	40	0.648	1.195	1.256	1.256	287	530	557	557
L2BL3	ROUTE	1443	101.1	127.74	13.8	8.32	544	263	94	40	0.608	1.178	1.256	1.256	270	523	557	557
L2C	BASIN	692			12.8	1.33	145	36	12	5	1.013	1.013	1.013	1.013	72	72	72	72
L2C-2D	ROUTE	651	12.9	27.24	13.2	1.33	145	36	12	5	1.013	1.013	1.013	1.013	72	72	72	72
L2D	BASIN	655			12.7	1.23	124	31	10	4	0.934	0.934	0.934	0.934	61	61	61	61
L3RB	COMBINE	1104			13	2.56	266	66	22	10	0.965	0.965	0.965	0.965	132	132	132	132
L2D-L3	ROUTE	705	12.5	201.22	16.1	2.56	263	66	22	10	0.956	0.965	0.965	0.965	130	132	132	132
L3	BASIN	2129			13.2	5.85	658	166	56	24	1.045	1.058	1.058	1.058	326	330	330	330
L	COMBINE	3021			13.5	16.73	1321	470	164	71	0.734	1.046	1.091	1.091	655	933	974	974
M1	BASIN	3301			12.8	5.69	825	236	79	34	1.349	1.543	1.548	1.548	409	468	469	469
RRCM1	STORAGE	422	9.6	301.43	14.9	5.69	396	227	79	34	0.648	1.483	1.548	1.548	196	450	469	469
M1-N1	ROUTE	421	100.6	19.04	15.2	5.69	396	227	79	34	0.647	1.483	1.548	1.548	196	450	469	469
N1	BASIN	1211			12.5	1.52	192	52	17	7	1.172	1.269	1.27	1.27	95	103	103	103
CN1	COMBINE	1264			12.5	7.21	525	276	96	41	0.677	1.421	1.481	1.481	260	547	570	570
RRCN1	STORAGE	420	9.5	74.55	16.3	7.21	415	275	96	41	0.535	1.42	1.481	1.481	206	546	570	570
N1-P1A	ROUTE	420	100.8	23.92	16.7	7.21	415	275	96	41	0.535	1.419	1.481	1.481	206	546	570	570
N2A	BASIN	1211			12.5	1.52	192	52	17	7	1.172	1.269	1.27	1.27	95	103	103	103
CN2AR	COMBINE	1276			12.5	8.73	537	323	113	49	0.572	1.376	1.437	1.437	266	641	670	670
P1A	BASIN	441			12.4	0.5	73	21	7	3	1.351	1.542	1.545	1.545	36	41	41	41
RRP1A	STORAGE	77	5.1	23.93	13.5	0.5	61	21	7	3	1.136	1.535	1.545	1.545	30	41	41	41
CN2A	COMBINE	1332			12.5	9.23	596	342	119	52	0.6	1.377	1.44	1.44	296	678	709	709
P1A-1B	ROUTE	994	101.1	101.34	13.4	9.23	572	341	119	52	0.575	1.375	1.44	1.44	283	677	709	709
P1B	BASIN	842			13	1.94	231	61	20	9	1.108	1.174	1.175	1.175	114	121	121	121
PR	COMBINE	1586			13.2	11.17	739	395	138	60	0.615	1.315	1.378	1.378	367	784	821	821
Q1A	BASIN	915			12.5	1.3	173	48	16	7	1.242	1.372	1.374	1.374	86	95	95	95
RRQ1A	STORAGE	100	8.7	65.43	14.1	1.3	92	47	16	7	0.658	1.338	1.374	1.374	46	93	95	95
Q1A-P	ROUTE	100	100.7	4.14	14.5	1.3	92	47	16	7	0.657	1.338	1.374	1.374	45	93	95	95
P	COMBINE	1645			13.2	12.47	821	436	152	66	0.612	1.302	1.362	1.362	407	866	906	906
N2B	BASIN	1331			13.1	3.33	378	99	33	14	1.057	1.102	1.103	1.103	187	195	196	196
O1	BASIN	1163			13.3	3.09	349	91	30	13	1.05	1.095	1.096	1.096	173	180	180	180
M2	BASIN	2347			13.4	7.44	786	198	66	29	0.983	0.989	0.99	0.99	390	392	392	392
Z1	BASIN	558			12.5	0.66	80	21	7	3	1.127	1.161	1.161	1.161	40	41	41	41

Channels Hydraulics Summary

		Design Geometry						Hydraulics										
Structure ID	Type	Initial Slope (ft/ft)	Long-term Slope (ft/ft)	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Chnl Mannings n	Flow Rate (cfs)	Wetted Perimeter (ft)	Wetted XS Area (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flow Depth (ft)	Freeboard (ft)	Top Width (ft)	Velocity (ft/s)	Froude Number	Shear Stress (lb/sq. ft)
L3R10	Leveed	0.0154	0.0060	3.80	3	4.5	0.045	1703	307.7	367.8	1.2	1.2	1.2	3.3	307	4.6	0.75	0.45
L10	Leveed	0.0093	0.0040	2.40	3	5.0	0.045	3270	411.1	711.4	1.7	1.7	1.8	3.2	411	4.6	0.62	0.44
N110	Leveed	0.0234	0.0080	1.00	3	4.0	0.045	873	156.8	165.9	1.1	1.1	1.1	2.9	156	5.3	0.90	0.54
N120	Leveed	0.0133	0.0050	0.60	3	4.5	0.045	1264	169.7	253.1	1.5	1.5	1.5	3.0	169	5.0	0.72	0.48
N125	Leveed	0.0131	0.0050	1.50	3	4.5	0.045	1276	169.8	255.9	1.5	1.5	1.6	2.9	169	5.0	0.71	0.48
N130	Leveed	0.0132	0.0050	2.10	3	4.5	0.045	1537	248.6	332.6	1.3	1.3	1.4	3.1	248	4.6	0.70	0.43
N140	Leveed	0.0072	0.0040	1.10	3	5.0	0.045	1645	250.8	416.7	1.7	1.7	1.7	3.3	250	3.9	0.54	0.42
P1B10	Leveed	0.0112	0.0060	1.00	3	4.5	0.045	303	54.2	71.7	1.3	1.3	1.5	3.0	54	4.2	0.64	0.54
L20	Leveed	0.0084	0.0040	0.90	3	5.0	0.045	3021	410.9	699.2	1.7	1.7	1.7	3.3	410	4.3	0.58	0.43
RRP1A10	Leveed	0.0196	0.0090	0.30	3	4.5	0.045	87	21.9	20.0	0.9	0.9	1.1	3.4	22	4.4	0.80	0.61

Basins Hydraulics Summary

			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac.	Peak Inflow into Basin (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Freeboard (ft)
RRL2BR	Online Basin	0.0240	1800	780	10.0	252.3	241.9	342.0	2519	278	8.6	1.4
DL3R	Offline Basin	0.0140	260	200	4.0	3.0	3.0	3.0	118	0	0.0	4.0
RRCM1	Online Basin	0.0250	1980	800	11.0	314.3	301.4	469.0	3301	422	9.6	1.4
RRCN1	Online Basin	0.0210	860	480	11.0	78.4	74.6	570.0	1264	420	9.5	1.5
RRP1A	Online Basin	0.0222	700	360	8.0	33.4	31.2	44.0	575	87	6.6	1.4
RRQ1A	Online Basin	0.0300	1000	420	11.0	76.6	73.8	97.0	990	106	9.7	1.3

Online Basin

HEC1 ID	RRL2BR

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	4.2	sq. mi
Total Sediment Yield Volume	8.1	ac ft

Required Minimum Sediment Volume

Sediment Volume	8.1	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.024	0.024
Basin Length (ft)	1800	2090
Basin Width (ft)	780	780
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	10	10
Freeboard (ft)	1	1
Effective Basin Width (ft)	724	668
Top Area (acres)	32.2	37.4
U/S-D/S Height Difference (ft)	18.7	18.7
Excess Area on Upstream (acres)	2.4	5.4

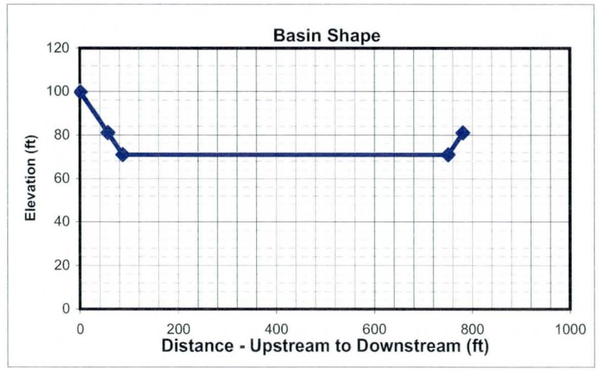
			Base	LC Enhanced
Bottom Length (ft)	1740	Allocated Storage Volume (ac. ft)	252.3	251.9
Bottom Width (ft)	664	Total Available Volume (ac. ft) (incl. Freeboard)	282.1	283.6
		Total Excavation Volume (ac. ft)	583.9	634.1

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	5.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	2	4	6	7	8	9	10	11	13
Volume	0.00	53.71	108.76	165.16	193.87	222.92	252.32	282.07	312.16	373.39
Outflow	0.0	133.7	189.1	231.6	250.1	267.4	283.6	299.0	313.6	340.9



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	314.0	342	342.0
Peak Inflow (cfs)	2391	2519	2519.0
Peak Outflow (cfs)	278	276	278.0
Stage at Peak Outflow (ft)	8.6	8.5	8.6
Volume at Peak Outflow (ac. ft)	241.9	238.46	241.9

Volume Check

Total Volume needed	250.0	ac. ft
Total Volume Provided	252.3	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	9.6	ft
Depth Provided	10	ft
Depth OK?	Yes	

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	523200	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	1800	ft
Base Total ROW Width	780	ft
LC Enh. Total ROW Length	2190	ft
LC Enh. Total ROW Length	880	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	942025	1023015
Excavated Area (sq. Yd)	156000	214133

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	91	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	1008	sq. Yd
Material Volume	504	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	526	ft
Unit Cost	160	per ft
Cost per outlet	$84,160	
Other Cost	$ -	
Total Cost	$84,160	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		942,025	cu. Yd	$ 4.00	$ 3,768,100	156,000	sq. Yd	$ 9.00	$ 1,404,000	156,000	sq. Yd	$ 8.33	$ 1,300,000
Basin - LC Enhancement		80,990	cu. Yd	$ 4.00	$ 323,960	58,133	sq. Yd	$ 9.00	$ 523,197	58,133	sq. Yd	$ 8.33	$ 484,442
Inlet	Riprap	504	sq. Yd	$ 75.00	$ 37,800	1,008	sq. Yd	$ -	$ -	1,008	sq. Yd	$ 33.33	$ 33,600
Inlet - LC Enhancement (20%Inlet)					$ 7,560				$ -				$ 6,720
Outlet	Pipe	1	EA	$ 84,160	$ 84,160	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 4,208				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,404,000	Base Maintenance Cost			$ 1,335,817
						LC Enh. Landscape Cost			$ 523,197	LC Enh. Maintenance Cost			$ 491,273
						Total Landscape Cost			$ 1,927,197	Total Maintenance Cost			$ 1,827,089

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,890,060	$ 323,960	$ 4,214,020
Contingency Cost (25% of Construction Cost)	$ 972,515	$ 80,990	$ 1,053,505
Engineering Design Cost (5% of Construction Cost)	$ 194,503	$ 16,198	$ 210,701
Total Construction Cost	$ 5,057,078	$ 421,148	$ 5,478,226

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	12.0	$100,000	$ 1,200,000
Basin	32.2	$100,000	$ 3,220,000
Other		$100,000	$ -
Total	44.2	$100,000	$ 4,420,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	32.2	$100,000	$ 3,220,000
LC Enhancement Cost	acre	12.0	$100,000	$ 1,200,000
Total Land Cost	acre	44.2	$100,000	$ 4,420,000

Total Cost

Base Total Cost	$ 11,016,895
Total LC Enhancement Cost	$ 2,635,618
Total Cost Including LC Enh.	$ 13,652,512

Open Channel

Structure ID	L3R10

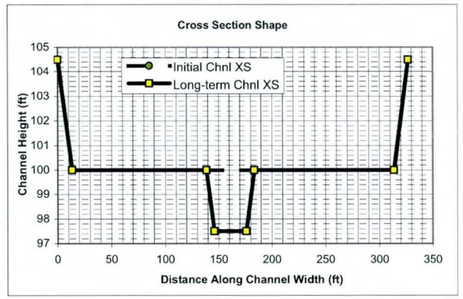
HEC1 ID	L2AL2B

Longitudal Geometry

Length	20092.5	ft
U/S Elev	1548.0	ft
D/S Elev	1238.5	ft
Initial Channel Slope	0.0154	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

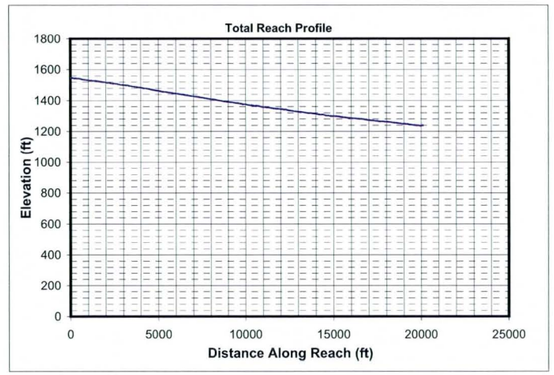
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	300	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	313.5	313.5	313.5	327
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	125	3	30	7	3	130	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	138.5	146	176	183.5	313.5	327
Y	104.5	100	100	97.5	97.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	L3R								TOTAL
HEC1 Peak-Flow	1703								1703
Weighting Factor	1.00								
Flow into Channel	1703								1703

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	4.08	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	1703	cfs	
Long-term Max. Chnl Capacity	10625	cfs	
Q2 Channel	170	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	327	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
170	301.9	91.8	0.3	100.0	100.3	1.9	0.3	301.8	0.3	0.11	0.59
511	303.7	177.6	0.6	100.0	100.6	2.9	0.6	303.5	0.6	0.22	0.66
1277	306.4	309.0	1.0	100.0	101.0	4.1	1.0	306.1	1.0	0.38	0.72
1703	307.7	367.8	1.2	100.0	101.2	4.6	1.2	307.3	1.2	0.45	0.75

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
170	39.9	54.1	1.4	97.5	99.1	3.1	1.6	39.4	1.4	0.58	0.47
511	303.8	235.8	0.8	97.5	100.5	2.2	3.0	302.8	0.8	1.11	0.43
1277	307.4	410.6	1.3	97.5	101.0	3.1	3.5	306.3	1.3	1.33	0.47
1703	309.0	489.0	1.6	97.5	101.3	3.5	3.8	307.8	1.6	1.42	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
170										0
511										0
1277										0
1703										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
170	1.74	1.0283	0.9769	Erosive	Erosive	Erosive	0.2	Stable	6.0	Stable	Stable
511	1.74	1.2303	1.1687	Erosive	Erosive	Erosive	0.3	Stable	7.6	Stable	Stable
1277	1.74	1.3983	1.3284	Erosive	Erosive	Erosive	0.3	Stable	9.1	Stable	Stable
1703	1.74	1.4509	1.3784	Erosive	Erosive	Erosive	0.3	Stable	9.7	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	170	511	1277	1703	170	511	1277	1703	170	511	1277	1703
Bray - Equation #1	36	64	103	120	1.5	2.1	2.9	3.2	3.2	3.8	4.3	4.5
Bray - Equation #2	47	84	136	158	1.6	2.3	3.2	3.5	2.2	2.6	3.0	3.1
Hey	11	20	33	39	4.5	6.9	9.8	10.9				
Ackers & Charlton/Lacey	31	49	73	82					1.9	2.3	2.6	2.8
Parker	90	155	246	284	1.2	1.8	2.7	3.0				
Chang	63	124	216	257	0.1	-0.1	-0.5	-0.7				
Kellerhals	23	41	64	74	2.1	3.3	4.8	5.3	3.4	3.8	4.2	4.3
AMAFCA/Schumm	39	303	307	308								
Moody & Odem	21	21	21	21	1.2	1.2	1.2	1.2				
BUREC	17.6	26.6	37.5	41.8	5	7	10	11	3.2	4.2	5.3	5.7
Average	38	89	124	138	2.1	3.1	4.2	4.7	2.8	3.3	3.9	4.1
Values As Designed	39	303	306	308	1.6	3.0	3.5	3.8	3.1	2.2	3.1	3.5
Difference with Design	-2	-214	-183	-169	0.5	0.1	0.7	0.9	-0.3	1.2	0.8	0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
170	1302	849	1768	2348	4362	383	360	192	5552	403	1374	1717
511	7135	3543	6802	15142	7040	2247	1553	1421	17828	1786	7828	6575
1277	29280	10435	17520	71453	10005	8237	4205	5604	45451	6618	29034	21622
1703	45572	14465	22760	116208	11109	12271	5638	8375	60798	10042	43074	31847

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
170	2837	1850	3852	5114	9502	835	783	418	12095	878	2992	3742
511	5182	2573	4939	10996	5112	1632	1128	1032	12946	1297	5684	4775
1277	8505	3031	5089	20755	2906	2393	1221	1628	13202	1922	8434	6281
1703	9928	3151	4958	25316	2420	2673	1228	1825	13245	2188	9384	6938

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
170	1055	482	734	2057	860	227	164	246	1427	226	1232	792
511	1923	1006	1767	3198	4368	380	357	381	3975	437	2180	1816
1277	7879	3449	5545	15063	6579	1693	1238	1830	10685	1670	9191	5893
1703	12261	4950	7624	24478	7406	2582	1734	2845	14413	2563	14087	8631

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
170	2297	1051	1599	4481	1874	494	356	535	3109	492	2683	1725
511	1396	731	1283	2323	3172	276	259	277	2886	317	1583	1318
1277	2289	1002	1611	4375	1911	492	360	532	3104	485	2670	1712
1703	2671	1078	1661	5333	1613	562	378	620	3140	558	3069	1880

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
170	0.0027	0.0040	127	0.39	0.046	0.0008	30	0.035	0.0006	0.0159	0.0008	0.0020	0.0063	0.0004	0.0028	0.0154	0.0060
511	0.0012	0.0021	177	0.54	0.049	0.0005	30	0.036	0.0003	0.0159	0.0004	0.0010	0.0063	0.0002	0.0012	0.0154	0.0057
1277	0.0006	0.0012	232	0.71	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0063	0.0001	0.0006	0.0154	0.0056
1703	0.0005	0.0010	253	0.77	0.053	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0063	0.0001	0.0005	0.0154	0.0056

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	189.0	ft
Height of Drop Structure	3	ft
No . of Drop Structures	63	
Distance between structs.	319	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	3.87	sq. mi
Total Sediment Yield Volume	7.34	ac ft

Sedimentation Basins

Length	319 ft	Depth	3 ft
Width	327 ft	Side slope	3 ft/ft
Total Volume per Basin		6.79	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		4	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
170	1.1	-0.5	0.1	24.6	1.6	1.4	3.1	0.0060	0.2	1.5	2.5	5.5
511	1.1	-1.0	0.1	24.6	3.0	0.8	2.2	0.0060	0.3	1.5	2.5	5.6
1277	1.1	-1.1	0.1	24.6	3.5	1.3	3.1	0.0060	0.4	1.5	2.5	5.8
1703	1.1	-1.1	0.2	24.6	3.8	1.6	3.5	0.0060	0.4	1.5	2.5	5.9

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	275	cfs
Stage at Peak Flow	100.4	ft
Volume at Peak Flow	342.0	ac. ft

Freeboard

Max. Flow Depth	1.2	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	7.34	ac. ft
Outflowing Sediment Volume	0.24	ac. ft
Deposited(+)/Eroded(-) Volume	7.10	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	20093	20093
Side Slope (?H:1V)	3	3
Channel Width (ft)	327	327
Channel XS Area (sq. ft)	1504.5	1504.5
Channel Perimeter (ft)	329	329

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	20093	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	6698	sq. Yd
Volume	20093	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	20093	20093
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	93767	194232
Left Levee Volume (cu. Yd)	92279	217302
Right Levee Length (ft)	20093	20093
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	93767	194232
Right Levee Volume (cu. Yd)	92279	217302
Total Levee Surface Area (sq. Yd)	187534	388464
Total Levee Volume (cu. Yd)	184558	434604

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	20093	20093
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	31256	73674
Left Levee Lining Volume (cu. Yd)	15628	36837
Right Levee Length (ft)	20093	20093
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	31256	73674
Right Levee Lining Volume (cu. Yd)	15628	36837
Total Lining Area (sq. Yd)	62512	147349
Total Lining Volume (cu. Yd)	31256	73674

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	327	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	6.3	ft	
Structure Height	9.3	ft	
Number of Structures	63		
Volume per structure	336	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 25,200		
Area per structure	109	sq. Yd	
Total Area	6,867	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	4	
Total Volume per Basin	10955	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 43,820	
Other Cost	$ -	
Total cost per basin	$ 43,820	
Area per basin	11,588	sq. Yd
Total Area	46,352	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	184,558	cu. Yd	$ 7.00	$ 1,291,906	187,534	sq. Yd	$ 9.00	$ 1,687,806	187,534	sq. Yd	$ 11.67	$ 2,187,897
Levee - LC Enhancement	Fill	250,046	cu. Yd	$ 7.00	$ 1,750,322	200,930	sq. Yd	$ 9.00	$ 1,808,370	250,046	sq. Yd	$ 11.67	$ 2,917,203
Levee Lining	Riprap	31,256	cu. Yd	$ 75.00	$ 2,344,200	62,512	sq. Yd	$ -	$ -	62,512	sq. Yd	$ 20.83	$ 1,302,324
Levee Lining -LC Enhancement	Riprap	42,418	cu. Yd	$ 75.00	$ 3,181,350	84,837	sq. Yd	$ -	$ -	84,837	sq. Yd	$ 20.83	$ 1,767,440
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	20,093	cu. Yd	$ 75.00	$ 1,506,975	6,698	sq. Yd	$ -	$ -	6,698	sq. Yd	$ 25.00	$ 167,450
Drop Structures	Riprap	63	EA	$ 25,200.00	$ 1,587,600	6,867	sq. Yd	$ -	$ -	6,867	sq. Yd	$ 33.33	$ 228,900
Drop Str. - LC Enhancement	Riprap	63	EA	$ 2,520.00	$ 158,760	687	sq. Yd	$ -	$ -	687	sq. Yd	$ 33.33	$ 22,890
Sedimentation Basins		4	EA	$ 43,820.00	$ 175,280	46,352	sq. Yd	$ -	$ -	46,352	sq. Yd	$ 8.33	$ 386,267
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,687,806	Base Maintenance Cost			$ 4,272,837
						LC Enhancement Cost			$ 1,808,370	LC Enhancement Cost			$ 4,707,533
						Total Landscape Cost			$ 3,496,176	Total Maintenance Cost			$ 8,980,371

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 6,905,961	$ 5,090,432	$ 11,996,393
Contingency Cost (25% of Construction Cost)	$ 1,726,490	$ 1,272,608	$ 2,999,098
Engineering Design Cost (5% of Construction Cost)	$ 345,298	$ 254,522	$ 599,820
Total Construction Cost	$ 8,977,749	$ 6,617,562	$ 15,595,311

Land Cost

Channel Length	20093	ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	327	150.8	$100,000	$ 15,080,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	25.4	$100,000	$ 2,540,000
Levee LC Enhancement	51	23.5	$100,000	$ 2,350,000
Other	0	0	$100,000	$ -
Total	433	199.7		$ 19,970,000

Total Cost

Base Total Cost	$	32,558,393
Total Landscape Enhancement Cost	$	15,483,465
Total Cost Including LC Enh.	$	48,041,857

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	176.2	$100,000	$ 17,620,000
LC Enhancement Cost	acre	23.5	$100,000	$ 2,350,000
Total Land Cost	acre	199.7	$100,000	$ 19,970,000

Offline Basin

HEC1 ID	DL3R

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.0	sq. mi
Total Sediment Yield Volume	0.0	ac ft

Required Minimum Sediment Volume

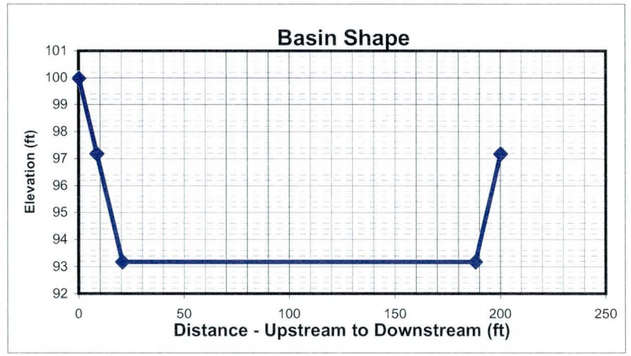
Sediment Volume	0.0	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.014	0.014
Basin Length (ft)	260	310
Basin Width (ft)	200	200
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	4	4
Freeboard (ft)	1	1
Effective Basin Width (ft)	191.6	183.2
Top Area (acres)	1.2	1.4
U/S-D/S Height Difference (ft)	2.8	2.8
Excess Area on Upstream (acres)	0.1	0.1

			Base	LC Enhanced
Bottom Length (ft)	236	Allocated Storage Volume (ac. ft)	3.0	3
Bottom Width (ft)	167.6	Total Available Volume (ac. ft) (incl. Freeboard)	4.1	4.2
		Total Excavation Volume (ac. ft)	5.8	6.2

Stage-Storage-Discharge

Stage (ft)	0	1.6	2.5	3.3	4.5	5	5.7	7.5	8.3	9	9.6	
Inflow (cfs)	0	360	720	1080	1440	1585	1820	2520	2880	3240	3600	
Outflow (cfs)	0	0	0	0	0	0	235	935	1295	1655	2015	



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Peak flow before diversion (cfs)	1321	1703	1703
Peak flow after diversion (cfs)	1321	1585	1585
Diverted Peak Flow (cfs)	0	118	118
Total Diverted Flow Volume (ac. ft)	0.0	3	3.0
Peak Stage	0	ft	

Volume Check			***Stage Check***	
Total Volume needed	3.0	ac. ft	Depth Needed	1.0
Total Volume Provided	3.0	ac. ft	Depth Provided	4

Volume OK?	Yes	Depth OK?	Yes

Culvert at Sta. 195+10

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
Landscape Enhancement	71000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	260	ft
Base Total ROW Width	200	ft
LC Enh. Total ROW Length	410	ft
LC Enh. Total ROW Length	300	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	9357	10003
Excavated Area (sq. Yd)	5778	13667

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	22	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	239	sq. Yd
Material Volume	120	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	444	ft
Unit Cost	160	per ft
Cost per outlet	$71,040	
Other Cost	$ -	
Total Cost	$71,040	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction					Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		9,357	cu. Yd	$ 4.00	$ 37,428	5,778	sq. Yd	$ 9.00	$ 52,002	5,778	sq. Yd	$ 8.33	$ 48,150
Basin - LC Enhanced		646	cu. Yd	$ 4.00	$ 2,584	7,889	sq. Yd	$ 9.00	$ 71,001	7,889	sq. Yd	$ 8.33	$ 65,742
Inlet	Riprap	120	sq. Yd	$ 75.00	$ 9,000	239	sq. Yd	$ -	$ -	239	sq. Yd	$ 33.33	$ 7,967
Inlet - LC Enhanced (20%Total)					$ 1,800				$ -				$ 1,593
Outlet	Pipe	1	EA	$ 71,040	$ 71,040	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhanced (5%Total)					$ 3,552				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 52,002	Base Maintenance Cost			$ 58,333
						LC Enh. Landscape Cost			$ 71,001	LC Enh. Maintenance Cost			$ 67,446
						Total Landscape Cost			$ 123,003	Total Maintenance Cost			$ 125,779

Construction Cost Component	Base	LC Enhanced	Total
Construction Cost	$ 117,468	$ 2,584	$ 120,052
Contingency Cost (25% of Construction Cost)	$ 29,367	$ 646	$ 30,013
Engineering Design Cost (5% of Construction Cost)	$ 5,873	$ 129	$ 6,003
Total Construction Cost	$ 152,708	$ 3,359	$ 156,068

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	1.6	$100,000	$ 162,994
Basin	1.2	$100,000	$ 120,000
Other		$100,000	$ -
Total	2.8	$100,000	$ 280,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	1.2	$100,000	$ 119,376
LC Enhancement Cost	acre	1.6	$100,000	$ 160,624
Total Land Cost	acre	2.8	$100,000	$ 280,000

Total Cost

Base Total Cost	$ 382,419
Total LC Enhancement Cost	$ 302,430
Total Cost Including LC Enh.	$ 684,850

Open Channel

Structure ID	L10	HEC1 ID	L2BL3

Longitudnal Geometry

Length	12870.8	ft
U/S Elev	1238.5	ft
D/S Elev	1119.1	ft
Initial Channel Slope	0.0093	ft/ft
Long-term Channel Slope	0.0040	ft/ft

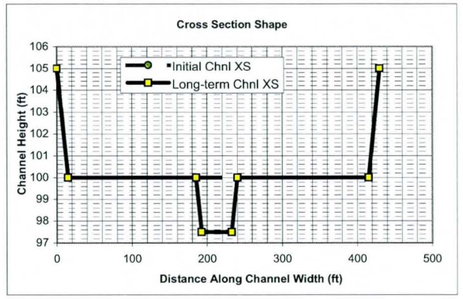
Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	6

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	400	5	3	0	5	3

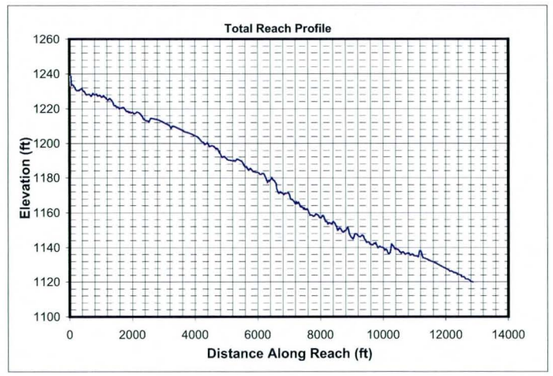
PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	415	415	415	430
Y	105	100	100	100	100	100	100	105



Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	170	3	40	7.5	3	175	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	185	192.5	232.5	240	415	430
Y	105	100	100	97.5	97.5	100	100	105



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	L2BL3	L2D-L3	L3						TOTAL
HEC1 Peak-Flow	1443	705	2129						4277
Weighting Factor	1.00	1.00	0.53						
Flow into Channel	1443	705	1122						3270

Reach Sediment Inflow Characteristics

U/S Contributing ID	L2AL2B_L3R10								TOTAL
Flow Volume (ac. ft)	342.00								342
Sediment Conc. (ppm)	1880								
Sediment Volume (ac. ft)	0.24								0.24
Weighting Factor									
Weighted Sed. Vol. (ac. ft)	0.00								0.00

Hydrology

Drainage Area	13.962	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	3270	cfs	
Long-term Max. Chnl Capacity	13563	cfs	
Q2 Channel	327	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	430	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
327	402.8	177.3	0.4	100.0	100.4	1.8	0.4	402.7	0.4	0.11	0.49
981	405.4	343.5	0.8	100.0	100.9	2.9	0.9	405.1	0.8	0.21	0.55
2453	409.3	597.6	1.5	100.0	101.5	4.1	1.5	408.9	1.5	0.37	0.60
3270	411.1	711.4	1.7	100.0	101.8	4.6	1.8	410.5	1.7	0.44	0.62

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
327	53.9	102.0	1.9	97.5	99.7	3.2	2.2	53.1	1.9	0.55	0.41
981	405.9	442.3	1.1	97.5	100.8	2.2	3.3	404.8	1.1	0.82	0.37
2453	411.0	770.4	1.9	97.5	101.6	3.2	4.1	409.7	1.9	1.03	0.41
3270	413.3	917.5	2.2	97.5	102.0	3.6	4.5	411.8	2.2	1.11	0.42

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
	L2AL2B_L3R10									
327	792									792
981	1816									1816
2453	5893									5893
3270	8631									8631

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
327	1.74	1.1426	1.0854	Erosive	Erosive	Erosive	0.2	Stable	6.2	Stable	Stable
981	1.74	1.3445	1.2773	Erosive	Erosive	Erosive	0.3	Stable	6.9	Stable	Stable
2453	1.74	1.5125	1.4369	Erosive	Erosive	Erosive	0.4	Stable	8.4	Stable	Stable
3270	1.74	1.5650	1.4867	Erosive	Erosive	Erosive	0.4	Stable	9.1	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	327	981	2453	3270	327	981	2453	3270	327	981	2453	3270
Bray - Equation #1	50	90	146	169	1.8	2.6	3.6	3.9	3.6	4.1	4.7	4.9
Bray - Equation #2	66	118	191	223	2.0	2.9	3.9	4.3	2.4	2.8	3.2	3.4
Hey	15	29	48	56	5.8	8.8	12.5	14.0				
Ackers & Charlton/Lacey	41	65	95	108					2.1	2.5	2.9	3.1
Parker	124	215	340	393	1.5	2.4	3.5	4.0				
Chang	82	161	281	335	0.2	-0.1	-0.6	-0.8				
Kellerhals	33	56	89	103	2.8	4.3	6.2	6.9	3.6	4.1	4.5	4.6
AMAFCA/Schumm	53	405	410	412								
Moody & Odem	33	33	33	33	1.4	1.4	1.4	1.4				
BUREC	24.3	36.7	51.7	57.6	6	10	14	15	3.3	4.3	5.4	5.8
Average	52	121	169	189	2.8	4.0	5.5	6.1	3.0	3.6	4.2	4.4
Values As Designed	53	405	410	412	2.2	3.3	4.1	4.5	3.2	2.2	3.2	3.6
Difference with Design	-1	-284	-241	-223	0.6	0.7	1.4	1.7	-0.2	1.4	1.0	0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
327	1512	936	1674	2518	5209	326	327	229	4788	402	1604	1775
981	8270	4097	7082	16235	8568	2136	1580	1758	15798	1900	9437	6987
2453	33926	12340	19168	76571	12297	7979	4416	7048	40574	7296	35868	23408
3270	52819	17199	24757	124510	13685	11912	5960	10576	54339	11176	53615	34595

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
327	1715	1062	1899	2857	5910	370	371	260	5432	456	1820	2014
981	3128	1549	2678	6140	3240	808	597	665	5975	718	3569	2642
2453	5132	1867	2900	11583	1860	1207	668	1066	6138	1104	5426	3541
3270	5993	1951	2809	14126	1553	1352	676	1200	6165	1268	6083	3925

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
327	1399	632	873	2589	1106	255	191	354	1478	281	1670	984
981	2568	1331	2028	4053	5535	411	398	565	4052	537	2944	2220
2453	10523	4611	6604	19083	8403	1915	1447	2658	11064	2090	12536	7358
3270	16371	6629	9014	31004	9479	2935	2040	4116	14960	3226	19285	10823

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
327	1587	718	990	2937	1254	289	216	402	1676	319	1895	1117
981	971	503	767	1533	2093	155	151	214	1533	203	1113	840
2453	1592	698	999	2887	1271	290	219	402	1674	316	1896	1113
3270	1857	752	1023	3518	1075	333	231	467	1697	366	2188	1228

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
327	0.0020	0.0028	119	0.36	0.046	0.0006	29	0.035	0.0004	0.0159	0.0006	0.0014	0.0051	0.0003	0.0021	0.0093	0.0040
981	0.0009	0.0014	165	0.50	0.049	0.0003	30	0.036	0.0002	0.0159	0.0003	0.0007	0.0051	0.0002	0.0009	0.0093	0.0038
2453	0.0005	0.0008	217	0.66	0.051	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0051	0.0001	0.0005	0.0093	0.0037
3270	0.0004	0.0007	236	0.72	0.052	0.0002	31	0.036	0.0001	0.0159	0.0001	0.0003	0.0051	0.0001	0.0004	0.0093	0.0037

Drop Structures

Design Slope	0.0040	ft/ft
Total Drop Needed	67.9	ft
Height of Drop Structure	3	ft
No . of Drop Structures	23	
Distance between structs.	560	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	3.08	sq. mi
Total Sediment Yield Volume	5.86	ac ft

Sedimentation Basins

Length	560 ft	Depth	3 ft
Width	430 ft	Side slope	3 ft/ft
Total Volume per Basin		15.97	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
327	1.1	-0.7	0.1	24.6	2.2	1.9	3.2	0.0040	0.2	1.5	2.5	5.6
981	1.1	-1.1	0.1	24.6	3.3	1.1	2.2	0.0040	0.3	1.5	2.5	5.7
2453	1.1	-1.2	0.1	24.6	4.1	1.9	3.2	0.0040	0.4	1.5	2.5	5.9
3270	1.1	-1.3	0.2	24.6	4.5	2.2	3.6	0.0040	0.5	1.5	2.5	6.0

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	1443	cfs
Stage at Peak Flow	101.1	ft
Volume at Peak Flow	557.0	ac. ft

Freeboard

Max. Flow Depth	1.8	ft
Channel Depth as designed	5.0	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	5.86	ac. ft
Outflowing Sediment Volume	0.26	ac. ft
Deposited(+)/Eroded(-) Volume	5.60	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	12871	12871
Side Slope (?H:1V)	3	3
Channel Width (ft)	430	430
Channel XS Area (sq. ft)	2193.8	2193.8
Channel Perimeter (ft)	432	432

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	12871	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	4290	sq. Yd
Volume	12871	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	12871	12871
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	5	6
Left Levee Surface Area (sq. Yd)	65785	133000
Left Levee Volume (cu. Yd)	69122	160172
Right Levee Length (ft)	12871	12871
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5	6
Right Levee Surface Area (sq. Yd)	65785	133000
Right Levee Volume (cu. Yd)	69122	160172
Total Levee Surface Area (sq. Yd)	131570	266000
Total Levee Volume (cu. Yd)	138244	320344

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	12871	12871
Left Levee Lining Width (ft)	16	36
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	22882	51484
Left Levee Lining Volume (cu. Yd)	11441	25742
Right Levee Length (ft)	12871	12871
Right Levee Lining Width (ft)	16	36
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	22882	51484
Right Levee Lining Volume (cu. Yd)	11441	25742
Total Lining Area (sq. Yd)	45764	102968
Total Lining Volume (cu. Yd)	22882	51484

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	430	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	7.7	ft	
Structure Height	10.7	ft	
Number of Structures	23		
Volume per structure	511	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 38,325		
Area per structure	143	sq. Yd	
Total Area	3,297	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	25765	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 103,060	
Other Cost	$ -	
Total cost per basin	$ 103,060	
Area per basin	26,736	sq. Yd
Total Area	53,472	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	138,244	cu. Yd	$ 7.00	$ 967,708	131,570	sq. Yd	$ 9.00	$ 1,184,130	131,570	sq. Yd	$ 11.67	$ 1,534,983
Levee - LC Enhancement	Fill	182,100	cu. Yd	$ 7.00	$ 1,274,700	134,430	sq. Yd	$ 9.00	$ 1,209,870	182,100	sq. Yd	$ 11.67	$ 2,124,500
Levee Lining	Riprap	22,882	cu. Yd	$ 75.00	$ 1,716,150	45,764	sq. Yd	$ -	$ -	45,764	sq. Yd	$ 20.83	$ 953,407
Levee Lining -LC Enhancement	Riprap	28,602	cu. Yd	$ 75.00	$ 2,145,150	57,204	sq. Yd	$ -	$ -	57,204	sq. Yd	$ 20.83	$ 1,191,759
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	12,871	cu. Yd	$ 75.00	$ 965,325	4,290	sq. Yd	$ -	$ -	4,290	sq. Yd	$ 25.00	$ 107,250
Drop Structures	Riprap	23	EA	$ 38,325.00	$ 881,475	3,297	sq. Yd	$ -	$ -	3,297	sq. Yd	$ 33.33	$ 109,900
Drop Str. - LC Enhancement	Riprap	23	EA	$ 3,832.50	$ 88,148	330	sq. Yd	$ -	$ -	330	sq. Yd	$ 33.33	$ 10,990
Sedimentation Basins		2	EA	$ 103,060.00	$ 206,120	53,472	sq. Yd	$ -	$ -	53,472	sq. Yd	$ 8.33	$ 445,600
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,184,130	Base Maintenance Cost			$ 3,151,141
						LC Enhancement Cost			$ 1,209,870	LC Enhancement Cost			$ 3,327,249
						Total Landscape Cost			$ 2,394,000	Total Maintenance Cost			$ 6,478,390

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 4,736,778	$ 3,507,998	$ 8,244,776
Contingency Cost (25% of Construction Cost)	$ 1,184,195	$ 876,999	$ 2,061,194
Engineering Design Cost (5% of Construction Cost)	$ 236,839	$ 175,400	$ 412,239
Total Construction Cost	$ 6,157,811	$ 4,560,397	$ 10,718,208

Land Cost

Channel Length	12871 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	430	127.1	$100,000	$ 12,710,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	58	17.1	$100,000	$ 1,710,000
Levee LC Enhancement	54	16	$100,000	$ 1,600,000
Other	0	0	$100,000	$ -
Total	542	160.2		$ 16,020,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	144.2	$100,000	$ 14,420,000
LC Enhancement Cost	acre	16	$100,000	$ 1,600,000
Total Land Cost	acre	160.2	$100,000	$ 16,020,000

Total Cost

Base Total Cost	$ 24,913,082
Total Landscape Enhancement Cost	$ 10,697,516
Total Cost Including LC Enh.	$ 35,610,598

Online Basin

HEC1 ID	RRCM1

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	5.7	sq. mi
Total Sediment Yield Volume	10.8	ac ft

Required Minimum Sediment Volume

Sediment Volume	10.8	ac. ft

Geometry

	Base	LC Enhanced
Topography slope (ft/ft)	0.025	0.025
Basin Length (ft)	1980	2320
Basin Width (ft)	800	800
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	11	11
Freeboard (ft)	1	1
Effective Basin Width (ft)	740	680
Top Area (acres)	36.4	42.6
U/S-D/S Height Difference (ft)	20.0	20.0
Excess Area on Upstream (acres)	2.9	6.5

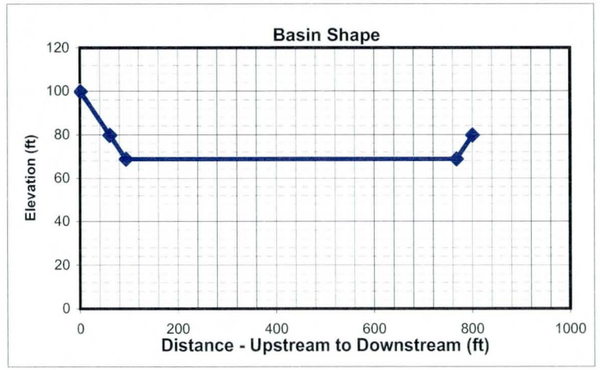
			Base	LC Enhanced
Bottom Length (ft)	1914	Allocated Storage Volume (ac. ft)	314.3	314
Bottom Width (ft)	674	Total Available Volume (ac. ft) (incl. Freeboard)	347.7	349.9
		Total Excavation Volume (ac. ft)	711.5	776.1

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	6.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	3	5	6	7	8	10	12	14
Volume	0.00	29.79	90.46	152.57	184.17	216.13	248.47	314.25	381.52	450.30
Outflow	0.0	136.1	235.8	304.4	333.5	360.2	385.1	430.5	471.6	509.4



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	402.0	469	469.0
Peak Inflow (cfs)	2809	3301	3301.0
Peak Outflow (cfs)	414	422	422.0
Stage at Peak Outflow (ft)	9.3	9.6	9.6
Volume at Peak Outflow (ac. ft)	290.0	301.43	301.4

Volume Check

Total Volume needed	312.2	ac. ft
Total Volume Provided	314.3	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	10.6	ft
Depth Provided	11	ft
Depth OK?	Yes	

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	594000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	1980	ft
Base Total ROW Width	800	ft
LC Enh. Total ROW Length	2420	ft
LC Enh. Total ROW Length	900	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	1147887	1252108
Excavated Area (sq. Yd)	176000	242000

Inlet

Inlet Type	Riprap		
(Riprap, Concrete)			
Inlet Length	98	ft	
Inlet Width	100	ft	
Material Thickness	1.5	ft	
Inlet Area	1089	sq. Yd	
Material Volume	545	cu. Yd	

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	550	ft
Unit Cost	160	per ft
Cost per outlet	$88,000	
Other Cost	$ -	
Total Cost	$88,000	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		1,147,887	cu. Yd	$ 4.00	$ 4,591,548	176,000	sq. Yd	$ 9.00	$ 1,584,000	176,000	sq. Yd	$ 8.33	$ 1,466,667
Basin - LC Enhancement		104,221	cu. Yd	$ 4.00	$ 416,884	66,000	sq. Yd	$ 9.00	$ 594,000	66,000	sq. Yd	$ 8.33	$ 550,000
Inlet	Riprap	545	sq. Yd	$ 75.00	$ 40,875	1,089	sq. Yd	$ -	$ -	1,089	sq. Yd	$ 33.33	$ 36,300
Inlet - LC Enhancement (20%Inlet)					$ 8,175				$ -				$ 7,260
Outlet	Pipe	1	EA	$ 88,000	$ 88,000	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 4,400				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,584,000	Base Maintenance Cost			$ 1,505,183
						LC Enh. Landscape Cost			$ 594,000	LC Enh. Maintenance Cost			$ 557,371
						Total Landscape Cost			$ 2,178,000	Total Maintenance Cost			$ 2,062,554

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 4,720,423	$ 416,884	$ 5,137,307
Contingency Cost (25% of Construction Cost)	$ 1,180,106	$ 104,221	$ 1,284,327
Engineering Design Cost (5% of Construction Cost)	$ 236,021	$ 20,844	$ 256,865
Total Construction Cost	$ 6,136,550	$ 541,949	$ 6,678,499

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	13.6	$100,000	$ 1,360,000
Basin	36.4	$100,000	$ 3,640,000
Other		$100,000	$ -
Total	50.0	$100,000	$ 5,000,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	36.4	$100,000	$ 3,640,000
LC Enhancement Cost	acre	13.6	$100,000	$ 1,360,000
Total Land Cost	acre	50	$100,000	$ 5,000,000

Total Cost

Base Total Cost	$ 12,865,733
Total LC Enhancement Cost	$ 3,053,320
Total Cost Including LC Enh.	$ 15,919,053

Open Channel

Structure ID	N110

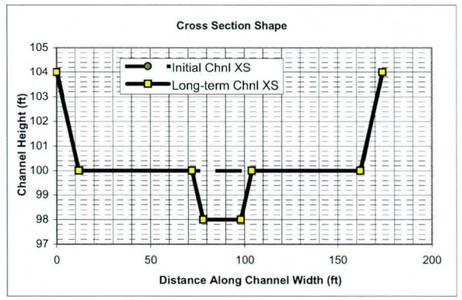
HEC1 ID	M1-N1

Longitudal Geometry

Length	5444.1	ft
U/S Elev	1565.0	ft
D/S Elev	1437.4	ft
Initial Channel Slope	0.0234	ft/ft
Long-term Channel Slope	0.0080	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	4



Initial Channel XS Geometry

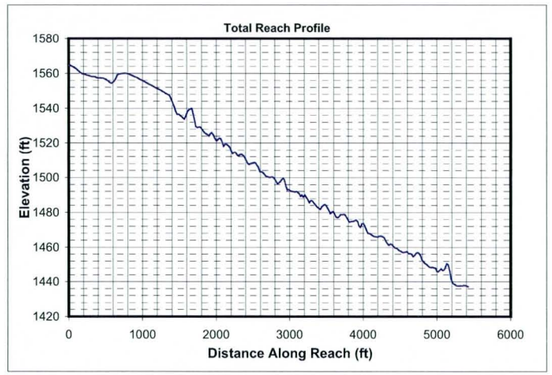
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	0	3	150	4	3	0	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	12	12	162	162	162	174
Y	104	100	100	100	100	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	60	3	20	6	3	58	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	72	78	98	104	162	174
Y	104	100	100	98	98	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RRCM1	N1							TOTAL
HEC1 Peak-Flow	422	1253							1675
Weighting Factor	1.00	0.36							
Flow into Channel	422	451							873

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	6.23	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	873	cfs	
Long-term Max. Chnl Capacity	5205	cfs	
Q2 Channel	87	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	174	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
87	151.7	41.1	0.3	100.0	100.3	2.1	0.3	151.6	0.3	0.14	0.72
262	153.3	79.8	0.5	100.0	100.5	3.3	0.5	153.2	0.5	0.26	0.80
655	155.8	139.2	0.9	100.0	100.9	4.7	0.9	155.5	0.9	0.45	0.88
873	156.8	165.9	1.1	100.0	101.1	5.3	1.1	156.5	1.1	0.54	0.90

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
87	27.7	28.7	1.0	98.0	99.2	3.0	1.2	27.3	1.1	0.61	0.52
262	153.1	110.1	0.7	98.0	100.4	2.4	2.4	152.3	0.7	1.19	0.49
655	156.5	192.5	1.2	98.0	100.9	3.4	2.9	155.5	1.2	1.46	0.54
873	158.0	229.7	1.5	98.0	101.2	3.8	3.2	156.9	1.5	1.58	0.55

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
87										0
262										0
655										0
873										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
87	1.74	0.9933	0.9436	Erosive	Erosive	Erosive	0.2	Stable	5.9	Stable	Stable
262	1.74	1.1945	1.1347	Erosive	Erosive	Erosive	0.3	Stable	7.8	Stable	Stable
655	1.74	1.3614	1.2933	Erosive	Erosive	Erosive	0.3	Stable	9.4	Stable	Stable
873	1.74	1.4134	1.3428	Erosive	Erosive	Erosive	0.3	Stable	10.0	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	87	262	655	873	87	262	655	873	87	262	655	873
Bray - Equation #1	25	45	73	84	1.2	1.7	2.3	2.5	3.0	3.4	3.9	4.1
Bray - Equation #2	33	59	95	111	1.3	1.9	2.5	2.8	2.0	2.4	2.7	2.8
Hey	7	14	23	27	3.5	5.3	7.6	8.4				
Ackers & Charlton/Lacey	24	37	55	62					1.7	2.0	2.4	2.5
Parker	64	111	176	203	0.9	1.4	2.0	2.3				
Chang	46	91	158	188	0.1	-0.1	-0.4	-0.6				
Kellerhals	17	29	46	53	1.6	2.5	3.6	4.1	3.2	3.6	3.9	4.0
AMAFCA/Schumm	27	152	156	157								
Moody & Odem	24	24	24	24	1.2	1.2	1.2	1.2				
BUREC	13.0	19.6	27.7	30.8	3	5	7	8	3.0	4.0	5.0	5.4
Average	28	58	83	94	1.7	2.4	3.3	3.6	2.6	3.1	3.6	3.8
Values As Designed	27	152	156	157	1.2	2.4	2.9	3.2	3.0	2.4	3.4	3.8
Difference with Design	1	-94	-72	-63	0.4	0.0	0.4	0.5	-0.5	0.7	0.2	0.0

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
87	1206	761	1799	2438	2762	460	376	206	5587	394	1296	1571
262	6592	2925	6051	15678	4318	2342	1376	1267	17393	1688	6733	6033
655	26937	8289	14001	73642	6057	8360	3537	4648	43957	6102	23708	19931
873	41865	11390	18502	119532	6712	12421	4696	6841	58716	9185	34679	29503

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
87	5126	3236	7646	10362	11736	1956	1599	876	23744	1674	5507	6678
262	9338	4143	8571	22209	6117	3318	1950	1794	24638	2392	9537	8546
655	15264	4697	7933	41728	3432	4737	2004	2634	24908	3457	13433	11293
873	17791	4840	7863	50798	2852	5279	1996	2907	24953	3903	14738	12538

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
87	681	319	527	1372	605	165	118	150	1130	153	783	546
262	1479	755	1450	2670	2588	355	303	300	3268	348	1697	1383
655	6024	2461	4119	12489	3837	1424	937	1329	8563	1318	6798	4482
873	9348	3493	5698	20236	4310	2141	1288	2032	11505	2013	10284	6577

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
87	2893	1356	2240	5829	2571	701	501	638	4803	652	3329	2319
262	2096	1069	2054	3782	3665	503	429	424	4630	493	2404	1959
655	3413	1395	2334	7077	2174	807	531	753	4852	747	3852	2539
873	3973	1484	2421	8600	1831	910	547	864	4889	855	4371	2795

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
87	0.0026	0.0045	148	0.45	0.048	0.0010	30	0.036	0.0007	0.0159	0.0009	0.0022	0.0079	0.0005	0.0029	0.0234	0.0085
262	0.0012	0.0023	206	0.63	0.051	0.0005	31	0.036	0.0004	0.0159	0.0005	0.0011	0.0079	0.0003	0.0013	0.0234	0.0082
655	0.0006	0.0014	269	0.82	0.053	0.0003	32	0.036	0.0002	0.0159	0.0003	0.0006	0.0079	0.0002	0.0006	0.0234	0.0080
873	0.0005	0.0011	293	0.89	0.054	0.0003	32	0.036	0.0002	0.0159	0.0002	0.0005	0.0079	0.0002	0.0005	0.0234	0.0080

Drop Structures

Design Slope	0.0080	ft/ft
Total Drop Needed	84.0	ft
Height of Drop Structure	3	ft
No . of Drop Structures	29	
Distance between structs.	188	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.54	sq. mi
Total Sediment Yield Volume	1.03	ac ft

Sedimentation Basins

Length	188 ft	Depth	3 ft
Width	174 ft	Side slope	3 ft/ft
Total Volume per Basin		2.03	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
87	1.1	-0.4	0.1	24.6	1.2	1.1	3.0	0.0080	0.1	1.5	2.0	4.8
262	1.1	-0.8	0.1	24.6	2.4	0.7	2.4	0.0080	0.2	1.5	2.0	4.9
655	1.1	-0.8	0.2	24.6	2.9	1.2	3.4	0.0080	0.3	1.5	2.0	5.1
873	1.1	-0.9	0.2	24.6	3.2	1.5	3.8	0.0080	0.4	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	421	cfs
Stage at Peak Flow	100.6	ft
Volume at Peak Flow	469.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.0	ft
Available Freeboard	2.9	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.03	ac. ft
Outflowing Sediment Volume	0.49	ac. ft
Deposited(+)/Eroded(-) Volume	0.54	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5444	5444
Side Slope (?H:1V)	3	3
Channel Width (ft)	174	174
Channel XS Area (sq. ft)	700	700
Channel Perimeter (ft)	176	176

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5444	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1815	sq. Yd
Volume	5444	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5444	5444
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4	5
Left Levee Surface Area (sq. Yd)	23591	48996
Left Levee Volume (cu. Yd)	20969	50407
Right Levee Length (ft)	5444	5444
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4	5
Right Levee Surface Area (sq. Yd)	23591	48996
Right Levee Volume (cu. Yd)	20969	50407
Total Levee Surface Area (sq. Yd)	47182	97992
Total Levee Volume (cu. Yd)	41938	100814

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5444	5444
Left Levee Lining Width (ft)	13	30
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	7864	18147
Left Levee Lining Volume (cu. Yd)	3932	9073
Right Levee Length (ft)	5444	5444
Right Levee Lining Width (ft)	13	30
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	7864	18147
Right Levee Lining Volume (cu. Yd)	3932	9073
Total Lining Area (sq. Yd)	15727	36293
Total Lining Volume (cu. Yd)	7864	18146

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	174	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.3	ft
Structure Height	9.3	ft
Number of Structures	29	
Volume per structure	179	cu. Yd
Other Cost	$ -	
Cost per structure	$ 13,425	
Area per structure	58	sq. Yd
Total Area	1,682	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	3275	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 13,100	
Other Cost	$ -	
Total cost per basin	$ 13,100	
Area per basin	3,629	sq. Yd
Total Area	7,258	sq. Yd

Structure Type	Structure Cost											
	Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	41,938	cu. Yd	$ 7.00	$ 293,566	47,182	sq. Yd	$ 9.00	$ 424,638	47,182	sq. Yd	$ 11.67	$ 550,457
Levee - LC Enhancement	Fill	58,876	cu. Yd	$ 7.00	$ 412,132	50,810	sq. Yd	$ 9.00	$ 457,290	58,876	sq. Yd	$ 11.67	$ 686,887
Levee Lining	Riprap	7,864	cu. Yd	$ 75.00	$ 589,800	15,727	sq. Yd	$ -	$ -	15,727	sq. Yd	$ 20.83	$ 327,648
Levee Lining -LC Enhancement	Riprap	10,282	cu. Yd	$ 75.00	$ 771,150	20,566	sq. Yd	$ -	$ -	20,566	sq. Yd	$ 20.83	$ 428,463
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	5,444	cu. Yd	$ 75.00	$ 408,300	1,815	sq. Yd	$ -	$ -	1,815	sq. Yd	$ 25.00	$ 45,375
Drop Structures	Riprap	29	EA	$ 13,425.00	$ 389,325	1,682	sq. Yd	$ -	$ -	1,682	sq. Yd	$ 33.33	$ 56,067
Drop Str. - LC Enhancement	Riprap	29	EA	$ 1,342.50	$ 38,933	168	sq. Yd	$ -	$ -	168	sq. Yd	$ 33.33	$ 5,607
Sedimentation Basins		2	EA	$ 13,100.00	$ 26,200	7,258	sq. Yd	$ -	$ -	7,258	sq. Yd	$ 8.33	$ 60,483
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 424,638	Base Maintenance Cost			$ 1,040,030
						LC Enhancement Cost			$ 457,290	LC Enhancement Cost			$ 1,120,956
						Total Landscape Cost			$ 881,928	Total Maintenance Cost			$ 2,160,986

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 1,707,191	$ 1,222,215	$ 2,929,406
Contingency Cost (25% of Construction Cost)	$ 426,798	$ 305,554	$ 732,351
Engineering Design Cost (5% of Construction Cost)	$ 85,360	$ 61,111	$ 146,470
Total Construction Cost	$ 2,219,348	$ 1,588,879	$ 3,808,227

Land Cost

Channel Length	5444	ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	174	21.7	$100,000	$ 2,170,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	52	6.5	$100,000	$ 650,000
Levee LC Enhancement	48	6	$100,000	$ 600,000
Other	0	0	$100,000	$ -
Total	274	34.2		$ 3,420,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	28.2	$100,000	$ 2,820,000
LC Enhancement Cost	acre	6	$100,000	$ 600,000
Total Land Cost	acre	34.2	$100,000	$ 3,420,000

Total Cost

Base Total Cost	$	6,504,016
Total Landscape Enhancement Cost	$	3,767,125
Total Cost Including LC Enh.	$	10,271,141

Open Channel

Structure ID	N120

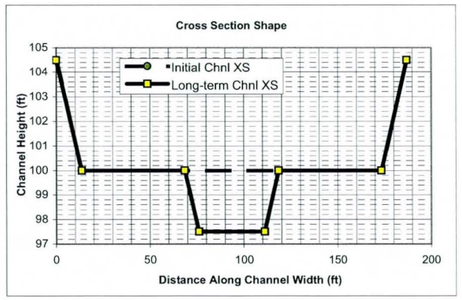
HEC1 ID	M1-N1

Longitudinal Geometry

Length	3160.5	ft
U/S Elev	1318.6	ft
D/S Elev	1276.4	ft
Initial Channel Slope	0.0133	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	4



Initial Channel XS Geometry

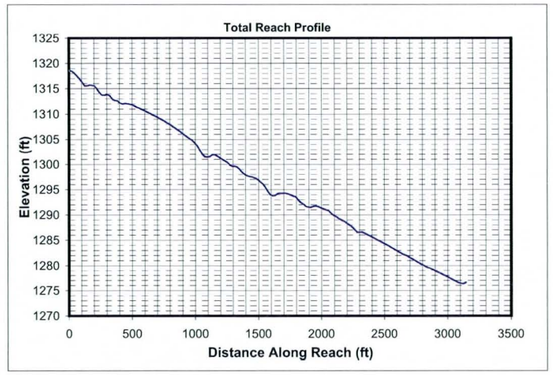
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	160	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	173.5	173.5	173.5	187
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	55	3	35	7	3	55	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	68.5	76	111	118.5	173.5	187
Y	104.5	100	100	97.5	97.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	CN1									TOTAL
HEC1 Peak-Flow	1264									1264
Weighting Factor	1.00									
Flow into Channel	1264									1264

Reach Sediment Inflow Characteristics

U/S Contributing ID	M1-N1_N110									TOTAL
Flow Volume (ac. ft)	469.00									469
Sediment Conc. (ppm)	2795									
Sediment Volume (ac. ft)	0.49									0.49
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.49									0.49

Hydrology

Drainage Area	7.21	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	1264	cfs	
Long-term Max. Chnl Capacity	5816	cfs	
Q2 Channel	126	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	187	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (ib/sq. ft)	Froude Number
126	162.5	62.5	0.4	100.0	100.4	2.0	0.4	162.3	0.4	0.12	0.57
379	164.7	121.4	0.7	100.0	100.7	3.1	0.7	164.5	0.7	0.23	0.64
948	168.2	212.2	1.3	100.0	101.3	4.5	1.3	167.8	1.3	0.40	0.70
1264	169.7	253.1	1.5	100.0	101.5	5.0	1.5	169.2	1.5	0.48	0.72

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
126	43.0	49.3	1.1	97.5	98.8	2.6	1.3	42.6	1.2	0.40	0.42
379	50.2	101.4	2.0	97.5	99.9	3.7	2.4	49.4	2.1	0.75	0.46
948	167.7	284.6	1.7	97.5	101.1	3.3	3.6	166.6	1.7	1.12	0.45
1264	169.8	339.9	2.0	97.5	101.4	3.7	3.9	168.5	2.0	1.22	0.46

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)								TOTAL
	M1-N1_N110								
126	546								546
379	1383								1383
948	4482								4482
1264	6577								6577

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
126	1.74	1.1012	1.0461	Erosive	Erosive	Erosive	0.2	Stable	4.8	Stable	Stable
379	1.74	1.3019	1.2368	Erosive	Erosive	Erosive	0.3	Stable	7.3	Stable	Stable
948	1.74	1.4679	1.3945	Erosive	Erosive	Erosive	0.3	Stable	8.7	Stable	Stable
1264	1.74	1.5196	1.4436	Erosive	Erosive	Erosive	0.4	Stable	9.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	126	379	948	1264	126	379	948	1264	126	379	948	1264
Bray - Equation #1	30	54	88	103	1.3	1.9	2.6	2.9	3.1	3.6	4.1	4.3
Bray - Equation #2	40	71	116	135	1.5	2.1	2.9	3.1	2.1	2.5	2.8	3.0
Hey	9	17	28	33	4.1	6.2	8.7	9.7				
Ackers & Charlton/Lacey	27	44	64	72					1.8	2.2	2.5	2.6
Parker	77	134	212	244	1.0	1.6	2.4	2.7				
Chang	50	97	170	202	0.2	0.0	-0.2	-0.4				
Kellerhals	20	35	55	64	1.9	2.9	4.2	4.7	3.3	3.7	4.0	4.2
AMAFCA/Schumm	43	49	167	169								
Moody & Odem	26	26	26	26	1.3	1.3	1.3	1.3				
BUREC	16.3	24.6	34.7	38.7	4	7	9	10	2.8	3.7	4.6	5.0
Average	34	55	96	109	2.0	2.8	3.9	4.3	2.6	3.1	3.6	3.8
Values As Designed	43	49	167	169	1.3	2.4	3.6	3.9	2.6	3.7	3.3	3.7
Difference with Design	-9	6	-71	-60	0.7	0.4	0.3	0.4	0.1	-0.6	0.3	0.1

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
126	945	587	1180	1724	2523	273	245	157	3368	266	1031	1118
379	5147	2382	4346	11056	4045	1506	994	1050	10716	1228	5641	4374
948	20975	6936	10854	51760	5759	5447	2644	3995	27252	4609	20550	14617
1264	32560	9590	14169	83892	6408	8093	3535	5926	36440	7004	30353	21634

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
126	2773	1722	3462	5059	7404	801	720	459	9884	781	3027	3281
379	5035	2331	4252	10817	3958	1474	973	1027	10484	1201	5519	4279
948	8209	2714	4248	20256	2254	2132	1035	1564	10665	1804	8042	5720
1264	9557	2815	4159	24623	1881	2375	1037	1739	10696	2056	8909	6350

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
126	497	259	402	868	724	98	83	114	774	106	586	410
379	2484	991	1375	5061	1247	481	311	594	2448	511	2865	1670
948	5354	2265	3348	10282	3727	1061	753	1292	6052	1100	6278	3774
1264	8296	3230	4611	16628	4207	1606	1047	1982	8155	1690	9560	5546

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
126	1459	761	1179	2548	2125	287	245	336	2272	311	1719	1204
379	2430	970	1345	4952	1220	471	304	581	2395	500	2803	1634
948	2095	887	1310	4024	1458	415	295	506	2368	431	2457	1477
1264	2435	948	1353	4880	1235	471	307	582	2394	496	2806	1628

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Sif (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
126	0.0021	0.0031	133	0.41	0.047	0.0007	30	0.035	0.0005	0.0159	0.0007	0.0016	0.0069	0.0004	0.0023	0.0133	0.0056
379	0.0009	0.0016	185	0.56	0.050	0.0004	31	0.036	0.0003	0.0159	0.0003	0.0008	0.0069	0.0003	0.0010	0.0133	0.0053
948	0.0005	0.0010	242	0.74	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0069	0.0002	0.0005	0.0133	0.0052
1264	0.0004	0.0008	263	0.80	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0069	0.0001	0.0004	0.0133	0.0052

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	26.4	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	351	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.98	sq. mi
Total Sediment Yield Volume	1.87	ac ft

Sedimentation Basins

Length	351 ft	Depth	3 ft
Width	187 ft	Side slope	3 ft/ft
Total Volume per Basin		4.20	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
126	1.1	-0.4	0.1	24.6	1.3	1.2	2.6	0.0050	0.1	1.5	2.5	5.4
379	1.1	-0.7	0.2	24.6	2.4	2.1	3.7	0.0050	0.3	1.5	2.5	5.7
948	1.1	-1.0	0.2	24.6	3.6	1.7	3.3	0.0050	0.4	1.5	2.5	5.8
1264	1.1	-1.1	0.2	24.6	3.9	2.0	3.7	0.0050	0.4	1.5	2.5	5.9

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	421	cfs
Stage at Peak Flow	100.6	ft
Volume at Peak Flow	469.0	ac. ft

Freeboard

Max. Flow Depth	1.5	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	2.36	ac. ft
Outflowing Sediment Volume	0.29	ac. ft
Deposited(+)/Eroded(-) Volume	2.07	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	3160	3160
Side Slope (?H:1V)	3	3
Channel Width (ft)	187	187
Channel XS Area (sq. ft)	887	887
Channel Perimeter (ft)	189	189

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3160	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1053	sq. Yd
Volume	3160	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	3160	3160
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	14747	30547
Left Levee Volume (cu. Yd)	14513	34175
Right Levee Length (ft)	3160	3160
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	14747	30547
Right Levee Volume (cu. Yd)	14513	34175
Total Levee Surface Area (sq. Yd)	29494	61094
Total Levee Volume (cu. Yd)	29026	68350

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3160	3160
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	4916	11587
Left Levee Lining Volume (cu. Yd)	2458	5793
Right Levee Length (ft)	3160	3160
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	4916	11587
Right Levee Lining Volume (cu. Yd)	2458	5793
Total Lining Area (sq. Yd)	9831	23173
Total Lining Volume (cu. Yd)	4916	11586

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	187	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	7.4	ft
Structure Height	10.4	ft
Number of Structures	9	
Volume per structure	217	cu. Yd
Other Cost	$ -	
Cost per structure	$ 16,275	
Area per structure	62	sq. Yd
Total Area	561	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	6776	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 27,104	
Other Cost	$ -	
Total cost per basin	$ 27,104	
Area per basin	7,296	sq. Yd
Total Area	14,592	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	29,026	cu. Yd	$ 7.00	$ 203,182	29,494	sq. Yd	$ 9.00	$ 265,446	29,494	sq. Yd	$ 11.67	$ 344,097
Levee - LC Enhancement	Fill	39,324	cu. Yd	$ 7.00	$ 275,268	31,600	sq. Yd	$ 9.00	$ 284,400	39,324	sq. Yd	$ 11.67	$ 458,780
Levee Lining	Riprap	4,916	cu. Yd	$ 75.00	$ 368,700	9,831	sq. Yd	$ -	$ -	9,831	sq. Yd	$ 20.83	$ 204,815
Levee Lining -LC Enhancement	Riprap	6,670	cu. Yd	$ 75.00	$ 500,250	13,342	sq. Yd	$ -	$ -	13,342	sq. Yd	$ 20.83	$ 277,963
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	3,160	cu. Yd	$ 75.00	$ 237,000	1,053	sq. Yd	$ -	$ -	1,053	sq. Yd	$ 25.00	$ 26,325
Drop Structures	Riprap	9	EA	$ 16,275.00	$ 146,475	561	sq. Yd	$ -	$ -	561	sq. Yd	$ 33.33	$ 18,700
Drop Str. - LC Enhancement	Riprap	9	EA	$ 1,627.50	$ 14,648	56	sq. Yd	$ -	$ -	56	sq. Yd	$ 33.33	$ 1,870
Sedimentation Basins		2	EA	$ 27,104.00	$ 54,208	14,592	sq. Yd	$ -	$ -	14,592	sq. Yd	$ 8.33	$ 121,600
Other					$ -				$ -				$ -

Base Landscape Cost	$ 265,446	Base Maintenance Cost	$ 715,536
LC Enhancement Cost	$ 284,400	LC Enhancement Cost	$ 738,613
Total Landscape Cost	$ 549,846	Total Maintenance Cost	$ 1,454,149

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 1,009,565	$ 790,166	$ 1,799,731
Contingency Cost (25% of Construction Cost)	$ 252,391	$ 197,541	$ 449,933
Engineering Design Cost (5% of Construction Cost)	$ 50,478	$ 39,508	$ 89,987
Total Construction Cost	$ 1,312,435	$ 1,027,215	$ 2,339,650

Land Cost

Channel Length	3160 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	187	13.6	$100,000	$ 1,360,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	4	$100,000	$ 400,000
Levee LC Enhancement	51	3.7	$100,000	$ 370,000
Other	0	0	$100,000	$ -
Total	293	21.3		$ 2,130,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	17.6	$100,000	$ 1,760,000
LC Enhancement Cost	acre	3.7	$100,000	$ 370,000
Total Land Cost	acre	21.3	$100,000	$ 2,130,000

Total Cost

Base Total Cost	$ 4,053,417
Total Landscape Enhancement Cost	$ 2,420,228
Total Cost Including LC Enh.	$ 6,473,645

Online Basin

HEC1 ID	RRCN1

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID	M1-N1						Total Volume (ac. ft)
Inflow Volume (ac. ft)	469						469
Volume Fraction	1						
Weighted Volume	469						469
Sediment Conc. (ppm)	1634						
Sediment Volume (ac. ft)	0.29						0.29
Weighting Factor	1						
Weighted Sed. Vol. (ac. ft)	0.29						0.29

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.5	sq. mi
Total Sediment Yield Volume	2.9	ac ft

Required Minimum Sediment Volume

Sediment Volume	3.2	ac. ft

Geometry

	Base	LC Enhanced
Topography slope (ft/ft)	0.021	0.021
Basin Length (ft)	860	1050
Basin Width (ft)	480	480
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	11	11
Freeboard (ft)	1	1
Effective Basin Width (ft)	450	420
Top Area (acres)	9.5	11.6
U/S-D/S Height Difference (ft)	10.1	10.1
Excess Area on Upstream (acres)	0.6	1.5

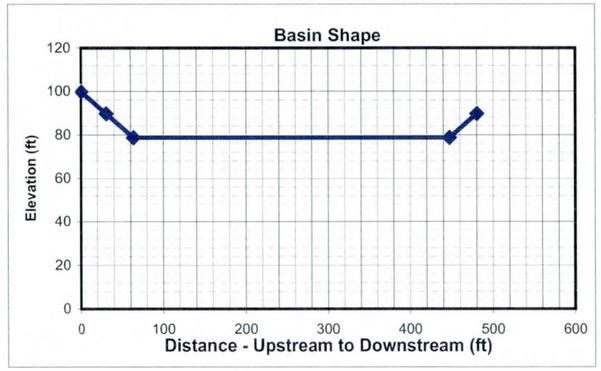
			Base	LC Enhanced
Bottom Length (ft)	794	Allocated Storage Volume (ac. ft)	78.4	78.4
Bottom Width (ft)	384	Total Available Volume (ac. ft) (incl. Freeboard)	87.2	88.3
		Total Excavation Volume (ac. ft)	135.0	146.7

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	6.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	3	5	6	7	8	9	11	13
Volume	0.00	7.08	21.74	37.06	44.98	53.07	61.33	69.77	87.18	105.31
Outflow	0.0	136.1	235.8	304.4	333.5	360.2	385.1	408.4	451.5	490.9



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	473.0	570	570.0
Peak Inflow (cfs)	914	1264	1264.0
Peak Outflow (cfs)	395	420	420.0
Stage at Peak Outflow (ft)	8.4	9.5	9.5
Volume at Peak Outflow (ac. ft)	65.0	74.55	74.6

Volume Check

Total Volume needed	77.8	ac. ft
Total Volume Provided	78.4	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	10.5	ft
Depth Provided	11	ft
Depth OK?	Yes	

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	254200	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	860	ft
Base Total ROW Width	480	ft
LC Enh. Total ROW Length	1150	ft
LC Enh. Total ROW Length	580	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	217800	236676
Excavated Area (sq. Yd)	45867	74111

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	67	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	741	sq. Yd
Material Volume	371	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	688	ft
Unit Cost	160	per ft
Cost per outlet	$110,080	
Other Cost	$ -	
Total Cost	$110,080	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		217,800	cu. Yd	$ 4.00	$ 871,200	45,867	sq. Yd	$ 9.00	$ 412,803	45,867	sq. Yd	$ 8.33	$ 382,225
Basin - LC Enhancement		18,876	cu. Yd	$ 4.00	$ 75,504	28,244	sq. Yd	$ 9.00	$ 254,196	28,244	sq. Yd	$ 8.33	$ 235,367
Inlet	Riprap	371	sq. Yd	$ 75.00	$ 27,825	741	sq. Yd	$ -	$ -	741	sq. Yd	$ 33.33	$ 24,700
Inlet - LC Enhancement (20%Inlet)					$ 5,565				$ -				$ 4,940
Outlet	Pipe	1	EA	$ 110,080	$ 110,080	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 5,504				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 412,803	Base Maintenance Cost			$ 409,142
						LC Enh. Landscape Cost			$ 254,196	LC Enh. Maintenance Cost			$ 240,418
						Total Landscape Cost			$ 666,999	Total Maintenance Cost			$ 649,559

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,009,105	$ 75,504	$ 1,084,609
Contingency Cost (25% of Construction Cost)	$ 252,276	$ 18,876	$ 271,152
Engineering Design Cost (5% of Construction Cost)	$ 50,455	$ 3,775	$ 54,230
Total Construction Cost	$ 1,311,837	$ 98,155	$ 1,409,992

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	5.8	$100,000	$ 580,000
Basin	9.5	$100,000	$ 950,000
Other		$100,000	$ -
Total	15.3	$100,000	$ 1,530,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	9.5	$100,000	$ 950,000
LC Enhancement Cost	acre	5.8	$100,000	$ 580,000
Total Land Cost	acre	15.3	$100,000	$ 1,530,000

Total Cost

Base Total Cost	$ 3,083,781
Total LC Enhancement Cost	$ 1,172,769
Total Cost Including LC Enh.	$ 4,256,550

Open Channel

Structure ID	N125

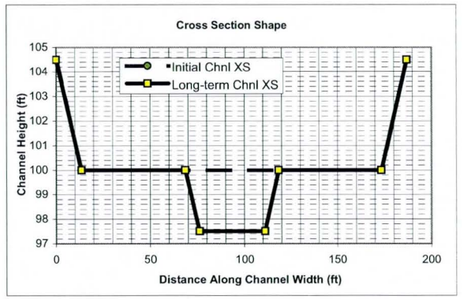
HEC1 ID	N1-P1A

Longitundal Geometry

Length	8101.2	ft
U/S Elev	1382.8	ft
D/S Elev	1276.4	ft
Initial Channel Slope	0.0131	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	4



Initial Channel XS Geometry

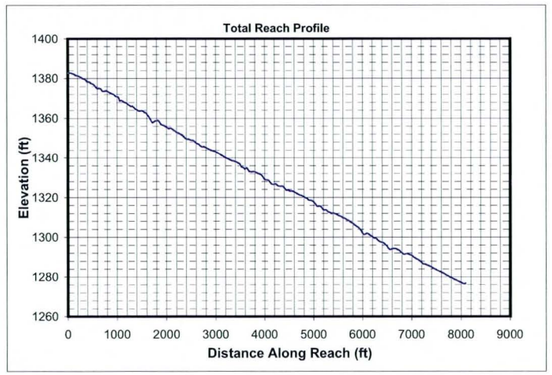
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	160	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	173.5	173.5	173.5	187
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	55	3	35	7	3	55	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	68.5	76	111	118.5	173.5	187
Y	104.5	100	100	97.5	97.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	CN2AR									TOTAL
HEC1 Peak-Flow	1276									1276
Weighting Factor	1.00									
Flow into Channel	1276									1276

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	9.23	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	1276	cfs	
Long-term Max. Chnl Capacity	5816	cfs	
Q2 Channel	128	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	187	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (ib/sq. ft)	Froude Number
128	162.5	63.2	0.4	100.0	100.4	2.0	0.4	162.4	0.4	0.12	0.57
383	164.8	122.7	0.7	100.0	100.8	3.1	0.8	164.5	0.7	0.24	0.64
957	168.3	214.5	1.3	100.0	101.3	4.5	1.3	167.9	1.3	0.41	0.70
1276	169.8	255.9	1.5	100.0	101.6	5.0	1.6	169.3	1.5	0.48	0.71

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
128	43.1	49.6	1.2	97.5	98.8	2.6	1.3	42.7	1.2	0.40	0.42
383	50.3	102.0	2.0	97.5	99.9	3.8	2.4	49.5	2.1	0.75	0.46
957	167.8	286.3	1.7	97.5	101.1	3.3	3.6	166.6	1.7	1.12	0.45
1276	169.9	341.9	2.0	97.5	101.4	3.7	3.9	168.6	2.0	1.23	0.46

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
128										0
383										0
957										0
1276										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
128	1.74	1.1044	1.0492	Erosive	Erosive	Erosive	0.2	Stable	4.9	Stable	Stable
383	1.74	1.3051	1.2398	Erosive	Erosive	Erosive	0.3	Stable	7.3	Stable	Stable
957	1.74	1.4711	1.3976	Erosive	Erosive	Erosive	0.3	Stable	8.7	Stable	Stable
1276	1.74	1.5228	1.4467	Erosive	Erosive	Erosive	0.4	Stable	9.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	128	383	957	1276	128	383	957	1276	128	383	957	1276
Bray - Equation #1	31	55	89	103	1.3	1.9	2.6	2.9	3.1	3.6	4.1	4.3
Bray - Equation #2	40	72	116	135	1.5	2.1	2.9	3.2	2.1	2.5	2.8	3.0
Hey	9	17	28	33	4.1	6.2	8.7	9.8				
Ackers & Charlton/Lacey	28	44	64	73					1.8	2.2	2.5	2.6
Parker	78	134	213	245	1.0	1.6	2.4	2.7				
Chang	50	98	171	203	0.2	0.0	-0.3	-0.4				
Kellerhals	20	35	56	64	1.9	2.9	4.2	4.7	3.3	3.7	4.1	4.2
AMAFCA/Schumm	43	50	167	169								
Moody & Odem	28	28	28	28	1.3	1.3	1.3	1.3				
BUREC	16.4	24.7	34.8	38.8	4	7	9	10	2.8	3.7	4.6	5.0
Average	34	56	97	109	2.0	2.8	3.9	4.3	2.6	3.1	3.6	3.8
Values As Designed	43	49	167	169	1.3	2.4	3.6	3.9	2.6	3.8	3.3	3.7
Difference with Design	-8	6	-70	-59	0.7	0.4	0.3	0.4	0.1	-0.6	0.3	0.1

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
128	937	581	1163	1704	2511	268	242	155	3311	263	1023	1105
383	5104	2365	4298	10927	4030	1485	983	1043	10544	1214	5602	4327
957	20788	6888	10756	51142	5740	5369	2616	3972	26823	4563	20425	14462
1276	32269	9525	14037	82887	6388	7978	3499	5893	35867	6936	30177	21405

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
128	2723	1689	3382	4953	7301	779	702	451	9627	764	2973	3213
383	4947	2292	4166	10590	3906	1439	953	1011	10219	1177	5430	4194
957	8059	2670	4170	19826	2225	2081	1014	1540	10398	1769	7918	5607
1276	9382	2769	4081	24099	1857	2319	1017	1713	10428	2017	8774	6224

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
128	504	262	407	882	728	99	84	116	782	108	594	415
383	2518	1002	1389	5137	1253	487	314	602	2472	518	2903	1691
957	5432	2292	3383	10446	3742	1075	761	1311	6112	1116	6366	3821
1276	8416	3268	4660	16892	4224	1627	1058	2009	8235	1714	9692	5618

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
128	1466	763	1183	2563	2115	289	246	338	2274	313	1727	1207
383	2440	971	1347	4979	1214	472	304	583	2396	502	2813	1638
957	2106	889	1312	4049	1451	417	295	508	2369	433	2468	1481
1276	2447	950	1355	4911	1228	473	308	584	2394	498	2818	1633

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
128	0.0021	0.0031	133	0.41	0.047	0.0007	30	0.035	0.0005	0.0159	0.0007	0.0016	0.0069	0.0004	0.0023	0.0131	0.0055
383	0.0009	0.0016	184	0.56	0.050	0.0004	31	0.036	0.0003	0.0159	0.0003	0.0008	0.0069	0.0003	0.0010	0.0131	0.0053
957	0.0005	0.0009	241	0.73	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0069	0.0002	0.0005	0.0131	0.0052
1276	0.0004	0.0008	262	0.80	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0069	0.0001	0.0004	0.0131	0.0051

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	65.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	22	
Distance between structs.	368	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.48	sq. mi
Total Sediment Yield Volume	2.81	ac ft

Sedimentation Basins

Length	368 ft	Depth	3 ft
Width	187 ft	Side slope	3 ft/ft
Total Volume per Basin		4.41	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
128	1.1	-0.4	0.1	24.6	1.3	1.2	2.6	0.0050	0.1	1.5	2.5	5.4
383	1.1	-0.7	0.2	24.6	2.4	2.1	3.8	0.0050	0.3	1.5	2.5	5.7
957	1.1	-1.0	0.2	24.6	3.6	1.7	3.3	0.0050	0.4	1.5	2.5	5.8
1276	1.1	-1.1	0.2	24.6	3.9	2.0	3.7	0.0050	0.4	1.5	2.5	5.9

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	420	cfs
Stage at Peak Flow	100.8	ft
Volume at Peak Flow	570.0	ac. ft

Freeboard

Max. Flow Depth	1.6	ft
Channel Depth as designed	4.5	ft
Available Freeboard	2.9	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	2.81	ac. ft
Outflowing Sediment Volume	0.35	ac. ft
Deposited(+)/Eroded(-) Volume	2.46	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	8101	8101
Side Slope (?H:1V)	3	3
Channel Width (ft)	187	187
Channel XS Area (sq. ft)	887	887
Channel Perimeter (ft)	189	189

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	8101	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	2700	sq. Yd
Volume	8101	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	8101	8101
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	37805	78310
Left Levee Volume (cu. Yd)	37205	87611
Right Levee Length (ft)	8101	8101
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	37805	78310
Right Levee Volume (cu. Yd)	37205	87611
Total Levee Surface Area (sq. Yd)	75610	156620
Total Levee Volume (cu. Yd)	74410	175222

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	8101	8101
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	12602	29704
Left Levee Lining Volume (cu. Yd)	6301	14852
Right Levee Length (ft)	8101	8101
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	12602	29704
Right Levee Lining Volume (cu. Yd)	6301	14852
Total Lining Area (sq. Yd)	25203	59407
Total Lining Volume (cu. Yd)	12602	29704

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	187	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	7.5	ft	
Structure Height	10.5	ft	
Number of Structures	22		
Volume per structure	218	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 16,350		
Area per structure	62	sq. Yd	
Total Area	1,371	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	7115	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 28,460	
Other Cost	$ -	
Total cost per basin	$ 28,460	
Area per basin	7,651	sq. Yd
Total Area	15,302	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	74,410	cu. Yd	$ 7.00	$ 520,870	75,610	sq. Yd	$ 9.00	$ 680,490	75,610	sq. Yd	$ 11.67	$ 882,117
Levee - LC Enhancement	Fill	100,812	cu. Yd	$ 7.00	$ 705,684	81,010	sq. Yd	$ 9.00	$ 729,090	100,812	sq. Yd	$ 11.67	$ 1,176,140
Levee Lining	Riprap	12,602	cu. Yd	$ 75.00	$ 945,150	25,203	sq. Yd	$ -	$ -	25,203	sq. Yd	$ 20.83	$ 525,065
Levee Lining -LC Enhancement	Riprap	17,102	cu. Yd	$ 75.00	$ 1,282,650	34,204	sq. Yd	$ -	$ -	34,204	sq. Yd	$ 20.83	$ 712,588
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	8,101	cu. Yd	$ 75.00	$ 607,575	2,700	sq. Yd	$ -	$ -	2,700	sq. Yd	$ 25.00	$ 67,500
Drop Structures	Riprap	22	EA	$ 16,350.00	$ 359,700	1,371	sq. Yd	$ -	$ -	1,371	sq. Yd	$ 33.33	$ 45,700
Drop Str. - LC Enhancement	Riprap	22	EA	$ 1,635.00	$ 35,970	137	sq. Yd	$ -	$ -	137	sq. Yd	$ 33.33	$ 4,570
Sedimentation Basins		2	EA	$ 28,460.00	$ 56,920	15,302	sq. Yd	$ -	$ -	15,302	sq. Yd	$ 8.33	$ 127,517
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 680,490	Base Maintenance Cost			$ 1,647,898
						LC Enhancement Cost			$ 729,090	LC Enhancement Cost			$ 1,893,298
						Total Landscape Cost			$ 1,409,580	Total Maintenance Cost			$ 3,541,196

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 2,490,215	$ 2,024,304	$ 4,514,519
Contingency Cost (25% of Construction Cost)	$ 622,554	$ 506,076	$ 1,128,630
Engineering Design Cost (5% of Construction Cost)	$ 124,511	$ 101,215	$ 225,726
Total Construction Cost	$ 3,237,280	$ 2,631,595	$ 5,868,875

Land Cost

Channel Length	8101 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	187	34.8	$100,000	$ 3,480,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	10.2	$100,000	$ 1,020,000
Levee LC Enhancement	51	9.5	$100,000	$ 950,000
Other	0	0	$100,000	$ -
Total	293	54.5		$ 5,450,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	45	$100,000	$ 4,500,000
LC Enhancement Cost	acre	9.5	$100,000	$ 950,000
Total Land Cost	acre	54.5	$100,000	$ 5,450,000

Total Cost

Base Total Cost	$ 10,065,668
Total Landscape Enhancement Cost	$ 6,203,983
Total Cost Including LC Enh.	$ 16,269,651

Online Basin

HEC1 ID	RRP1A

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.5	sq. mi
Total Sediment Yield Volume	1.0	ac ft

Required Minimum Sediment Volume

Sediment Volume	1.0	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.0222	0.0222
Basin Length (ft)	700	860
Basin Width (ft)	360	360
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	8	8
Freeboard (ft)	1	1
Effective Basin Width (ft)	336	312
Top Area (acres)	5.8	7.1
U/S-D/S Height Difference (ft)	8.0	8.0
Excess Area on Upstream (acres)	0.4	1.0

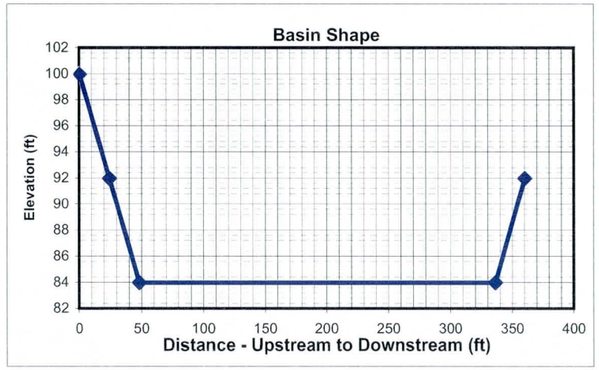
			Base	LC Enhanced
Bottom Length (ft)	652	Allocated Storage Volume (ac. ft)	33.4	33.5
Bottom Width (ft)	288	Total Available Volume (ac. ft) (incl. Freeboard)	38.8	39.5
		Total Excavation Volume (ac. ft)	61.9	67.9

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	3.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	2	3	4	5	6	7	8	10
Volume	0.00	4.38	8.88	13.52	18.30	23.21	28.25	33.44	38.77	49.86
Outflow	0.0	34.0	48.1	59.0	68.1	76.1	83.4	90.0	96.3	107.6



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	44.0	41	44.0
Peak Inflow (cfs)	575	441	575.0
Peak Outflow (cfs)	87	77	87.0
Stage at Peak Outflow (ft)	6.6	5.1	6.6
Volume at Peak Outflow (ac. ft)	31.2	23.93	31.2

Volume Check

Total Volume needed	32.2	ac. ft
Total Volume Provided	33.4	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	7.6	ft
Depth Provided	8	ft
Depth OK?	Yes	

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	189600	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	700	ft
Base Total ROW Width	360	ft
LC Enh. Total ROW Length	960	ft
LC Enh. Total ROW Length	460	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	99865	109545
Excavated Area (sq. Yd)	28000	49067

Inlet

Inlet Type	Riprap		
(Riprap, Concrete)			
Inlet Length	51	ft	
Inlet Width	100	ft	
Material Thickness	1.5	ft	
Inlet Area	562	sq. Yd	
Material Volume	281	cu. Yd	

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	465	ft
Unit Cost	160	per ft
Cost per outlet	$74,400	
Other Cost	$ -	
Total Cost	$74,400	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		99,865	cu. Yd	$ 4.00	$ 399,460	28,000	sq. Yd	$ 9.00	$ 252,000	28,000	sq. Yd	$ 8.33	$ 233,333
Basin - LC Enhancement		9,680	cu. Yd	$ 4.00	$ 38,720	21,067	sq. Yd	$ 9.00	$ 189,603	21,067	sq. Yd	$ 8.33	$ 175,558
Inlet	Riprap	281	sq. Yd	$ 75.00	$ 21,075	562	sq. Yd	$ -	$ -	562	sq. Yd	$ 33.33	$ 18,733
Inlet - LC Enhancement (20%Inlet)					$ 4,215				$ -				$ 3,747
Outlet	Pipe	1	EA	$ 74,400	$ 74,400	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 3,720				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 252,000	Base Maintenance Cost			$ 254,283
						LC Enh. Landscape Cost			$ 189,603	LC Enh. Maintenance Cost			$ 179,416
						Total Landscape Cost			$ 441,603	Total Maintenance Cost			$ 433,699

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 494,935	$ 38,720	$ 533,655
Contingency Cost (25% of Construction Cost)	$ 123,734	$ 9,680	$ 133,414
Engineering Design Cost (5% of Construction Cost)	$ 24,747	$ 1,936	$ 26,683
Total Construction Cost	$ 643,416	$ 50,336	$ 693,752

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	4.4	$100,000	$ 440,000
Basin	5.8	$100,000	$ 580,000
Other		$100,000	$ -
Total	10.2	$100,000	$ 1,020,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	5.8	$100,000	$ 580,000
LC Enhancement Cost	acre	4.4	$100,000	$ 440,000
Total Land Cost	acre	10.2	$100,000	$ 1,020,000

Total Cost

Base Total Cost	$ 1,729,699
Total LC Enhancement Cost	$ 859,355
Total Cost Including LC Enh.	$ 2,589,054

Open Channel

Structure ID	N130	HEC1 ID	P1A-1B

Longitudal Geometry

Length	10853.3	ft
U/S Elev	1276.4	ft
D/S Elev	1133.0	ft
Initial Channel Slope	0.0132	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	11

Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	240	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	253.5	253.5	253.5	267
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	92	3	35	7.5	3	95	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	105.5	114.5	149.5	158.5	253.5	267
Y	104.5	100	100	97	97	100	100	104.5

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	P1A-1B	P1B							TOTAL
HEC1 Peak-Flow	994	852							1846
Weighting Factor	1.00	0.64							
Flow into Channel	994	543							1537

Reach Sediment Inflow Characteristics

U/S Contributing ID	N1-P1A_N125	P1A-1B_RRP1A10							TOTAL
Flow Volume (ac. ft)	570.00	709.00							1279
Sediment Conc. (ppm)	1638	2874							
Sediment Volume (ac. ft)	0.35	0.77							1.12
Weighting Factor									
Weighted Sed. Vol. (ac. ft)	0.00	0.00							0.00

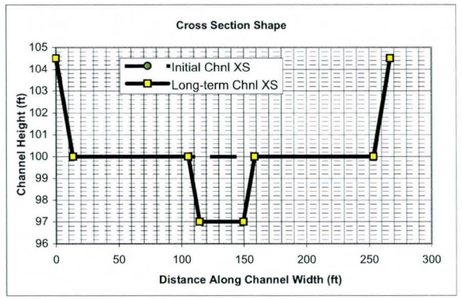
Hydrology

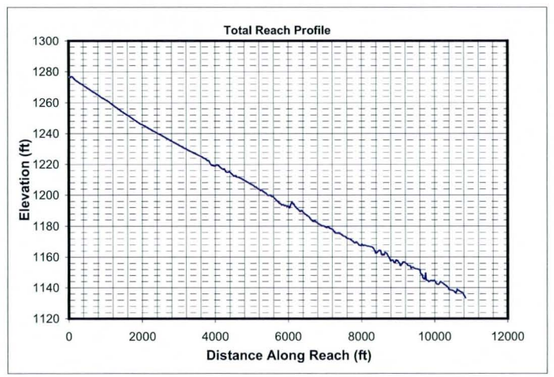
Drainage Area	10.608	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	1537	cfs	
Long-term Max. Chnl Capacity	8389	cfs	
Q2 Channel	154	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	267	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			





Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
154	242.2	82.7	0.3	100.0	100.3	1.9	0.3	242.1	0.3	0.11	0.56
461	244.2	160.3	0.7	100.0	100.7	2.9	0.7	244.0	0.7	0.21	0.63
1153	247.3	279.2	1.1	100.0	101.1	4.1	1.1	246.9	1.1	0.36	0.68
1537	248.6	332.6	1.3	100.0	101.4	4.6	1.4	248.2	1.3	0.43	0.70

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
154	44.0	55.9	1.3	97.0	98.4	2.7	1.4	43.5	1.3	0.44	0.43
461	52.0	115.6	2.2	97.0	99.7	4.0	2.7	51.1	2.3	0.84	0.47
1153	247.3	373.8	1.5	97.0	101.0	3.1	4.0	246.0	1.5	1.25	0.44
1537	249.1	445.5	1.8	97.0	101.3	3.4	4.3	247.7	1.8	1.34	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
	N1-P1A_N125	P1A-1B_RRP1A10								
154	415	41								456
461	1691	154								1844
1153	3821	471								4292
1537	5618	674								6292

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
154	1.74	1.0643	1.0111	Erosive	Erosive	Erosive	0.2	Stable	5.2	Stable	Stable
461	1.74	1.2659	1.2026	Erosive	Erosive	Erosive	0.3	Stable	7.9	Stable	Stable
1153	1.74	1.4334	1.3617	Erosive	Erosive	Erosive	0.3	Stable	9.0	Stable	Stable
1537	1.74	1.4857	1.4114	Erosive	Erosive	Erosive	0.3	Stable	9.6	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	154	461	1153	1537	154	461	1153	1537	154	461	1153	1537
Bray - Equation #1	34	60	98	114	1.4	2.1	2.8	3.1	3.2	3.7	4.2	4.4
Bray - Equation #2	44	79	128	149	1.6	2.2	3.0	3.4	2.2	2.6	2.9	3.0
Hey	10	19	31	37	4.4	6.6	9.4	10.5				
Ackers & Charlton/Lacey	30	47	70	78					1.9	2.2	2.6	2.7
Parker	85	148	233	269	1.1	1.8	2.6	2.9				
Chang	56	110	191	228	0.1	0.0	-0.3	-0.5				
Kellerhals	22	39	61	71	2.0	3.2	4.6	5.1	3.4	3.8	4.1	4.2
AMAFCA/Schumm	44	51	246	248								
Moody & Odem	30	30	30	30	1.3	1.3	1.3	1.3				
BUREC	17.6	26.5	37.4	41.6	5	7	10	11	2.9	3.9	4.9	5.2
Average	37	61	113	127	2.1	3.0	4.2	4.6	2.7	3.2	3.8	3.9
Values As Designed	44	51	246	248	1.4	2.7	4.0	4.3	2.7	4.0	3.1	3.4
Difference with Design	-6	10	-133	-121	0.7	0.3	0.2	0.3	0.0	-0.8	0.7	0.5

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
154	1014	650	1305	1787	3398	274	261	151	3945	298	1074	1287
461	5546	2746	5101	11511	5519	1646	1159	1124	12749	1351	6162	4965
1153	22708	8132	13330	54185	7880	6052	3163	4447	32560	5060	22975	16408
1537	35316	11287	17288	88034	8763	9015	4248	6650	43567	7696	34140	24182

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
154	2447	1570	3149	4315	8203	662	631	364	9521	720	2592	3107
461	4463	2210	4104	9261	4440	1324	933	904	10257	1087	4958	3995
1153	7308	2617	4290	17439	2536	1948	1018	1431	10479	1628	7394	5281
1537	8524	2724	4173	21250	2115	2176	1025	1605	10516	1858	8241	5837

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
154	664	333	523	1192	799	133	108	157	955	140	786	526
461	3290	1243	1705	6890	1373	626	384	777	2992	665	3746	2154
1153	5871	2597	4020	10916	5081	1174	882	1414	7289	1214	6930	4308
1537	9126	3735	5491	17713	5736	1796	1242	2198	9848	1865	10644	6309

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
154	1603	803	1262	2878	1928	320	260	378	2304	339	1897	1270
461	2647	1000	1372	5544	1105	504	309	625	2407	535	3014	1733
1153	1890	836	1294	3513	1635	378	284	455	2346	391	2230	1386
1537	2203	902	1325	4276	1384	433	300	531	2377	450	2569	1523

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Sf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
154	0.0024	0.0035	125	0.38	0.046	0.0007	29	0.035	0.0005	0.0159	0.0007	0.0018	0.0065	0.0004	0.0026	0.0132	0.0055
461	0.0011	0.0018	173	0.53	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0009	0.0065	0.0002	0.0012	0.0132	0.0052
1153	0.0005	0.0011	227	0.69	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0065	0.0002	0.0006	0.0132	0.0051
1537	0.0004	0.0009	248	0.75	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0065	0.0001	0.0005	0.0132	0.0051

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	89.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	30	
Distance between structs.	362	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.38	sq. mi
Total Sediment Yield Volume	2.62	ac ft

Sedimentation Basins

Length	362 ft	Depth	3 ft	
Width	267 ft	Side slope	3 ft/ft	
Total Volume per Basin		6.27	ac. ft.	
Basin Trap Efficiency		0.6		
No. of Basins		2		

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
154	1.1	-0.5	0.1	24.6	1.4	1.3	2.7	0.0050	0.1	1.5	3.0	6.1
461	1.1	-0.7	0.2	24.6	2.7	2.3	4.0	0.0050	0.3	1.5	3.0	6.4
1153	1.1	-1.2	0.1	24.6	4.0	1.5	3.1	0.0050	0.4	1.5	3.0	6.5
1537	1.1	-1.2	0.2	24.6	4.3	1.8	3.4	0.0050	0.5	1.5	3.0	6.6

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	994	cfs
Stage at Peak Flow	101.1	ft
Volume at Peak Flow	709.0	ac. ft

Freeboard

Max. Flow Depth	1.4	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.1	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	2.62	ac. ft
Outflowing Sediment Volume	0.46	ac. ft
Deposited(+)/Eroded(-) Volume	2.15	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	10853	10853
Side Slope (?H:1V)	3	3
Channel Width (ft)	267	267
Channel XS Area (sq. ft)	1272.8	1272.8
Channel Perimeter (ft)	269	269

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	10853	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	3618	sq. Yd
Volume	12059	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	10853	10853
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	50647	104912
Left Levee Volume (cu. Yd)	49843	117373
Right Levee Length (ft)	10853	10853
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	50647	104912
Right Levee Volume (cu. Yd)	49843	117373
Total Levee Surface Area (sq. Yd)	101294	209824
Total Levee Volume (cu. Yd)	99686	234746

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	10853	10853
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	16882	39794
Left Levee Lining Volume (cu. Yd)	8441	19897
Right Levee Length (ft)	10853	10853
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	16882	39794
Right Levee Lining Volume (cu. Yd)	8441	19897
Total Lining Area (sq. Yd)	33765	79589
Total Lining Volume (cu. Yd)	16882	39794

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	267	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	6.7	ft	
Structure Height	9.7	ft	
Number of Structures	30		
Volume per structure	287	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 21,525		
Area per structure	89	sq. Yd	
Total Area	2,670	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	10116	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 40,464	
Other Cost	$ -	
Total cost per basin	$ 40,464	
Area per basin	10,733	sq. Yd
Total Area	21,466	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	99,686	cu. Yd	$ 7.00	$ 697,802	101,294	sq. Yd	$ 9.00	$ 911,646	101,294	sq. Yd	$ 11.67	$ 1,181,763
Levee - LC Enhancement	Fill	135,060	cu. Yd	$ 7.00	$ 945,420	108,530	sq. Yd	$ 9.00	$ 976,770	135,060	sq. Yd	$ 11.67	$ 1,575,700
Levee Lining	Riprap	16,882	cu. Yd	$ 75.00	$ 1,266,150	33,765	sq. Yd	$ -	$ -	33,765	sq. Yd	$ 20.83	$ 703,435
Levee Lining -LC Enhancement	Riprap	22,912	cu. Yd	$ 75.00	$ 1,718,400	45,824	sq. Yd	$ -	$ -	45,824	sq. Yd	$ 20.83	$ 954,662
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	12,059	cu. Yd	$ 75.00	$ 904,425	3,618	sq. Yd	$ -	$ -	3,618	sq. Yd	$ 25.00	$ 90,450
Drop Structures	Riprap	30	EA	$ 21,525.00	$ 645,750	2,670	sq. Yd	$ -	$ -	2,670	sq. Yd	$ 33.33	$ 89,000
Drop Str. - LC Enhancement	Riprap	30	EA	$ 2,152.50	$ 64,575	267	sq. Yd	$ -	$ -	267	sq. Yd	$ 33.33	$ 8,900
Sedimentation Basins		2	EA	$ 40,464.00	$ 80,928	21,466	sq. Yd	$ -	$ -	21,466	sq. Yd	$ 8.33	$ 178,883
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 911,646	Base Maintenance Cost			$ 2,243,532
						LC Enhancement Cost			$ 976,770	LC Enhancement Cost			$ 2,539,262
						Total Landscape Cost			$ 1,888,416	Total Maintenance Cost			$ 4,782,794

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,595,055	$ 2,728,395	$ 6,323,450
Contingency Cost (25% of Construction Cost)	$ 898,764	$ 682,099	$ 1,580,863
Engineering Design Cost (5% of Construction Cost)	$ 179,753	$ 136,420	$ 316,173
Total Construction Cost	$ 4,673,572	$ 3,546,914	$ 8,220,485

Land Cost

Channel Length	10853 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	267	66.5	$100,000	$ 6,650,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	13.7	$100,000	$ 1,370,000
Levee LC Enhancement	51	12.7	$100,000	$ 1,270,000
Other	0	0	$100,000	$ -
Total	373	92.9		$ 9,290,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	80.2	$100,000	$ 8,020,000
LC Enhancement Cost	acre	12.7	$100,000	$ 1,270,000
Total Land Cost	acre	92.9	$100,000	$ 9,290,000

Total Cost

Base Total Cost	$ 15,848,749
Total Landscape Enhancement Cost	$ 8,332,946
Total Cost Including LC Enh.	$ 24,181,695

Open Channel

Structure ID	N140

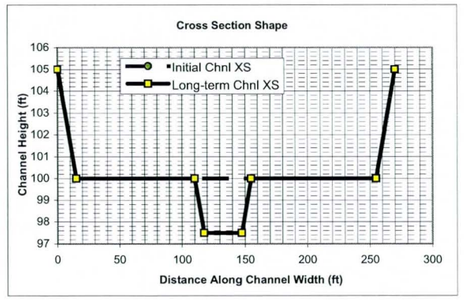
HEC1 ID	P1A-1B

Longitudnal Geometry

Length	5668.0	ft
U/S Elev	1133.0	ft
D/S Elev	1092.0	ft
Initial Channel Slope	0.0072	ft/ft
Long-term Channel Slope	0.0040	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	11



Initial Channel XS Geometry

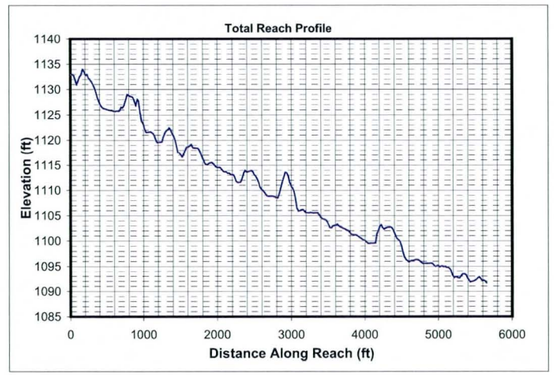
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	240	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	255	255	255	270
Y	105	100	100	100	100	100	100	105

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	95	3	30	7.5	3	100	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	110	117.5	147.5	155	255	270
Y	105	100	100	97.5	97.5	100	100	105



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	P									TOTAL
HEC1 Peak-Flow	1645									1645
Weighting Factor	1.00									
Flow into Channel	1645									1645

Reach Sediment Inflow Characteristics

U/S Contributing ID	P1A-1B_N130	Q1A-P_P1B10								TOTAL
Flow Volume (ac. ft)	709.00	97.00								806
Sediment Conc. (ppm)	1733	1891								
Sediment Volume (ac. ft)	0.46	0.07								0.53
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.46	0.07								0.53

Hydrology

Drainage Area	12.47	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	1645	cfs	
Long-term Max. Chnl Capacity	8408	cfs	
Q2 Channel	165	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	270	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (ib/sq. ft)	Froude Number
165	242.7	103.4	0.4	100.0	100.4	1.6	0.4	242.6	0.4	0.11	0.43
494	245.2	200.5	0.8	100.0	100.8	2.5	0.8	245.0	0.8	0.21	0.48
1234	249.1	349.7	1.4	100.0	101.4	3.5	1.4	248.6	1.4	0.36	0.52
1645	250.8	416.7	1.7	100.0	101.7	3.9	1.7	250.2	1.7	0.42	0.54

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
165	40.9	60.5	1.5	97.5	99.2	2.7	1.7	40.3	1.5	0.43	0.39
494	244.6	239.2	1.0	97.5	100.6	2.1	3.1	243.6	1.0	0.77	0.37
1234	249.2	417.6	1.7	97.5	101.3	3.0	3.8	248.0	1.7	0.96	0.40
1645	251.2	497.9	2.0	97.5	101.6	3.3	4.1	249.9	2.0	1.04	0.41

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)								TOTAL
	P1A-1B_N130	Q1A-P_P1B10							
165	526	112							638
494	2154	333							2487
1234	4308	1064							5372
1645	6309	1544							7853

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
165	1.74	1.1324	1.0758	Erosive	Erosive	Erosive	0.2	Stable	5.3	Stable	Stable
494	1.74	1.3337	1.2670	Erosive	Erosive	Erosive	0.3	Stable	6.6	Stable	Stable
1234	1.74	1.5007	1.4256	Erosive	Erosive	Erosive	0.4	Stable	8.0	Stable	Stable
1645	1.74	1.5527	1.4751	Erosive	Erosive	Erosive	0.4	Stable	8.6	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	165	494	1234	1645	165	494	1234	1645	165	494	1234	1645
Bray - Equation #1	35	63	101	118	1.5	2.1	2.8	3.1	3.2	3.8	4.3	4.5
Bray - Equation #2	46	82	133	155	1.6	2.3	3.1	3.4	2.2	2.6	2.9	3.1
Hey	10	19	33	38	4.5	6.8	9.6	10.7				
Ackers & Charlton/Lacey	31	49	72	81					1.9	2.3	2.6	2.8
Parker	88	153	241	279	1.2	1.8	2.7	3.0				
Chang	54	106	185	221	0.2	0.1	-0.2	-0.3				
Kellerhals	23	40	63	73	2.1	3.2	4.7	5.3	3.4	3.8	4.2	4.3
AMAFCA/Schumm	40	244	248	250								
Moody & Odem	32	32	32	32	1.4	1.4	1.4	1.4				
BUREC	18.8	28.3	40.0	44.5	5	8	11	12	2.7	3.6	4.5	4.9
Average	38	82	115	129	2.2	3.2	4.4	4.8	2.7	3.2	3.7	3.9
Values As Designed	40	244	248	250	1.7	3.1	3.8	4.1	2.7	2.1	3.0	3.3
Difference with Design	-3	-162	-133	-121	0.4	0.1	0.5	0.7	0.0	1.1	0.8	0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
165	487	292	410	739	2453	56	72	57	1488	130	466	604
494	2657	1440	2476	4752	4230	613	518	558	5292	605	3068	2382
1234	10863	4550	6962	22324	6235	2444	1588	2430	13852	2318	12259	7802
1645	16885	6407	9646	36239	6988	3676	2178	3706	18608	3554	18548	11494

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
165	1098	658	924	1667	5532	125	162	128	3357	293	1052	1363
494	1997	1082	1862	3572	3180	461	389	419	3978	454	2306	1791
1234	3267	1368	2094	6713	1875	735	477	731	4165	697	3686	2346
1645	3808	1445	2175	8173	1576	829	491	836	4197	802	4183	2592

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
165	561	281	410	977	704	101	85	139	722	115	670	433
494	1167	614	888	1798	3050	169	174	240	1977	232	1305	1056
1234	4768	2192	3287	8431	4707	869	691	1197	5501	956	5696	3481
1645	7408	3170	4443	13673	5334	1344	988	1873	7460	1471	8805	5088

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
165	1266	635	925	2203	1588	228	191	313	1629	259	1511	977
494	878	461	667	1352	2293	127	131	181	1486	175	981	794
1234	1434	659	988	2535	1415	261	208	360	1654	287	1713	1047
1645	1671	715	1002	3084	1203	303	223	422	1682	332	1986	1148

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
165	0.0023	0.0028	103	0.31	0.045	0.0006	29	0.035	0.0004	0.0159	0.0006	0.0016	0.0064	0.0004	0.0025	0.0072	0.0039
494	0.0010	0.0015	143	0.44	0.048	0.0003	30	0.036	0.0002	0.0159	0.0003	0.0008	0.0064	0.0002	0.0011	0.0072	0.0036
1234	0.0005	0.0009	187	0.57	0.050	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0064	0.0001	0.0006	0.0072	0.0035
1645	0.0004	0.0007	204	0.62	0.051	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0064	0.0001	0.0004	0.0072	0.0035

Drop Structures

Design Slope	0.0040	ft/ft
Total Drop Needed	18.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	7	
Distance between structs.	810	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.70	sq. mi
Total Sediment Yield Volume	1.34	ac ft

Sedimentation Basins

Length	810 ft	Depth	3 ft
Width	270 ft	Side slope	3 ft/ft
Total Volume per Basin		14.39	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
165	1.1	-0.6	0.1	24.6	1.7	1.5	2.7	0.0040	0.2	1.5	2.5	5.5
494	1.1	-1.1	0.1	24.6	3.1	1.0	2.1	0.0040	0.3	1.5	2.5	5.6
1234	1.1	-1.2	0.1	24.6	3.8	1.7	3.0	0.0040	0.4	1.5	2.5	5.8
1645	1.1	-1.2	0.1	24.6	4.1	2.0	3.3	0.0040	0.5	1.5	2.5	5.9

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	994	cfs
Stage at Peak Flow	101.1	ft
Volume at Peak Flow	709.0	ac. ft

Freeboard

Max. Flow Depth	1.7	ft
Channel Depth as designed	5.0	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	1.87	ac. ft
Outflowing Sediment Volume	0.31	ac. ft
Deposited(+)/Eroded(-) Volume	1.56	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5668	5668
Side Slope (?H:1V)	3	3
Channel Width (ft)	270	270
Channel XS Area (sq. ft)	1368.8	1368.8
Channel Perimeter (ft)	272	272

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5668	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1889	sq. Yd
Volume	5668	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5668	5668
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	5	6
Left Levee Surface Area (sq. Yd)	28970	58569
Left Levee Volume (cu. Yd)	30439	70535
Right Levee Length (ft)	5668	5668
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5	6
Right Levee Surface Area (sq. Yd)	28970	58569
Right Levee Volume (cu. Yd)	30439	70535
Total Levee Surface Area (sq. Yd)	57940	117138
Total Levee Volume (cu. Yd)	60878	141070

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5668	5668
Left Levee Lining Width (ft)	16	36
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	10076	22672
Left Levee Lining Volume (cu. Yd)	5038	11336
Right Levee Length (ft)	5668	5668
Right Levee Lining Width (ft)	16	36
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	10076	22672
Right Levee Lining Volume (cu. Yd)	5038	11336
Total Lining Area (sq. Yd)	20153	45344
Total Lining Volume (cu. Yd)	10076	22672

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	270	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	6.9	ft	
Structure Height	9.9	ft	
Number of Structures	7		
Volume per structure	297	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 22,275		
Area per structure	90	sq. Yd	
Total Area	630	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	23216	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 92,864	
Other Cost	$ -	
Total cost per basin	$ 92,864	
Area per basin	24,291	sq. Yd
Total Area	24,291	sq. Yd

Structure Type	Structure Cost											
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	60,878	cu. Yd	$ 7.00	$ 426,146	57,940	sq. Yd	$ 9.00	$ 521,460	57,940	sq. Yd	$ 11.67	$ 675,967
Levee - LC Enhancement	Fill	80,192	cu. Yd	$ 7.00	$ 561,344	59,198	sq. Yd	$ 9.00	$ 532,782	80,192	sq. Yd	$ 11.67	$ 935,573
Levee Lining	Riprap	10,076	cu. Yd	$ 75.00	$ 755,700	20,153	sq. Yd	$ -	$ -	20,153	sq. Yd	$ 20.83	$ 419,852
Levee Lining -LC Enhancement	Riprap	12,596	cu. Yd	$ 75.00	$ 944,700	25,191	sq. Yd	$ -	$ -	25,191	sq. Yd	$ 20.83	$ 524,815
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	5,668	cu. Yd	$ 75.00	$ 425,100	1,889	sq. Yd	$ -	$ -	1,889	sq. Yd	$ 25.00	$ 47,225
Drop Structures	Riprap	7	EA	$ 22,275.00	$ 155,925	630	sq. Yd	$ -	$ -	630	sq. Yd	$ 33.33	$ 21,000
Drop Str. - LC Enhancement	Riprap	7	EA	$ 2,227.50	$ 15,593	63	sq. Yd	$ -	$ -	63	sq. Yd	$ 33.33	$ 2,100
Sedimentation Basins		1	EA	$ 92,864.00	$ 92,864	24,291	sq. Yd	$ -	$ -	24,291	sq. Yd	$ 8.33	$ 202,425
Other					$ -				$ -				$ -

Base Landscape Cost	$ 521,460	Base Maintenance Cost	$ 1,366,469
LC Enhancement Cost	$ 532,782	LC Enhancement Cost	$ 1,462,488
Total Landscape Cost	$ 1,054,242	Total Maintenance Cost	$ 2,828,957

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 1,855,735	$ 1,521,637	$ 3,377,372
Contingency Cost (25% of Construction Cost)	$ 463,934	$ 380,409	$ 844,343
Engineering Design Cost (5% of Construction Cost)	$ 92,787	$ 76,082	$ 168,869
Total Construction Cost	$ 2,412,456	$ 1,978,127	$ 4,390,583

Land Cost

Channel Length	5668	ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	270	35.1	$100,000	$ 3,510,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	58	7.5	$100,000	$ 750,000
Levee LC Enhancement	54	7	$100,000	$ 700,000
Other	0	0	$100,000	$ -
Total	382	49.6		$ 4,960,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	42.6	$100,000	$ 4,260,000
LC Enhancement Cost	acre	7	$100,000	$ 700,000
Total Land Cost	acre	49.6	$100,000	$ 4,960,000

Total Cost

Base Total Cost	$	8,560,384
Total Landscape Enhancement Cost	$	4,673,398
Total Cost Including LC Enh.	$	13,233,782

Online Basin

HEC1 ID	RRQ1A

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.3	sq. mi
Total Sediment Yield Volume	2.5	ac ft

Required Minimum Sediment Volume

Sediment Volume	2.5	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.03	0.03
Basin Length (ft)	1000	1290
Basin Width (ft)	420	420
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	11	11
Freeboard (ft)	1	1
Effective Basin Width (ft)	382	344
Top Area (acres)	9.6	12.4
U/S-D/S Height Difference (ft)	12.6	12.6
Excess Area on Upstream (acres)	0.9	2.3

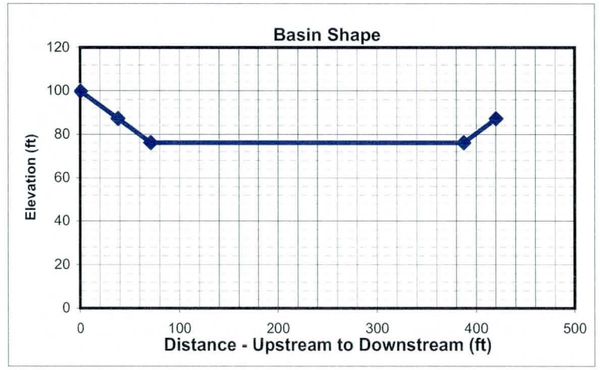
			Base	LC Enhanced
Bottom Length (ft)	934	Allocated Storage Volume (ac. ft)	76.6	76.3
Bottom Width (ft)	316	Total Available Volume (ac. ft) (incl. Freeboard)	85.3	86.3
		Total Excavation Volume (ac. ft)	146.1	164.7

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	3.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	3	5	7	8	9	10	11	13
Volume	0.00	6.86	21.11	36.06	51.74	59.86	68.15	76.64	85.31	103.24
Outflow	0.0	34.0	59.0	76.1	90.0	96.3	102.1	107.6	112.9	122.7



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	97.0	95	97.0
Peak Inflow (cfs)	990	915	990.0
Peak Outflow (cfs)	106	100	106.0
Stage at Peak Outflow (ft)	9.7	8.7	9.7
Volume at Peak Outflow (ac. ft)	73.8	65.43	73.8

Volume Check

Total Volume needed	76.3	ac. ft
Total Volume Provided	76.6	ac. ft

Volume OK?	Yes

Stage Check

Depth Needed	10.7	ft
Depth Provided	11	ft

Depth OK?	Yes

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	302800	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	1000	ft
Base Total ROW Width	420	ft
LC Enh. Total ROW Length	1390	ft
LC Enh. Total ROW Length	520	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	235708	265716
Excavated Area (sq. Yd)	46667	80311

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	75	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	829	sq. Yd
Material Volume	415	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	440	ft
Unit Cost	160	per ft
Cost per outlet	$70,400	
Other Cost	$ -	
Total Cost	$70,400	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		235,708	cu. Yd	$ 4.00	$ 942,832	46,667	sq. Yd	$ 9.00	$ 420,003	46,667	sq. Yd	$ 8.33	$ 388,892
Basin - LC Enhancement		30,008	cu. Yd	$ 4.00	$ 120,032	33,644	sq. Yd	$ 9.00	$ 302,796	33,644	sq. Yd	$ 8.33	$ 280,367
Inlet	Riprap	415	sq. Yd	$ 75.00	$ 31,125	829	sq. Yd	$ -	$ -	829	sq. Yd	$ 33.33	$ 27,633
Inlet - LC Enhancement (20%Inlet)					$ 6,225				$ -				$ 5,527
Outlet	Pipe	1	EA	$ 70,400	$ 70,400	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 3,520				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 420,003	Base Maintenance Cost			$ 418,742
						LC Enh. Landscape Cost			$ 302,796	LC Enh. Maintenance Cost			$ 286,004
						Total Landscape Cost			$ 722,799	Total Maintenance Cost			$ 704,746

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,044,357	$ 120,032	$ 1,164,389
Contingency Cost (25% of Construction Cost)	$ 261,089	$ 30,008	$ 291,097
Engineering Design Cost (5% of Construction Cost)	$ 52,218	$ 6,002	$ 58,219
Total Construction Cost	$ 1,357,664	$ 156,042	$ 1,513,706

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	7.0	$100,000	$ 700,000
Basin	9.6	$100,000	$ 960,000
Other		$100,000	$ -
Total	16.6	$100,000	$ 1,660,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	9.6	$100,000	$ 960,000
LC Enhancement Cost	acre	7.0	$100,000	$ 700,000
Total Land Cost	acre	16.6	$100,000	$ 1,660,000

Total Cost

Base Total Cost	$ 3,156,409
Total LC Enhancement Cost	$ 1,444,842
Total Cost Including LC Enh.	$ 4,601,251

Open Channel

Structure ID	P1B10

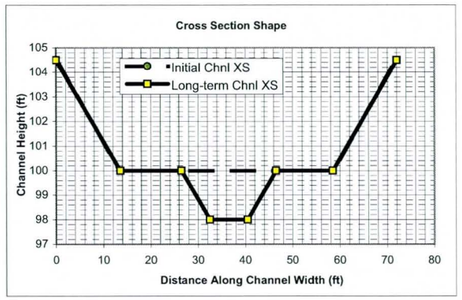
HEC1 ID	Q1A-P

Longitudal Geometry

Length	5122.9	ft
U/S Elev	1190.4	ft
D/S Elev	1133.0	ft
Initial Channel Slope	0.0112	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	7



Initial Channel XS Geometry

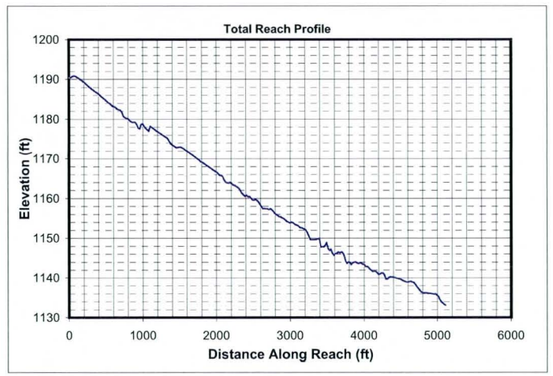
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	45	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	58.5	58.5	58.5	72
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	13	3	8	6.5	3	12	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	26.5	32.5	40.5	46.5	58.5	72
Y	104.5	100	100	98	98	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RRQ1A	P1B							TOTAL
HEC1 Peak-Flow	106	852							958
Weighting Factor	1.00	0.23							
Flow into Channel	106	197							303

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	1.384	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	303	cfs	
Long-term Max. Chnl Capacity	1860	cfs	
Q2 Channel	30	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	72	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
30	47.3	17.1	0.4	100.0	100.4	1.8	0.4	47.2	0.4	0.14	0.52
91	49.5	33.6	0.7	100.0	100.7	2.7	0.7	49.3	0.7	0.27	0.58
227	52.8	59.7	1.1	100.0	101.2	3.8	1.2	52.4	1.1	0.46	0.63
303	54.2	71.7	1.3	100.0	101.5	4.2	1.5	53.7	1.3	0.54	0.64

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
30	15.2	13.1	0.9	98.0	99.1	2.3	1.1	14.9	0.9	0.43	0.44
91	47.3	39.8	0.8	98.0	100.3	2.3	2.3	46.5	0.9	0.84	0.44
227	51.4	71.2	1.4	98.0	100.9	3.2	2.9	50.4	1.4	1.09	0.47
303	53.2	85.8	1.6	98.0	101.2	3.5	3.2	52.1	1.6	1.19	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
30										0
91										0
227										0
303										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
30	1.74	1.0818	1.0277	Erosive	Erosive	Erosive	0.2	Stable	4.8	Stable	Stable
91	1.74	1.2772	1.2133	Erosive	Erosive	Erosive	0.3	Stable	6.7	Stable	Stable
227	1.74	1.4359	1.3641	Erosive	Erosive	Erosive	0.3	Stable	8.3	Stable	Stable
303	1.74	1.4845	1.4103	Erosive	Erosive	Erosive	0.3	Stable	8.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	30	91	227	303	30	91	227	303	30	91	227	303
Bray - Equation #1	14	26	42	48	0.8	1.2	1.6	1.8	2.5	3.0	3.4	3.5
Bray - Equation #2	19	34	54	63	0.9	1.3	1.8	2.0	1.8	2.0	2.3	2.4
Hey	4	7	12	15	2.4	3.6	5.1	5.7				
Ackers & Charlton/Lacey	15	24	35	40					1.4	1.7	2.0	2.1
Parker	38	65	104	120	0.6	0.9	1.3	1.5				
Chang	22	43	76	90	0.2	0.1	0.0	0.0				
Kellerhals	10	17	27	31	1.1	1.7	2.4	2.7	2.9	3.2	3.5	3.6
AMAFCA/Schumm	15	47	51	52								
Moody & Odem	14	14	14	14	1.0	1.0	1.0	1.0				
BUREC	9.2	13.9	19.6	21.9	2	4	5	6	2.1	2.8	3.5	3.7
Average	16	29	43	50	1.2	1.7	2.3	2.6	2.1	2.5	2.9	3.1
Values As Designed	15	47	50	52	1.1	2.3	2.9	3.2	2.3	2.3	3.2	3.5
Difference with Design	1	-17	-7	-3	0.0	-0.6	-0.6	-0.6	-0.2	0.2	-0.3	-0.5

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
30	159	101	190	270	607	37	37	22	591	46	166	202
91	852	439	812	1698	1021	239	179	174	1942	206	965	775
227	3383	1310	2230	7720	1518	876	502	695	4987	758	3594	2507
303	5195	1820	2876	12364	1715	1298	678	1038	6679	1144	5330	3649

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
30	1951	1241	2323	3309	7431	451	454	272	7232	560	2026	2477
91	3478	1792	3314	6930	4169	975	731	710	7928	841	3937	3164
227	5523	2139	3641	12604	2479	1431	819	1134	8141	1238	5868	4092
303	6361	2229	3521	15138	2100	1589	830	1271	8177	1401	6527	4468

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
30	122	66	109	216	236	25	22	26	241	28	141	112
91	362	190	327	629	722	74	67	75	719	82	418	333
227	1423	622	978	2821	1123	306	218	332	1908	307	1663	1064
303	2177	882	1341	4493	1284	459	302	507	2569	464	2507	1544

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
30	1489	813	1340	2640	2886	308	273	313	2949	342	1726	1371
91	1479	775	1335	2567	2945	303	273	308	2936	337	1705	1360
227	2324	1016	1596	4605	1833	499	355	543	3114	501	2715	1736
303	2666	1080	1642	5501	1573	562	370	620	3145	568	3070	1891

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
30	0.0024	0.0034	118	0.36	0.046	0.0007	29	0.035	0.0005	0.0159	0.0007	0.0018	0.0112	0.0008	0.0033	0.0111	0.0062
91	0.0011	0.0018	162	0.49	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0009	0.0112	0.0005	0.0015	0.0111	0.0059
227	0.0006	0.0011	210	0.64	0.051	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0112	0.0003	0.0007	0.0111	0.0058
303	0.0005	0.0009	227	0.69	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0112	0.0003	0.0006	0.0111	0.0057

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	26.7	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	569	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.45	sq. mi
Total Sediment Yield Volume	0.85	ac ft

Sedimentation Basins

Length	569 ft	Depth	3 ft	
Width	72 ft	Side slope	3 ft/ft	
Total Volume per Basin		2.43	ac. ft.	
Basin Trap Efficiency		0.6		
No. of Basins		2		

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
30	1.1	-0.4	0.1	24.6	1.1	0.9	2.3	0.0060	0.1	1.5	2.0	4.7
91	1.1	-0.8	0.1	24.6	2.3	0.9	2.3	0.0060	0.2	1.5	2.0	4.9
227	1.1	-0.9	0.1	24.6	2.9	1.4	3.2	0.0060	0.3	1.5	2.0	5.0
303	1.1	-0.9	0.2	24.6	3.2	1.6	3.5	0.0060	0.3	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	106	cfs
Stage at Peak Flow	100.8	ft
Volume at Peak Flow	97.0	ac. ft

Freeboard

Max. Flow Depth	1.5	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.85	ac. ft
Outflowing Sediment Volume	0.07	ac. ft
Deposited(+)/Eroded(-) Volume	0.78	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5123	5123
Side Slope (?H:1V)	3	3
Channel Width (ft)	72	72
Channel XS Area (sq. ft)	291.2	291.2
Channel Perimeter (ft)	74	74

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5123	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1708	sq. Yd
Volume	5123	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5123	5123
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	23907	49522
Left Levee Volume (cu. Yd)	23528	55404
Right Levee Length (ft)	5123	5123
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	23907	49522
Right Levee Volume (cu. Yd)	23528	55404
Total Levee Surface Area (sq. Yd)	47814	99044
Total Levee Volume (cu. Yd)	47056	110808

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5123	5123
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	7969	18784
Left Levee Lining Volume (cu. Yd)	3985	9392
Right Levee Length (ft)	5123	5123
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	7969	18784
Right Levee Lining Volume (cu. Yd)	3985	9392
Total Lining Area (sq. Yd)	15938	37569
Total Lining Volume (cu. Yd)	7970	18784

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	72	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	6.4	ft	
Structure Height	9.4	ft	
Number of Structures	9		
Volume per structure	75	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 5,625		
Area per structure	24	sq. Yd	
Total Area	216	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	3920	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 15,680	
Other Cost	$ -	
Total cost per basin	$ 15,680	
Area per basin	4,554	sq. Yd
Total Area	9,108	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	47,056	cu. Yd	$ 7.00	$ 329,392	47,814	sq. Yd	$ 9.00	$ 430,326	47,814	sq. Yd	$ 11.67	$ 557,830
Levee - LC Enhancement	Fill	63,752	cu. Yd	$ 7.00	$ 446,264	51,230	sq. Yd	$ 9.00	$ 461,070	63,752	sq. Yd	$ 11.67	$ 743,773
Levee Lining	Riprap	7,970	cu. Yd	$ 75.00	$ 597,750	15,938	sq. Yd	$ -	$ -	15,938	sq. Yd	$ 20.83	$ 332,046
Levee Lining -LC Enhancement	Riprap	10,814	cu. Yd	$ 75.00	$ 811,050	21,630	sq. Yd	$ -	$ -	21,630	sq. Yd	$ 20.83	$ 450,634
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	5,123	cu. Yd	$ 75.00	$ 384,225	1,708	sq. Yd	$ -	$ -	1,708	sq. Yd	$ 25.00	$ 42,700
Drop Structures	Riprap	9	EA	$ 5,625.00	$ 50,625	216	sq. Yd	$ -	$ -	216	sq. Yd	$ 33.33	$ 7,200
Drop Str. - LC Enhancement	Riprap	9	EA	$ 562.50	$ 5,063	22	sq. Yd	$ -	$ -	22	sq. Yd	$ 33.33	$ 720
Sedimentation Basins		2	EA	$ 15,680.00	$ 31,360	9,108	sq. Yd	$ -	$ -	9,108	sq. Yd	$ 8.33	$ 75,900
Other					$ -				$ -				$ -

Base Landscape Cost	$ 430,326	Base Maintenance Cost	$ 1,015,676
LC Enhancement Cost	$ 461,070	LC Enhancement Cost	$ 1,195,128
Total Landscape Cost	$ 891,396	Total Maintenance Cost	$ 2,210,804

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 1,393,352	$ 1,262,377	$ 2,655,729
Contingency Cost (25% of Construction Cost)	$ 348,338	$ 315,594	$ 663,932
Engineering Design Cost (5% of Construction Cost)	$ 69,668	$ 63,119	$ 132,786
Total Construction Cost	$ 1,811,358	$ 1,641,089	$ 3,452,447

Land Cost

Channel Length	5123 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	72	8.5	$100,000	$ 850,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	6.5	$100,000	$ 650,000
Levee LC Enhancement	51	6	$100,000	$ 600,000
Other	0	0	$100,000	$ -
Total	178	21		$ 2,100,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	15	$100,000	$ 1,500,000
LC Enhancement Cost	acre	6	$100,000	$ 600,000
Total Land Cost	acre	21	$100,000	$ 2,100,000

Total Cost

Base Total Cost	$ 4,757,360
Total Landscape Enhancement Cost	$ 3,897,287
Total Cost Including LC Enh.	$ 8,654,647

Open Channel

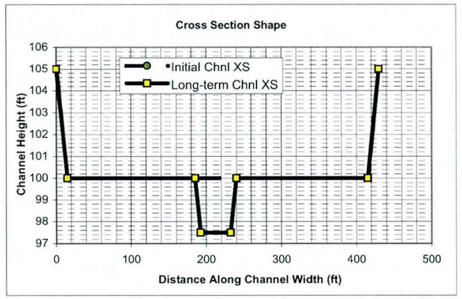
Structure ID	L20	HEC1 ID	L20

Longitudal Geometry

Length	4691.2	ft
U/S Elev	1119.1	ft
D/S Elev	1079.7	ft
Initial Channel Slope	0.0084	ft/ft
Long-term Channel Slope	0.0040	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	



Initial Channel XS Geometry

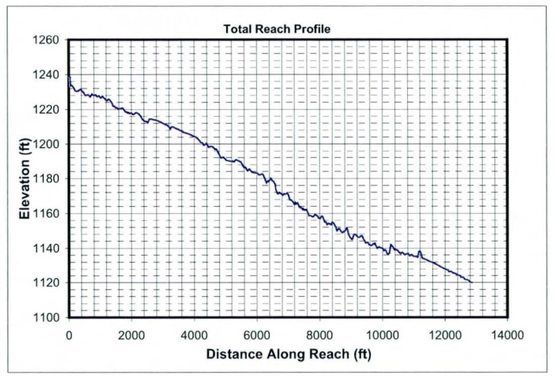
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	400	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	415	415	415	430
Y	105	100	100	100	100	100	100	105

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	170	3	40	7.5	3	175	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	185	192.5	232.5	240	415	430
Y	105	100	100	97.5	97.5	100	100	105



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	L									TOTAL
HEC1 Peak-Flow	3021									3021
Weighting Factor	1.00									
Flow into Channel	3021									3021

Reach Sediment Inflow Characteristics

U/S Contributing ID	L2BL3_L10									TOTAL
Flow Volume (ac. ft)	557.00									557
Sediment Conc. (ppm)	1228									
Sediment Volume (ac. ft)	0.26									0.26
Weighting Factor										
Weighted Sed. Vol. (ac. ft)	0.00									0.00

Hydrology

Drainage Area	16.73	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	3021	cfs	
Long-term Max. Chnl Capacity	13563	cfs	
Q2 Channel	302	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	430	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
302	402.7	174.3	0.4	100.0	100.4	1.7	0.4	402.6	0.4	0.11	0.46
906	405.3	337.6	0.8	100.0	100.8	2.7	0.8	405.0	0.8	0.21	0.52
2266	409.2	587.3	1.4	100.0	101.5	3.9	1.5	408.7	1.4	0.36	0.57
3021	410.9	699.2	1.7	100.0	101.7	4.3	1.7	410.4	1.7	0.43	0.58

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
302	53.2	96.8	1.8	97.5	99.6	3.1	2.1	52.6	1.8	0.52	0.41
906	405.6	421.7	1.0	97.5	100.8	2.1	3.3	404.5	1.0	0.81	0.37
2266	410.4	734.2	1.8	97.5	101.5	3.1	4.0	409.1	1.8	1.00	0.41
3021	412.6	874.4	2.1	97.5	101.9	3.5	4.4	411.2	2.1	1.09	0.42

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
	L2BL3_L10									
302	984									984
906	2220									2220
2266	7358									7358
3021	10823									10823

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
302	1.74	1.1373	1.0804	Erosive	Erosive	Erosive	0.2	Stable	6.0	Stable	Stable
906	1.74	1.3393	1.2723	Erosive	Erosive	Erosive	0.3	Stable	6.8	Stable	Stable
2266	1.74	1.5072	1.4319	Erosive	Erosive	Erosive	0.4	Stable	8.3	Stable	Stable
3021	1.74	1.5598	1.4818	Erosive	Erosive	Erosive	0.4	Stable	8.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	302	906	2266	3021	302	906	2266	3021	302	906	2266	3021
Bray - Equation #1	48	86	140	162	1.8	2.6	3.5	3.8	3.5	4.1	4.7	4.9
Bray - Equation #2	63	113	183	214	2.0	2.8	3.8	4.2	2.4	2.8	3.2	3.3
Hey	15	27	46	53	5.6	8.6	12.1	13.5				
Ackers & Charlton/Lacey	40	63	92	104					2.1	2.5	2.9	3.0
Parker	119	207	327	378	1.5	2.3	3.4	3.9				
Chang	78	154	268	319	0.2	-0.1	-0.5	-0.7				
Kellerhals	31	54	86	99	2.7	4.1	6.0	6.7	3.6	4.0	4.4	4.5
AMAFCA/Schumm	53	405	410	412								
Moody & Odem	35	35	35	35	1.4	1.4	1.4	1.4				
BUREC	23.6	35.6	50.2	55.9	6	10	13	15	3.2	4.2	5.3	5.7
Average	51	118	164	183	2.7	3.9	5.4	6.0	3.0	3.5	4.1	4.3
Values As Designed	53	405	409	411	2.1	3.3	4.0	4.4	3.1	2.1	3.1	3.5
Difference with Design	-2	-286	-245	-228	0.6	0.7	1.4	1.6	-0.2	1.4	1.0	0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
302	1162	717	1149	1863	4714	209	225	160	3666	310	1191	1397
906	6359	3284	5758	12014	7892	1581	1237	1351	12408	1456	7322	5515
2266	26100	10082	15830	56673	11427	6043	3577	5603	32080	5600	28421	18312
3021	40634	14110	20775	92158	12742	9046	4857	8463	43009	8587	42707	27008

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
302	1428	880	1411	2288	5789	256	276	197	4502	380	1463	1716
906	2603	1344	2357	4918	3231	647	506	553	5079	596	2997	2257
2266	4274	1651	2592	9280	1871	990	586	917	5253	917	4654	2999
3021	4990	1733	2551	11318	1565	1111	596	1039	5282	1055	5245	3317

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
302	1246	574	804	2280	1063	227	173	315	1360	251	1490	889
906	2273	1186	1793	3545	5323	351	348	487	3697	465	2579	2004
2266	9320	4166	6079	16695	8123	1699	1312	2350	10174	1855	11116	6626
3021	14497	6005	8255	27128	9173	2613	1859	3656	13774	2862	17145	9724

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
302	1530	705	987	2801	1305	279	213	387	1670	308	1829	1092
906	930	485	734	1451	2179	144	142	199	1513	190	1056	820
2266	1526	682	995	2734	1330	278	215	385	1666	304	1820	1085
3021	1780	737	1014	3332	1127	321	228	449	1691	351	2105	1194

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
302	0.0022	0.0028	112	0.34	0.045	0.0006	29	0.035	0.0004	0.0159	0.0006	0.0015	0.0052	0.0003	0.0023	0.0084	0.0038
906	0.0010	0.0015	156	0.47	0.048	0.0003	30	0.036	0.0002	0.0159	0.0003	0.0007	0.0052	0.0002	0.0010	0.0084	0.0036
2266	0.0005	0.0008	204	0.62	0.051	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0052	0.0001	0.0005	0.0084	0.0035
3021	0.0004	0.0007	222	0.68	0.052	0.0002	31	0.036	0.0001	0.0159	0.0001	0.0003	0.0052	0.0001	0.0004	0.0084	0.0035

Drop Structures

Design Slope	0.0040	ft/ft
Total Drop Needed	20.6	ft
Height of Drop Structure	3	ft
No . of Drop Structures	7	
Distance between structs.	670	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	2.77	sq. mi
Total Sediment Yield Volume	5.26	ac ft

Sedimentation Basins

Length	670 ft	Depth	3 ft
Width	430 ft	Side slope	3 ft/ft
Total Volume per Basin		19.17	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
302	1.1	-0.6	0.1	24.6	2.1	1.8	3.1	0.0040	0.2	1.5	2.5	5.6
906	1.1	-1.1	0.1	24.6	3.3	1.0	2.1	0.0040	0.3	1.5	2.5	5.7
2266	1.1	-1.2	0.1	24.6	4.0	1.8	3.1	0.0040	0.4	1.5	2.5	5.8
3021	1.1	-1.2	0.2	24.6	4.4	2.1	3.5	0.0040	0.5	1.5	2.5	5.9

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	1443	cfs
Stage at Peak Flow	101.1	ft
Volume at Peak Flow	557.0	ac. ft

Freeboard

Max. Flow Depth	1.7	ft
Channel Depth as designed	5.0	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	5.26	ac. ft
Outflowing Sediment Volume	0.25	ac. ft
Deposited(+)/Eroded(-) Volume	5.01	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	4691	4691
Side Slope (?H:1V)	3	3
Channel Width (ft)	430	430
Channel XS Area (sq. ft)	2193.8	2193.8
Channel Perimeter (ft)	432	432

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	4691	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1564	sq. Yd
Volume	4691	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	4691	4691
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	5	6
Left Levee Surface Area (sq. Yd)	23976	48474
Left Levee Volume (cu. Yd)	25192	58377
Right Levee Length (ft)	4691	4691
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5	6
Right Levee Surface Area (sq. Yd)	23976	48474
Right Levee Volume (cu. Yd)	25192	58377
Total Levee Surface Area (sq. Yd)	47952	96948
Total Levee Volume (cu. Yd)	50384	116754

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	4691	4691
Left Levee Lining Width (ft)	16	36
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	8340	18764
Left Levee Lining Volume (cu. Yd)	4170	9382
Right Levee Length (ft)	4691	4691
Right Levee Lining Width (ft)	16	36
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	8340	18764
Right Levee Lining Volume (cu. Yd)	4170	9382
Total Lining Area (sq. Yd)	16679	37528
Total Lining Volume (cu. Yd)	8340	18764

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	430	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	7.4	ft	
Structure Height	10.4	ft	
Number of Structures	7		
Volume per structure	495	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 37,125		
Area per structure	143	sq. Yd	
Total Area	1,003	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	30928	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 123,712	
Other Cost	$ -	
Total cost per basin	$ 123,712	
Area per basin	32,019	sq. Yd
Total Area	32,019	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	50,384	cu. Yd	$ 7.00	$ 352,688	47,952	sq. Yd	$ 9.00	$ 431,568	47,952	sq. Yd	$ 11.67	$ 559,440
Levee - LC Enhancement	Fill	66,370	cu. Yd	$ 7.00	$ 464,590	48,996	sq. Yd	$ 9.00	$ 440,964	66,370	sq. Yd	$ 11.67	$ 774,317
Levee Lining	Riprap	8,340	cu. Yd	$ 75.00	$ 625,500	16,679	sq. Yd	$ -	$ -	16,679	sq. Yd	$ 20.83	$ 347,481
Levee Lining -LC Enhancement	Riprap	10,424	cu. Yd	$ 75.00	$ 781,800	20,849	sq. Yd	$ -	$ -	20,849	sq. Yd	$ 20.83	$ 434,352
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	4,691	cu. Yd	$ 75.00	$ 351,825	1,564	sq. Yd	$ -	$ -	1,564	sq. Yd	$ 25.00	$ 39,100
Drop Structures	Riprap	7	EA	$ 37,125.00	$ 259,875	1,003	sq. Yd	$ -	$ -	1,003	sq. Yd	$ 33.33	$ 33,433
Drop Str. - LC Enhancement	Riprap	7	EA	$ 3,712.50	$ 25,988	100	sq. Yd	$ -	$ -	100	sq. Yd	$ 33.33	$ 3,343
Sedimentation Basins		1	EA	$ 123,712.00	$ 123,712	32,019	sq. Yd	$ -	$ -	32,019	sq. Yd	$ 8.33	$ 266,825
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 431,568	Base Maintenance Cost			$ 1,246,280
						LC Enhancement Cost			$ 440,964	LC Enhancement Cost			$ 1,212,012
						Total Landscape Cost			$ 872,532	Total Maintenance Cost			$ 2,458,292

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 1,713,600	$ 1,272,378	$ 2,985,978
Contingency Cost (25% of Construction Cost)	$ 428,400	$ 318,094	$ 746,494
Engineering Design Cost (5% of Construction Cost)	$ 85,680	$ 63,619	$ 149,299
Total Construction Cost	$ 2,227,680	$ 1,654,091	$ 3,881,771

Land Cost

Channel Length	4691 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	430	46.3	$100,000	$ 4,630,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	58	6.2	$100,000	$ 620,000
Levee LC Enhancement	54	5.8	$100,000	$ 580,000
Other	0	0	$100,000	$ -
Total	542	58.3		$ 5,830,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	52.5	$100,000	$ 5,250,000
LC Enhancement Cost	acre	5.8	$100,000	$ 580,000
Total Land Cost	acre	58.3	$100,000	$ 5,830,000

Total Cost

Base Total Cost	$ 9,155,528
Total Landscape Enhancement Cost	$ 3,887,067
Total Cost Including LC Enh.	$ 13,042,594

Note: Unit land cost increased to reflect existing homes in area.

Open Channel

Structure ID	RRP1A10

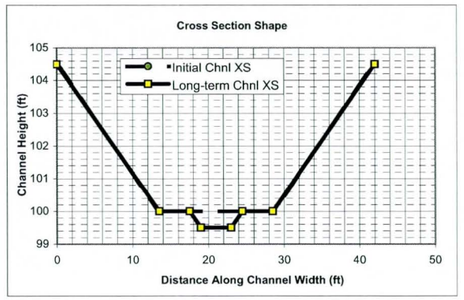
HEC1 ID	RRP1A10

Longitudnal Geometry

Length	1465.1	ft
U/S Elev	1276.4	ft
D/S Elev	1305.2	ft
Initial Channel Slope	0.0196	ft/ft
Long-term Channel Slope	0.0090	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	



Initial Channel XS Geometry

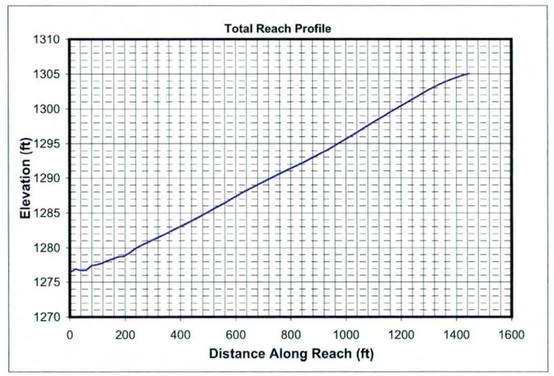
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	15	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	28.5	28.5	28.5	42
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	4	3	4	5	3	4	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	17.5	19	23	24.5	28.5	42
Y	104.5	100	100	99.5	99.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RRP1A								TOTAL
HEC1 Peak-Flow	87								87
Weighting Factor	1.00								
Flow into Channel	87								87

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	0.5	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	87	cfs	
Long-term Max. Chnl Capacity	857	cfs	
Q2 Channel	9	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	42	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
9	16.8	4.5	0.3	100.0	100.3	1.9	0.3	16.7	0.3	0.16	0.65
26	18.4	9.0	0.5	100.0	100.5	2.9	0.5	18.3	0.5	0.31	0.72
65	20.9	16.5	0.8	100.0	100.9	4.0	0.9	20.6	0.8	0.52	0.78
87	21.9	20.0	0.9	100.0	101.1	4.4	1.1	21.6	0.9	0.61	0.80

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
9	16.3	5.6	0.3	99.5	100.2	1.5	0.7	16.1	0.3	0.38	0.46
26	18.5	11.4	0.6	99.5	100.5	2.3	1.0	18.1	0.6	0.57	0.51
65	21.6	21.1	1.0	99.5	101.0	3.1	1.5	21.1	1.0	0.85	0.55
87	22.9	25.7	1.1	99.5	101.2	3.4	1.7	22.4	1.1	0.97	0.56

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
9										0
26										0
65										0
87										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
9	1.74	0.9917	0.9421	Erosive	Erosive	Erosive	0.2	Stable	3.9	Stable	Stable
26	1.74	1.1787	1.1198	Erosive	Erosive	Erosive	0.2	Stable	5.3	Stable	Stable
65	1.74	1.3270	1.2607	Erosive	Erosive	Erosive	0.3	Stable	6.9	Stable	Stable
87	1.74	1.3717	1.3031	Erosive	Erosive	Erosive	0.3	Stable	7.6	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	9	26	65	87	9	26	65	87	9	26	65	87
Bray - Equation #1	7	13	22	25	0.5	0.8	1.1	1.2	2.1	2.5	2.8	3.0
Bray - Equation #2	10	17	28	33	0.6	0.9	1.2	1.3	1.5	1.7	1.9	2.0
Hey	2	3	6	7	1.5	2.2	3.2	3.5				
Ackers & Charlton/Lacey	9	14	21	23					1.1	1.4	1.6	1.7
Parker	20	35	55	64	0.3	0.5	0.8	0.9				
Chang	12	23	40	48	0.1	0.1	0.0	0.0				
Kellerhals	5	9	15	17	0.6	1.0	1.4	1.6	2.5	2.8	3.1	3.2
AMAFCA/Schumm	16	18	21	22								
Moody & Odem	9	9	9	9	0.9	0.9	0.9	0.9				
BUREC	5.4	8.1	11.4	12.7	1	2	3	3	1.8	2.3	3.0	3.2
Average	10	15	23	26	0.8	1.1	1.5	1.6	1.8	2.2	2.5	2.6
Values As Designed	16	18	21	22	0.7	1.0	1.5	1.7	1.5	2.3	3.1	3.4
Difference with Design	-7	-3	2	4	0.1	0.0	-0.1	-0.1	0.3	-0.1	-0.6	-0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
9	88	58	128	169	266	30	27	14	417	29	94	120
26	458	226	462	1026	445	159	105	89	1315	121	493	445
65	1757	644	1169	4479	676	550	279	331	3339	417	1723	1397
87	2663	884	1521	7065	772	805	373	486	4463	617	2508	2014

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
9	3758	2455	5473	7197	11329	1286	1140	582	17774	1241	3994	5112
26	6515	3214	6564	14585	6324	2254	1498	1271	18693	1719	7010	6332
65	9987	3659	6647	25470	3844	3128	1585	1881	18983	2374	9795	7941
87	11355	3771	6487	30127	3293	3431	1591	2072	19033	2631	10696	8590

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
9	30	17	28	48	166	4	5	3	111	9	28	41
26	154	84	160	284	304	39	33	30	388	38	175	154
65	579	263	453	1214	489	147	101	126	1013	134	661	471
87	873	368	619	1900	567	217	139	189	1361	199	981	674

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
9	1289	744	1201	2039	7086	166	210	134	4751	377	1207	1746
26	2185	1198	2277	4044	4318	547	471	424	5514	541	2489	2183
65	3291	1494	2574	6903	2779	834	576	714	5759	760	3756	2676
87	3721	1571	2641	8103	2418	925	594	808	5803	847	4182	2874

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
9	0.0028	0.0045	135	0.41	0.047	0.0009	30	0.036	0.0007	0.0159	0.0009	0.0022	0.0170	0.0014	0.0057	0.0194	0.0100
26	0.0013	0.0024	183	0.56	0.050	0.0005	31	0.036	0.0004	0.0159	0.0005	0.0012	0.0170	0.0009	0.0025	0.0194	0.0096
65	0.0007	0.0015	232	0.71	0.052	0.0004	31	0.036	0.0002	0.0159	0.0003	0.0007	0.0170	0.0006	0.0013	0.0193	0.0094
87	0.0006	0.0013	249	0.76	0.053	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0170	0.0005	0.0010	0.0192	0.0093

Drop Structures

Design Slope	0.0090	ft/ft
Total Drop Needed	15.6	ft
Height of Drop Structure	3	ft
No . of Drop Structures	6	
Distance between structs.	244	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.00	sq. mi
Total Sediment Yield Volume	0.00	ac ft

Sedimentation Basins

Length	244 ft	Depth	3 ft
Width	42 ft	Side slope	3 ft/ft
Total Volume per Basin		0.54	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
9	1.1	-0.3	0.0	24.6	0.7	0.3	1.5	0.0090	0.1	1.5	0.5	2.7
26	1.1	-0.4	0.1	24.6	1.0	0.6	2.3	0.0090	0.1	1.5	0.5	2.8
65	1.1	-0.5	0.1	24.6	1.5	1.0	3.1	0.0090	0.2	1.5	0.5	2.9
87	1.1	-0.5	0.2	24.6	1.7	1.1	3.4	0.0090	0.2	1.5	0.5	2.9

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	421	cfs
Stage at Peak Flow	100.6	ft
Volume at Peak Flow	469.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.4	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.00	ac. ft
Outflowing Sediment Volume	0.51	ac. ft
Deposited(+)/Eroded(-) Volume	-0.51	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1465	1465
Side Slope (?H:1V)	3	3
Channel Width (ft)	42	42
Channel XS Area (sq. ft)	131	131
Channel Perimeter (ft)	44	44

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1465	ft
Thickness	1.5	ft
Protection Depth	3	ft
Tie-in Length/Depth	3.0	ft
Total Depth	6.0	ft
Area needed	488	sq. Yd
Volume	977	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1465	1465
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	6837	14162
Left Levee Volume (cu. Yd)	6728	15844
Right Levee Length (ft)	1465	1465
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	6837	14162
Right Levee Volume (cu. Yd)	6728	15844
Total Levee Surface Area (sq. Yd)	13674	28324
Total Levee Volume (cu. Yd)	13456	31688

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1465	1465
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	2279	5372
Left Levee Lining Volume (cu. Yd)	1139	2686
Right Levee Length (ft)	1465	1465
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	2279	5372
Right Levee Lining Volume (cu. Yd)	1139	2686
Total Lining Area (sq. Yd)	4558	10743
Total Lining Volume (cu. Yd)	2278	5372

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	42	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	5.1	ft	
Structure Height	8.1	ft	
Number of Structures	6		
Volume per structure	38	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 2,850		
Area per structure	14	sq. Yd	
Total Area	84	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	871	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 3,484	
Other Cost	$ -	
Total cost per basin	$ 3,484	
Area per basin	1,140	sq. Yd
Total Area	1,140	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	13,456	cu. Yd	$ 7.00	$ 94,192	13,674	sq. Yd	$ 9.00	$ 123,066	13,674	sq. Yd	$ 11.67	$ 159,530
Levee - LC Enhancement	Fill	18,232	cu. Yd	$ 7.00	$ 127,624	14,650	sq. Yd	$ 9.00	$ 131,850	18,232	sq. Yd	$ 11.67	$ 212,707
Levee Lining	Riprap	2,278	cu. Yd	$ 75.00	$ 170,850	4,558	sq. Yd	$ -	$ -	4,558	sq. Yd	$ 20.83	$ 94,954
Levee Lining -LC Enhancement	Riprap	3,094	cu. Yd	$ 75.00	$ 232,050	6,186	sq. Yd	$ -	$ -	6,186	sq. Yd	$ 20.83	$ 128,866
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	977	cu. Yd	$ 75.00	$ 73,275	488	sq. Yd	$ -	$ -	488	sq. Yd	$ 25.00	$ 12,200
Drop Structures	Riprap	6	EA	$ 2,850.00	$ 17,100	84	sq. Yd	$ -	$ -	84	sq. Yd	$ 33.33	$ 2,800
Drop Str. - LC Enhancement	Riprap	6	EA	$ 285.00	$ 1,710	8	sq. Yd	$ -	$ -	8	sq. Yd	$ 33.33	$ 280
Sedimentation Basins		1	EA	$ 3,484.00	$ 3,484	1,140	sq. Yd	$ -	$ -	1,140	sq. Yd	$ 8.33	$ 9,500
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 123,066	Base Maintenance Cost			$ 278,984
						LC Enhancement Cost			$ 131,850	LC Enhancement Cost			$ 341,852
						Total Landscape Cost			$ 254,916	Total Maintenance Cost			$ 620,836

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 358,901	$ 361,384	$ 720,285
Contingency Cost (25% of Construction Cost)	$ 89,725	$ 90,346	$ 180,071
Engineering Design Cost (5% of Construction Cost)	$ 17,945	$ 18,069	$ 36,014
Total Construction Cost	$ 466,571	$ 469,799	$ 936,371

Land Cost

Channel Length	1465 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	42	1.4	$100,000	$ 140,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	1.8	$100,000	$ 180,000
Levee LC Enhancement	51	1.7	$100,000	$ 170,000
Other	0	0	$100,000	$ -
Total	148	4.9		$ 490,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	3.2	$100,000	$ 320,000
LC Enhancement Cost	acre	1.7	$100,000	$ 170,000
Total Land Cost	acre	4.9	$100,000	$ 490,000

Total Cost

Base Total Cost	$ 1,188,621
Total Landscape Enhancement Cost	$ 1,113,502
Total Cost Including LC Enh.	$ 2,302,123

SUN VALLEY ADMP
Step 2 - Alt. B4-3
FRS No. 1

FRS No. 1 Sub-area

FEMA Floodplains

Floodplain

Floodway

Alluvial Fan Apices

Concentration Point

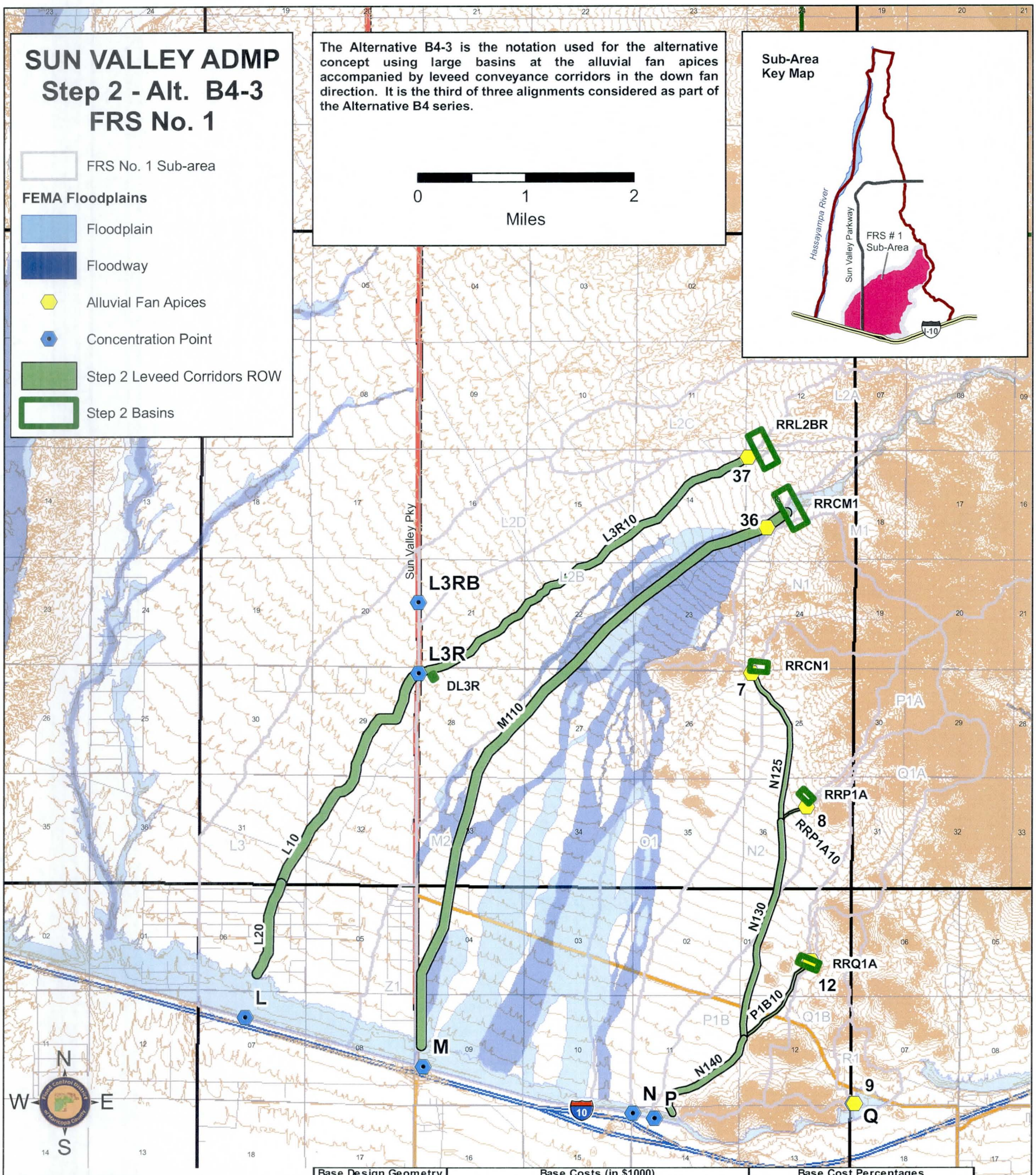
Step 2 Leveed Corridors ROW

Step 2 Basins

The Alternative B4-3 is the notation used for the alternative concept using large basins at the alluvial fan apices accompanied by leveed conveyance corridors in the down fan direction. It is the third of three alignments considered as part of the Alternative B4 series.

0 1 2

Miles



Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs (in $1000): Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Base Cost Percentages: Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
RRL2BR	Online Basin	278	32	584	0	1800	780	10	$ 3,220	$ 5,057	$ 1,404	$ 1,336	$ 11,017	29%	46%	13%	12%	5%
L3R10	Leveed Chl.	1703	176	0	114	3.8	382	5	$ 17,620	$ 8,978	$ 1,688	$ 4,273	$ 32,558	54%	28%	5%	13%	16%
DL3R	Offline Basin	1585	1	6	0	260	200	4	$ 119	$ 153	$ 52	$ 58	$ 382	31%	40%	14%	15%	0%
L10	Leveed Chl.	3270	144	0	86	2.4	488	5	$ 14,420	$ 6,158	$ 1,184	$ 3,151	$ 24,913	58%	25%	5%	13%	12%
RRCM1	Online Basin	422	36	712	0	1980	800	11	$ 3,640	$ 6,137	$ 1,584	$ 1,505	$ 12,866	28%	48%	12%	12%	6%
M110	Leveed Chl.	2347	373	0	192	6.4	482	5	$ 37,320	$ 16,566	$ 2,833	$ 7,401	$ 64,120	58%	26%	4%	12%	32%
RRCN1	Online Basin	187	10	135	0	860	480	11	$ 950	$ 1,312	$ 413	$ 409	$ 3,084	31%	43%	13%	13%	2%
N125	Leveed Chl.	1214	45	0	46	1.5	242	5	$ 4,500	$ 3,266	$ 680	$ 1,712	$ 10,158	44%	32%	7%	17%	5%
RRP1A	Online Basin	87	6	62	0	700	360	8	$ 580	$ 643	$ 252	$ 254	$ 1,730	34%	37%	15%	15%	1%
N130	Leveed Chl.	1394	80	0	62	2.1	322	5	$ 8,020	$ 4,292	$ 912	$ 2,244	$ 15,467	52%	28%	6%	15%	8%
N140	Leveed Chl.	1467	43	0	38	1.1	328	5	$ 4,260	$ 2,404	$ 521	$ 1,366	$ 8,552	50%	28%	6%	16%	4%
RRQ1A	Online Basin	106	10	146	0	1000	420	11	$ 960	$ 1,358	$ 420	$ 419	$ 3,156	30%	43%	13%	13%	2%
P1B10	Leveed Chl.	303	15	0	29	1	127	5	$ 1,500	$ 1,811	$ 430	$ 1,016	$ 4,757	32%	38%	9%	21%	2%
L20	Leveed Chl.	3021	53	0	31	0.9	488	5	$ 5,250	$ 2,228	$ 432	$ 1,246	$ 9,156	57%	24%	5%	14%	5%
RRP1A10	Leveed Chl.	87	3	0	8	0.3	97	5	$ 320	$ 467	$ 123	$ 279	$ 1,189	27%	39%	10%	23%	1%
	TOTAL	1027	1645	606					$ 102,679	$ 60,828	$12,928	$ 26,669	**$ 203,104**	51%	30%	6%	13%	100%
All Channels		932	0	606	19.5				$ 93,210	$ 46,169	$ 8,803	$ 22,688	$ 170,870	55%	27%	5%	13%	84%
All Online Basins		94	1639	0					$ 9,350	$ 14,507	$ 4,073	$ 3,923	$ 31,853	29%	46%	13%	12%	16%
All Offline Basins		1	6	0					$ 119	$ 153	$ 52	$ 58	$ 382	31%	40%	14%	15%	0%
Channel Cost per mile (in $1000)		$8,763		Basins Cost per ac. ft. (in $1000)					$2.51									

Cost Increase for Landscape Compatibility Enhancement over Base Costs

All Channels % increase	13%	0%	135%				13%	74%	106%	108%	47%	
All Online Basins % increase	45%	9%	0%				46%	9%	46%	45%	29%	
All Offline Basins % increase	200%	0%	0%				135%	2%	137%	116%	79%	
Total % increase	16%	9%	135%				16%	58%	87%	99%	44%	

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Costs Summary

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs ($1000): Land Cost	Base Costs ($1000): Constr. Cost	Base Costs ($1000): Lndscp Cost	Base Costs ($1000): 50 Yr Maint. Cost	Base Costs ($1000): Total Cost	Base Cost Percentages: Land Cost %	Base Cost Percentages: Constr. Cost %	Base Cost Percentages: Lndscp Cost %	Base Cost Percentages: 50 Yr Maint. Cost %	Base Cost Percentages: % of Total Cost
RRL2BR	Online Basin	278	32	584	0	1800	780	10	$ 3,220	$ 5,057	$ 1,404	$ 1,336	$ 11,017	29%	46%	13%	12%	5%
L3R10	Leveed Chl.	1703	176	0	114	3.8	382	5	$ 17,620	$ 8,978	$ 1,688	$ 4,273	$ 32,558	54%	28%	5%	13%	16%
DL3R	Offline Basin	1585	1	6	0	260	200	4	$ 119	$ 153	$ 52	$ 58	$ 382	31%	40%	14%	15%	0%
L10	Leveed Chl.	3270	144	0	86	2.4	488	5	$ 14,420	$ 6,158	$ 1,184	$ 3,151	$ 24,913	58%	25%	5%	13%	12%
RRCM1	Online Basin	422	36	712	0	1980	800	11	$ 3,640	$ 6,137	$ 1,584	$ 1,505	$ 12,866	28%	48%	12%	12%	6%
M110	Leveed Chl.	2347	373	0	192	6.4	482	5	$ 37,320	$ 16,566	$ 2,833	$ 7,401	$ 64,120	58%	26%	4%	12%	32%
RRCN1	Online Basin	187	10	135	0	860	480	11	$ 950	$ 1,312	$ 413	$ 409	$ 3,084	31%	43%	13%	13%	2%
N125	Leveed Chl.	1214	45	0	46	1.5	242	5	$ 4,500	$ 3,266	$ 680	$ 1,712	$ 10,158	44%	32%	7%	17%	5%
RRP1A	Online Basin	87	6	62	0	700	360	8	$ 580	$ 643	$ 252	$ 254	$ 1,730	34%	37%	15%	15%	1%
N130	Leveed Chl.	1394	80	0	62	2.1	322	5	$ 8,020	$ 4,292	$ 912	$ 2,244	$ 15,467	52%	28%	6%	15%	8%
N140	Leveed Chl.	1467	43	0	38	1.1	328	5	$ 4,260	$ 2,404	$ 521	$ 1,366	$ 8,552	50%	28%	6%	16%	4%
RRQ1A	Online Basin	106	10	146	0	1000	420	11	$ 960	$ 1,358	$ 420	$ 419	$ 3,156	30%	43%	13%	13%	2%
P1B10	Leveed Chl.	303	15	0	29	1	127	5	$ 1,500	$ 1,811	$ 430	$ 1,016	$ 4,757	32%	38%	9%	21%	2%
L20	Leveed Chl.	3021	53	0	31	0.9	488	5	$ 5,250	$ 2,228	$ 432	$ 1,246	$ 9,156	57%	24%	5%	14%	5%
RRP1A10	Leveed Chl.	87	3	0	8	0.3	97	5	$ 320	$ 467	$ 123	$ 279	$ 1,189	27%	39%	10%	23%	1%
	TOTAL	1027	1645	606					$ 102,679	$ 60,828	$ 12,928	$ 26,669	**$ 203,104**	51%	30%	6%	13%	100%
All Channels		932	0	606	19.5				$ 93,210	$ 46,169	$ 8,803	$ 22,688	$ 170,870	55%	27%	5%	13%	84%
All Online Basins		94	1639	0					$ 9,350	$ 14,507	$ 4,073	$ 3,923	$ 31,853	29%	46%	13%	12%	16%
All Offline Basins		1	6	0					$ 119	$ 153	$ 52	$ 58	$ 382	31%	40%	14%	15%	0%
Channel Cost per mile (in $1000)		$8,763		Basins Cost per ac. ft. (in $1000)					$2.51									

Cost Summary - Landscape Compatibility Enhanced (LCE)

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	LCE Design Geometry: Length (stor-ft; chl-mi)	LCE Design Geometry: ROW Width (ft)	LCE Design Geometry: Depth (ft)	LCE Costs ($1000): Land Cost	LCE Costs ($1000): Constr. Cost	LCE Costs ($1000): Lndscp Cost	LCE Costs ($1000): 50 Yr Maint. Cost	LCE Costs ($1000): Total Cost	LCE Cost Percentages: Land Cost %	LCE Cost Percentages: Constr. Cost %	LCE Cost Percentages: Lndscp Cost %	LCE Cost Percentages: 50 Yr Maint. Cost %	LCE Cost Percentages: % of Total Cost
RRL2BR	Online Basin	278	44	634	0	2190	880	10	$ 4,420	$ 5,478	$ 1,927	$ 1,827	$ 13,653	32%	40%	14%	13%	5%
L3R10	Leveed Chl.	1703	200	0	269	3.8	433	5	$ 19,970	$ 15,595	$ 3,496	$ 8,980	$ 48,042	42%	32%	7%	19%	16%
DL3R	Offline Basin	1585	3	6	0	410	300	4	$ 280	$ 156	$ 123	$ 126	$ 685	41%	23%	18%	18%	0%
L10	Leveed Chl.	3270	160	0	199	2.4	542	5	$ 16,020	$ 10,718	$ 2,394	$ 6,478	$ 35,611	45%	30%	7%	18%	12%
RRCM1	Online Basin	422	50	776	0	2420	900	11	$ 5,000	$ 6,678	$ 2,178	$ 2,063	$ 15,919	31%	42%	14%	13%	5%
M110	Leveed Chl.	2347	413	0	452	6.4	533	5	$ 41,270	$ 27,778	$ 5,868	$ 15,313	$ 90,229	46%	31%	7%	17%	31%
RRCN1	Online Basin	187	15	147	0	1150	580	11	$ 1,530	$ 1,410	$ 667	$ 650	$ 4,257	36%	33%	16%	15%	1%
N125	Leveed Chl.	1214	55	0	109	1.5	293	5	$ 5,450	$ 5,896	$ 1,410	$ 3,605	$ 16,361	33%	36%	9%	22%	6%
RRP1A	Online Basin	87	10	68	0	960	460	8	$ 1,020	$ 694	$ 442	$ 434	$ 2,589	39%	27%	17%	17%	1%
N130	Leveed Chl.	1394	93	0	146	2.1	373	5	$ 9,290	$ 7,836	$ 1,888	$ 4,783	$ 23,797	39%	33%	8%	20%	8%
N140	Leveed Chl.	1467	50	0	87	1.1	382	5	$ 4,960	$ 4,382	$ 1,054	$ 2,829	$ 13,225	38%	33%	8%	21%	5%
RRQ1A	Online Basin	106	17	165	0	1390	520	11	$ 1,660	$ 1,514	$ 723	$ 705	$ 4,601	36%	33%	16%	15%	2%
P1B10	Leveed Chl.	303	21	0	69	1	178	5	$ 2,100	$ 3,452	$ 891	$ 2,211	$ 8,655	24%	40%	10%	26%	3%
L20	Leveed Chl.	3021	58	0	72	0.9	542	5	$ 5,830	$ 3,882	$ 873	$ 2,458	$ 13,043	45%	30%	7%	19%	4%
RRP1A10	Leveed Chl.	87	5	0	20	0.3	148	5	$ 490	$ 936	$ 255	$ 621	$ 2,302	21%	41%	11%	27%	1%
	TOTAL	1194	1796	1423					$ 119,290	$ 96,406	$ 24,188	$ 53,082	**$ 292,966**	41%	33%	8%	18%	100%
All Channels		1055	0	1423	19.5				$ 105,380	$ 80,476	$ 18,129	$ 47,278	$ 251,263	42%	32%	7%	19%	86%
All Online Basins		136	1790	0					$ 13,630	$ 15,774	$ 5,937	$ 5,678	$ 41,018	33%	38%	14%	14%	14%
All Offline Basins		3	6	0					$ 280	$ 156	$ 123	$ 126	$ 685	41%	23%	18%	18%	0%
Channel Cost per mile (in $1000)		$12,885		Basins Cost per ac. ft. (in $1000)					$3.37									
All Channels % increase		13%	0%	135%					13%	74%	106%	108%	47%					
All Online Basins % increase		45%	9%	0%					46%	9%	46%	45%	29%					
All Offline Basins % increase		200%	0%	0%					135%	2%	137%	116%	79%					
Total % increase		16%	9%	135%					16%	58%	87%	99%	44%					

Hydrology - 6-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
R1	BASIN	506			4.2	0.28	47	12	4	2	1.525	1.527	1.527	1.527	23	23	23	23
Q1B	BASIN	851			4.5	0.94	155	39	13	6	1.533	1.544	1.544	1.544	77	77	77	77
DUMMY	COMBINE	1020			4.5	1.22	192	48	16	7	1.459	1.469	1.469	1.469	95	96	96	96
L1	BASIN	2128			4.7	3.55	543	139	46	20	1.424	1.453	1.453	1.453	269	275	275	275
L1-L2A	ROUTE	2066	14.4	40.14	4.9	3.55	543	139	46	20	1.423	1.453	1.453	1.453	269	275	275	275
L2A	BASIN	692			4.5	0.69	113	28	9	4	1.516	1.516	1.516	1.516	56	56	56	56
L2BR	COMBINE	2391			4.9	4.24	623	159	53	23	1.366	1.391	1.391	1.391	309	314	314	314
RRL2BR	STORAGE	278	8.6	241.92	7	4.24	261	153	53	23	0.573	1.347	1.391	1.391	130	304	314	314
L2AL2B	ROUTE	275	100.4	54.91	8.9	4.24	256	152	53	23	0.562	1.337	1.391	1.391	127	302	314	314
L2B	BASIN	1532			5	4.08	418	104	35	15	0.952	0.952	0.952	0.952	207	207	207	207
L3R	COMBINE	1321			5	8.32	486	228	79	34	0.543	1.022	1.057	1.057	241	453	469	469
DL3R	DIVERT	1321			5	8.32	486	228	79	34	0.543	1.022	1.057	1.057	241	453	469	469
L2BL3	ROUTE	1127	100.9	109.47	5.9	8.32	451	225	79	34	0.504	1.008	1.057	1.057	224	447	469	469
L2C	BASIN	754			4.8	1.33	161	40	13	6	1.125	1.125	1.125	1.125	80	80	80	80
L2C-2D	ROUTE	712	13	29.17	5.2	1.33	161	40	13	6	1.125	1.125	1.125	1.125	80	80	80	80
L2D	BASIN	706			4.7	1.23	136	34	11	5	1.025	1.025	1.025	1.025	67	67	67	67
L3RB	COMBINE	1043			5	2.56	260	65	22	9	0.945	0.946	0.946	0.946	129	129	129	129
L2D-L3	ROUTE	650	12.5	187.08	8.3	2.56	258	65	22	9	0.936	0.946	0.946	0.946	128	129	129	129
L3	BASIN	1832			5.2	5.85	581	146	49	21	0.923	0.926	0.926	0.926	288	289	289	289
L	COMBINE	1916			5.7	16.73	932	350	120	52	0.518	0.777	0.803	0.803	462	694	717	717
M1	BASIN	2809			4.8	5.69	790	203	68	29	1.291	1.327	1.327	1.327	392	402	402	402
RRCM1	STORAGE	414	9.3	289.98	6.8	5.69	384	201	68	29	0.628	1.317	1.327	1.327	191	399	402	402
M1-M2	ROUTE	407	100.4	135.66	10	5.69	373	200	68	29	0.609	1.311	1.327	1.327	185	398	402	402
M2	BASIN	1849			5.4	7.44	633	159	53	23	0.791	0.795	0.795	0.795	314	315	315	315
M	COMBINE	1595			5.4	13.12	650	313	106	46	0.461	0.887	0.901	0.901	323	621	631	631
N1	BASIN	1253			4.5	1.52	210	53	18	8	1.281	1.286	1.286	1.286	104	105	105	105
RRCN1	STORAGE	187	9.5	74.38	5.6	1.52	155	53	18	8	0.947	1.286	1.286	1.286	77	105	105	105
N1-P1A	ROUTE	184	100.5	14.57	6.3	1.52	152	53	18	8	0.926	1.286	1.286	1.286	75	105	105	105
N2A	BASIN	1253			4.5	1.52	210	53	18	8	1.281	1.286	1.286	1.286	104	105	105	105
CN2AR	COMBINE	1071			4.5	3.05	304	95	32	14	0.928	1.162	1.162	1.162	151	189	189	189
P1A	BASIN	575			4.4	0.5	89	22	7	3	1.655	1.663	1.663	1.663	44	44	44	44
RRP1A	STORAGE	87	6.6	31.21	5.5	0.5	70	22	7	3	1.305	1.663	1.663	1.663	35	44	44	44
CN2A	COMBINE	1084			4.5	3.55	356	111	37	16	0.934	1.163	1.164	1.164	177	220	220	220
P1A-1B	ROUTE	802	101	88.74	5.5	3.55	331	111	37	16	0.867	1.163	1.164	1.164	164	220	220	220
P1B	BASIN	852			5	1.94	244	62	21	9	1.172	1.194	1.194	1.194	121	123	123	123
PR	COMBINE	1233			5.5	5.49	490	156	52	22	0.83	1.058	1.058	1.058	243	310	310	310
Q1A	BASIN	990			4.5	1.3	193	49	16	7	1.385	1.396	1.396	1.396	96	97	97	97
RRQ1A	STORAGE	106	9.7	73.8	6.2	1.3	97	48	16	7	0.697	1.39	1.396	1.396	48	96	97	97
Q1A-P	ROUTE	106	100.8	4.28	6.5	1.3	97	48	16	7	0.696	1.389	1.396	1.396	48	96	97	97
P	COMBINE	1257			5.5	6.78	553	189	63	27	0.758	1.038	1.039	1.039	274	375	376	376
N2B	BASIN	1193			5.1	3.33	366	93	31	13	1.023	1.045	1.045	1.045	181	185	185	185
O1	BASIN	1057			5.3	3.09	343	88	29	13	1.033	1.059	1.059	1.059	170	174	174	174
Z1	BASIN	694			4.5	0.66	100	25	8	4	1.405	1.406	1.406	1.406	50	50	50	50

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
R1	BASIN	387			12.2	0.28	37	10	3	1	1.223	1.322	1.322	1.322	19	20	20	20
Q1B	BASIN	740			12.5	0.94	134	38	13	5	1.325	1.498	1.5	1.5	66	75	75	75
DUMMY	COMBINE	902			12.5	1.22	170	48	16	7	1.294	1.448	1.45	1.45	84	94	94	94
L1	BASIN	2267			12.7	3.55	527	150	50	22	1.382	1.572	1.576	1.576	261	297	298	298
L1-L2A	ROUTE	2154	14.4	41.37	12.9	3.55	527	150	50	22	1.381	1.571	1.576	1.576	261	297	298	298
L2A	BASIN	570			12.5	0.69	92	23	8	3	1.236	1.236	1.236	1.236	46	46	46	46
L2BR	COMBINE	2519			12.9	4.24	616	172	57	25	1.351	1.509	1.513	1.513	305	341	342	342
RRL2BR	STORAGE	276	8.5	238.46	15	4.24	262	162	57	25	0.574	1.42	1.513	1.513	130	321	342	342
L2AL2B	ROUTE	274	100.4	54.78	16.9	4.24	258	161	57	25	0.565	1.414	1.513	1.513	128	320	342	342
L2B	BASIN	1700			13	4.08	449	112	37	16	1.024	1.024	1.024	1.024	223	223	223	223
L3R	COMBINE	1703			13	8.32	585	269	94	41	0.654	1.202	1.263	1.263	290	533	560	560
DL3R	DIVERT	1585			12.9	8.32	580	267	94	40	0.648	1.195	1.256	1.256	287	530	557	557
L2BL3	ROUTE	1443	101.1	127.74	13.8	8.32	544	263	94	40	0.608	1.178	1.256	1.256	270	523	557	557
L2C	BASIN	692			12.8	1.33	145	36	12	5	1.013	1.013	1.013	1.013	72	72	72	72
L2C-2D	ROUTE	651	12.9	27.24	13.2	1.33	145	36	12	5	1.013	1.013	1.013	1.013	72	72	72	72
L2D	BASIN	655			12.7	1.23	124	31	10	4	0.934	0.934	0.934	0.934	61	61	61	61
L3RB	COMBINE	1104			13	2.56	266	66	22	10	0.965	0.965	0.965	0.965	132	132	132	132
L2D-L3	ROUTE	705	12.5	201.22	16.1	2.56	263	66	22	10	0.956	0.965	0.965	0.965	130	132	132	132
L3	BASIN	2129			13.2	5.85	658	166	56	24	1.045	1.058	1.058	1.058	326	330	330	330
L	COMBINE	3021			13.5	16.73	1321	470	164	71	0.734	1.046	1.091	1.091	655	933	974	974
M1	BASIN	3301			12.8	5.69	825	236	79	34	1.349	1.543	1.548	1.548	409	468	469	469
RRCM1	STORAGE	422	9.6	301.43	14.9	5.69	396	227	79	34	0.648	1.483	1.548	1.548	196	450	469	469
M1-M2	ROUTE	416	100.4	137.78	18	5.69	387	226	79	34	0.633	1.478	1.548	1.548	192	448	469	469
M2	BASIN	2347			13.4	7.44	786	198	66	29	0.983	0.989	0.99	0.99	390	392	392	392
M	COMBINE	2312			13.4	13.12	904	409	141	61	0.64	1.159	1.199	1.199	448	811	839	839
N1	BASIN	1211			12.5	1.52	192	52	17	7	1.172	1.269	1.27	1.27	95	103	103	103
RRCN1	STORAGE	178	8.6	66.71	13.5	1.52	147	52	17	7	0.899	1.265	1.27	1.27	73	103	103	103
N1-P1A	ROUTE	175	100.5	14.18	14.4	1.52	144	52	17	7	0.878	1.264	1.27	1.27	71	103	103	103
N2A	BASIN	1211			12.5	1.52	192	52	17	7	1.172	1.269	1.27	1.27	95	103	103	103
CN2AR	COMBINE	1214			12.5	3.05	311	103	34	15	0.947	1.252	1.26	1.26	154	203	205	205
P1A	BASIN	441			12.4	0.5	73	21	7	3	1.351	1.542	1.545	1.545	36	41	41	41
RRP1A	STORAGE	77	5.1	23.93	13.5	0.5	61	21	7	3	1.136	1.535	1.545	1.545	30	41	41	41
CN2A	COMBINE	1269			12.5	3.55	369	123	41	18	0.968	1.285	1.294	1.294	183	243	245	245
P1A-1B	ROUTE	851	101	92.15	13.5	3.55	344	122	41	18	0.901	1.284	1.294	1.294	170	243	245	245
P1B	BASIN	842			13	1.94	231	61	20	9	1.108	1.174	1.175	1.175	114	121	121	121
PR	COMBINE	1385			13.3	5.49	543	182	61	26	0.92	1.233	1.242	1.242	269	361	363	363
Q1A	BASIN	915			12.5	1.3	173	48	16	7	1.242	1.372	1.374	1.374	86	95	95	95
RRQ1A	STORAGE	100	8.7	65.43	14.1	1.3	92	47	16	7	0.658	1.338	1.374	1.374	46	93	95	95
Q1A-P	ROUTE	100	100.7	4.14	14.5	1.3	92	47	16	7	0.657	1.338	1.374	1.374	45	93	95	95
P	COMBINE	1467			13.4	6.78	627	227	77	33	0.859	1.244	1.26	1.26	311	450	456	456
N2B	BASIN	1331			13.1	3.33	378	99	33	14	1.057	1.102	1.103	1.103	187	195	196	196
O1	BASIN	1163			13.3	3.09	349	91	30	13	1.05	1.095	1.096	1.096	173	180	180	180
Z1	BASIN	558			12.5	0.66	80	21	7	3	1.127	1.161	1.161	1.161	40	41	41	41

Channels Hydraulics Summary

		Design Geometry						Hydraulics										
Structure ID	Type	Initial Slope (ft/ft)	Long-term Slope (ft/ft)	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Chnl Mannings n	Flow Rate (cfs)	Wetted Perimeter (ft)	Wetted XS Area (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flow Depth (ft)	Freeboard (ft)	Top Width (ft)	Velocity (ft/s)	Froude Number	Shear Stress (lb/sq. ft)
L3R10	Leveed	0.0154	0.0060	3.80	3	4.5	0.045	1703	307.7	367.8	1.2	1.2	1.2	3.3	307	4.6	0.75	0.45
L10	Leveed	0.0093	0.0040	2.40	3	5.0	0.045	3270	411.1	711.4	1.7	1.7	1.8	3.2	411	4.6	0.62	0.44
M110	Leveed	0.0142	0.0050	6.40	3	4.5	0.045	2347	408.0	511.1	1.3	1.3	1.3	3.2	408	4.6	0.72	0.39
N125	Leveed	0.0131	0.0050	1.50	3	4.5	0.045	1214	169.5	248.2	1.5	1.5	1.5	3.0	169	4.9	0.71	0.47
N130	Leveed	0.0132	0.0050	2.10	3	4.5	0.045	1394	248.1	313.4	1.3	1.3	1.3	3.2	248	4.4	0.70	0.40
N140	Leveed	0.0072	0.0040	1.10	3	5.0	0.045	1467	250.0	388.6	1.6	1.6	1.6	3.4	250	3.8	0.53	0.40
P1B10	Leveed	0.0112	0.0060	1.00	3	4.5	0.045	303	54.2	71.7	1.3	1.3	1.5	3.0	54	4.2	0.64	0.54
L20	Leveed	0.0084	0.0040	0.90	3	5.0	0.045	3021	410.9	699.2	1.7	1.7	1.7	3.3	410	4.3	0.58	0.43
RRP1A10	Leveed	0.0196	0.0090	0.30	3	4.5	0.045	87	21.9	20.0	0.9	0.9	1.1	3.4	22	4.4	0.80	0.61

Basins Hydraulics Summary

			Design Geometry				Hydraulics					
Structure ID	Type	Adjacent Topo. Slope	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac.	Peak Inflow into Basin (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Freeboard (ft)
RRL2BR	Online Basin	0.0240	1800	780	10.0	252.3	241.9	342.0	2519	278	8.6	1.4
DL3R	Offline Basin	0.0140	260	200	4.0	3.0	3.0	3.0	118	0	0.0	4.0
RRCM1	Online Basin	0.0250	1980	800	11.0	314.3	301.4	469.0	3301	422	9.6	1.4
RRCN1	Online Basin	0.0210	860	480	11.0	78.4	74.4	105.0	1253	187	9.5	1.5
RRP1A	Online Basin	0.0222	700	360	8.0	33.4	31.2	44.0	575	87	6.6	1.4
RRQ1A	Online Basin	0.0300	1000	420	11.0	76.6	73.8	97.0	990	106	9.7	1.3

Online Basin

HEC1 ID	RRL2BR

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	4.2	sq. mi
Total Sediment Yield Volume	8.1	ac ft

Required Minimum Sediment Volume

Sediment Volume	8.1	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.024	0.024
Basin Length (ft)	1800	2090
Basin Width (ft)	780	780
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	10	10
Freeboard (ft)	1	1
Effective Basin Width (ft)	724	668
Top Area (acres)	32.2	37.4
U/S-D/S Height Difference (ft)	18.7	18.7
Excess Area on Upstream (acres)	2.4	5.4

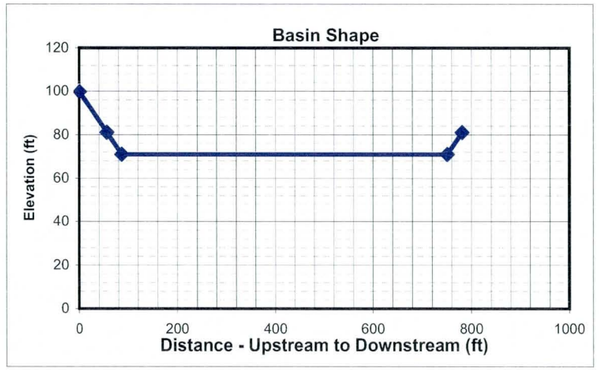
			Base	LC Enhanced
Bottom Length (ft)	1740	Allocated Storage Volume (ac. ft)	252.3	251.9
Bottom Width (ft)	664	Total Available Volume (ac. ft) (incl. Freeboard)	282.1	283.6
		Total Excavation Volume (ac. ft)	583.9	634.1

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	5.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	2	4	6	7	8	9	10	11	13
Volume	0.00	53.71	108.76	165.16	193.87	222.92	252.32	282.07	312.16	373.39
Outflow	0.0	133.7	189.1	231.6	250.1	267.4	283.6	299.0	313.6	340.9



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	314.0	342	342.0
Peak Inflow (cfs)	2391	2519	2519.0
Peak Outflow (cfs)	278	276	278.0
Stage at Peak Outflow (ft)	8.6	8.5	8.6
Volume at Peak Outflow (ac. ft)	241.9	238.46	241.9

Volume Check

Total Volume needed	250.0	ac. ft
Total Volume Provided	252.3	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	9.6	ft
Depth Provided	10	ft
Depth OK?	Yes	

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	523200	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	1800	ft
Base Total ROW Width	780	ft
LC Enh. Total ROW Length	2190	ft
LC Enh. Total ROW Length	880	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	942025	1023015
Excavated Area (sq. Yd)	156000	214133

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	91	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	1008	sq. Yd
Material Volume	504	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	526	ft
Unit Cost	160	per ft
Cost per outlet	$84,160	
Other Cost	$ -	
Total Cost	$84,160	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		942,025	cu. Yd	$ 4.00	$ 3,768,100	156,000	sq. Yd	$ 9.00	$ 1,404,000	156,000	sq. Yd	$ 8.33	$ 1,300,000
Basin - LC Enhancement		80,990	cu. Yd	$ 4.00	$ 323,960	58,133	sq. Yd	$ 9.00	$ 523,197	58,133	sq. Yd	$ 8.33	$ 484,442
Inlet	Riprap	504	sq. Yd	$ 75.00	$ 37,800	1,008	sq. Yd	$ -	$ -	1,008	sq. Yd	$ 33.33	$ 33,600
Inlet - LC Enhancement (20%Inlet)					$ 7,560				$ -				$ 6,720
Outlet	Pipe	1	EA	$ 84,160	$ 84,160	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 4,208				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,404,000	Base Maintenance Cost			$ 1,335,817
						LC Enh. Landscape Cost			$ 523,197	LC Enh. Maintenance Cost			$ 491,273
						Total Landscape Cost			$ 1,927,197	Total Maintenance Cost			$ 1,827,089

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 3,890,060	$ 323,960	$ 4,214,020
Contingency Cost (25% of Construction Cost)	$ 972,515	$ 80,990	$ 1,053,505
Engineering Design Cost (5% of Construction Cost)	$ 194,503	$ 16,198	$ 210,701
Total Construction Cost	$ 5,057,078	$ 421,148	$ 5,478,226

Land Cost

Land Cost Component	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	12.0	$100,000	$ 1,200,000
Basin	32.2	$100,000	$ 3,220,000
Other		$100,000	$ -
Total	44.2	$100,000	$ 4,420,000

	Units	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	32.2	$100,000	$ 3,220,000
LC Enhancement Cost	acre	12.0	$100,000	$ 1,200,000
Total Land Cost	acre	44.2	$100,000	$ 4,420,000

Total Cost

Base Total Cost	$ 11,016,895
Total LC Enhancement Cost	$ 2,635,618
Total Cost Including LC Enh.	$ 13,652,512

Open Channel

Structure ID	L3R10

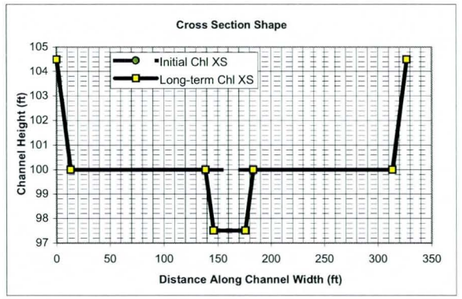
HEC1 ID	L2AL2B

Longitudal Geometry

Length	20092.5	ft
U/S Elev	1548.0	ft
D/S Elev	1238.5	ft
Initial Channel Slope	0.0154	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	8



Initial Channel XS Geometry

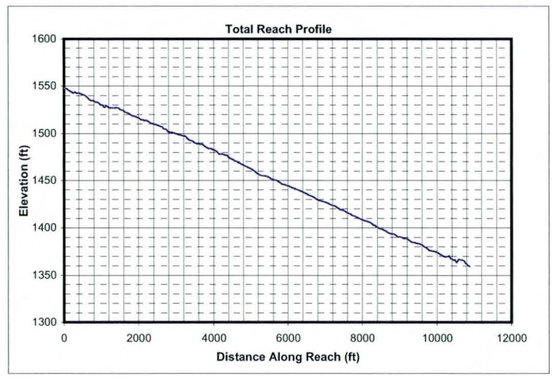
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	300	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	313.5	313.5	313.5	327
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	125	3	30	7	3	130	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	138.5	146	176	183.5	313.5	327
Y	104.5	100	100	97.5	97.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	L3R									TOTAL
HEC1 Peak-Flow	1703									1703
Weighting Factor	1.00									
Flow into Channel	1703									1703

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	4.077	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	1703	cfs	
Long-term Max. Chnl Capacity	10625	cfs	
Q2 Channel	170	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	327	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
170	301.9	91.8	0.3	100.0	100.3	1.9	0.3	301.8	0.3	0.11	0.59
511	303.7	177.6	0.6	100.0	100.6	2.9	0.6	303.5	0.6	0.22	0.66
1277	306.4	309.0	1.0	100.0	101.0	4.1	1.0	306.1	1.0	0.38	0.72
1703	307.7	367.8	1.2	100.0	101.2	4.6	1.2	307.3	1.2	0.45	0.75

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
170	39.9	54.1	1.4	97.5	99.1	3.1	1.6	39.4	1.4	0.58	0.47
511	303.8	235.8	0.8	97.5	100.5	2.2	3.0	302.8	0.8	1.11	0.43
1277	307.4	410.6	1.3	97.5	101.0	3.1	3.5	306.3	1.3	1.33	0.47
1703	309.0	489.0	1.6	97.5	101.3	3.5	3.8	307.8	1.6	1.42	0.49

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
170										0
511										0
1277										0
1703										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
170	1.74	1.0283	0.9769	Erosive	Erosive	Erosive	0.2	Stable	6.0	Stable	Stable
511	1.74	1.2303	1.1687	Erosive	Erosive	Erosive	0.3	Stable	7.6	Stable	Stable
1277	1.74	1.3983	1.3284	Erosive	Erosive	Erosive	0.3	Stable	9.1	Stable	Stable
1703	1.74	1.4509	1.3784	Erosive	Erosive	Erosive	0.3	Stable	9.7	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	170	511	1277	1703	170	511	1277	1703	170	511	1277	1703
Bray - Equation #1	36	64	103	120	1.5	2.1	2.9	3.2	3.2	3.8	4.3	4.5
Bray - Equation #2	47	84	136	158	1.6	2.3	3.2	3.5	2.2	2.6	3.0	3.1
Hey	11	20	33	39	4.5	6.9	9.8	10.9				
Ackers & Charlton/Lacey	31	49	73	82					1.9	2.3	2.6	2.8
Parker	90	155	246	284	1.2	1.8	2.7	3.0				
Chang	63	124	216	257	0.1	-0.1	-0.5	-0.7				
Kellerhals	23	41	64	74	2.1	3.3	4.8	5.3	3.4	3.8	4.2	4.3
AMAFCA/Schumm	39	303	307	308								
Moody & Odem	21	21	21	21	1.2	1.2	1.2	1.2				
BUREC	17.6	26.6	37.5	41.8	5	7	10	11	3.2	4.2	5.3	5.7
Average	38	89	124	138	2.1	3.1	4.2	4.7	2.8	3.3	3.9	4.1
Values As Designed	39	303	306	308	1.6	3.0	3.5	3.8	3.1	2.2	3.1	3.5
Difference with Design	-2	-214	-183	-169	0.5	0.1	0.7	0.9	-0.3	1.2	0.8	0.6

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
170	1302	849	1768	2348	4362	383	360	192	5552	403	1374	1717
511	7135	3543	6802	15142	7040	2247	1553	1421	17828	1786	7828	6575
1277	29280	10435	17520	71453	10005	8237	4205	5604	45451	6618	29034	21622
1703	45572	14465	22760	116208	11109	12271	5638	8375	60798	10042	43074	31847

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
170	2837	1850	3852	5114	9502	835	783	418	12095	878	2992	3742
511	5182	2573	4939	10996	5112	1632	1128	1032	12946	1297	5684	4775
1277	8505	3031	5089	20755	2906	2393	1221	1628	13202	1922	8434	6281
1703	9928	3151	4958	25316	2420	2673	1228	1825	13245	2188	9384	6938

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
170	1055	482	734	2057	860	227	164	246	1427	226	1232	792
511	1923	1006	1767	3198	4368	380	357	381	3975	437	2180	1816
1277	7879	3449	5545	15063	6579	1693	1238	1830	10685	1670	9191	5893
1703	12261	4950	7624	24478	7406	2582	1734	2845	14413	2563	14087	8631

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
170	2297	1051	1599	4481	1874	494	356	535	3109	492	2683	1725
511	1396	731	1283	2323	3172	276	259	277	2886	317	1583	1318
1277	2289	1002	1611	4375	1911	492	360	532	3104	485	2670	1712
1703	2671	1078	1661	5333	1613	562	378	620	3140	558	3069	1880

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
170	0.0027	0.0040	127	0.39	0.046	0.0008	30	0.035	0.0006	0.0159	0.0008	0.0020	0.0063	0.0004	0.0028	0.0154	0.0060
511	0.0012	0.0021	177	0.54	0.049	0.0005	30	0.036	0.0003	0.0159	0.0004	0.0010	0.0063	0.0002	0.0012	0.0154	0.0057
1277	0.0006	0.0012	232	0.71	0.052	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0063	0.0001	0.0006	0.0154	0.0056
1703	0.0005	0.0010	253	0.77	0.053	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0063	0.0001	0.0005	0.0154	0.0056

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	189.0	ft
Height of Drop Structure	3	ft
No . of Drop Structures	63	
Distance between structs.	319	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	4.08	sq. mi
Total Sediment Yield Volume	7.75	ac ft

Sedimentation Basins

Length	319 ft	Depth	3 ft
Width	327 ft	Side slope	3 ft/ft
Total Volume per Basin		6.79	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		4	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
170	1.1	-0.5	0.1	24.6	1.6	1.4	3.1	0.0060	0.2	1.5	2.5	5.5
511	1.1	-1.0	0.1	24.6	3.0	0.8	2.2	0.0060	0.3	1.5	2.5	5.6
1277	1.1	-1.1	0.1	24.6	3.5	1.3	3.1	0.0060	0.4	1.5	2.5	5.8
1703	1.1	-1.1	0.2	24.6	3.8	1.6	3.5	0.0060	0.4	1.5	2.5	5.9

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	275	cfs
Stage at Peak Flow	100.4	ft
Volume at Peak Flow	342.0	ac. ft

Freeboard

Max. Flow Depth	1.2	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	7.75	ac. ft
Outflowing Sediment Volume	0.24	ac. ft
Deposited(+)/Eroded(-) Volume	7.50	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	20093	20093
Side Slope (?H:1V)	3	3
Channel Width (ft)	327	327
Channel XS Area (sq. ft)	1504.5	1504.5
Channel Perimeter (ft)	329	329

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	20093	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	6698	sq. Yd
Volume	20093	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	20093	20093
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	93767	194232
Left Levee Volume (cu. Yd)	92279	217302
Right Levee Length (ft)	20093	20093
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	93767	194232
Right Levee Volume (cu. Yd)	92279	217302
Total Levee Surface Area (sq. Yd)	187534	388464
Total Levee Volume (cu. Yd)	184558	434604

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	20093	20093
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	31256	73674
Left Levee Lining Volume (cu. Yd)	15628	36837
Right Levee Length (ft)	20093	20093
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	31256	73674
Right Levee Lining Volume (cu. Yd)	15628	36837
Total Lining Area (sq. Yd)	62512	147349
Total Lining Volume (cu. Yd)	31256	73674

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	327	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.3	ft
Structure Height	9.3	ft
Number of Structures	63	
Volume per structure	336	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 25,200	
Area per structure	109	sq. Yd
Total Area	6,867	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	4	
Total Volume per Basin	10955	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 43,820	
Other Cost	$ -	
Total cost per basin	$ 43,820	
Area per basin	11,588	sq. Yd
Total Area	46,352	sq. Yd

Structure Type	Structure Cost											
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	184,558	cu. Yd	$ 7.00	$ 1,291,906	187,534	sq. Yd	$ 9.00	$ 1,687,806	187,534	sq. Yd	$ 11.67	$ 2,187,897
Levee - LC Enhancement	Fill	250,046	cu. Yd	$ 7.00	$ 1,750,322	200,930	sq. Yd	$ 9.00	$ 1,808,370	250,046	sq. Yd	$ 11.67	$ 2,917,203
Levee Lining	Riprap	31,256	cu. Yd	$ 75.00	$ 2,344,200	62,512	sq. Yd	$ -	$ -	62,512	sq. Yd	$ 20.83	$ 1,302,324
Levee Lining -LC Enhancement	Riprap	42,418	cu. Yd	$ 75.00	$ 3,181,350	84,837	sq. Yd	$ -	$ -	84,837	sq. Yd	$ 20.83	$ 1,767,440
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	20,093	cu. Yd	$ 75.00	$ 1,506,975	6,698	sq. Yd	$ -	$ -	6,698	sq. Yd	$ 25.00	$ 167,450
Drop Structures	Riprap	63	EA	$ 25,200.00	$ 1,587,600	6,867	sq. Yd	$ -	$ -	6,867	sq. Yd	$ 33.33	$ 228,900
Drop Str. - LC Enhancement	Riprap	63	EA	$ 2,520.00	$ 158,760	687	sq. Yd	$ -	$ -	687	sq. Yd	$ 33.33	$ 22,890
Sedimentation Basins		4	EA	$ 43,820.00	$ 175,280	46,352	sq. Yd	$ -	$ -	46,352	sq. Yd	$ 8.33	$ 386,267
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,687,806	Base Maintenance Cost			$ 4,272,837
						LC Enhancement Cost			$ 1,808,370	LC Enhancement Cost			$ 4,707,533
						Total Landscape Cost			$ 3,496,176	Total Maintenance Cost			$ 8,980,371

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 6,905,961	$ 5,090,432	$ 11,996,393
Contingency Cost (25% of Construction Cost)	$ 1,726,490	$ 1,272,608	$ 2,999,098
Engineering Design Cost (5% of Construction Cost)	$ 345,298	$ 254,522	$ 599,820
Total Construction Cost	$ 8,977,749	$ 6,617,562	$ 15,595,311

Land Cost

Channel Length	20093 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	327	150.8	$100,000	$ 15,080,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	25.4	$100,000	$ 2,540,000
Levee LC Enhancement	51	23.5	$100,000	$ 2,350,000
Other	0	0	$100,000	$ -
Total	433	199.7		$ 19,970,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	176.2	$100,000	$ 17,620,000
LC Enhancement Cost	acre	23.5	$100,000	$ 2,350,000
Total Land Cost	acre	199.7	$100,000	$ 19,970,000

Total Cost

Base Total Cost	$ 32,558,393
Total Landscape Enhancement Cost	$ 15,483,465
Total Cost Including LC Enh.	$ 48,041,857

Offline Basin

HEC1 ID	DL3R

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.0	sq. mi
Total Sediment Yield Volume	0.0	ac ft

Required Minimum Sediment Volume

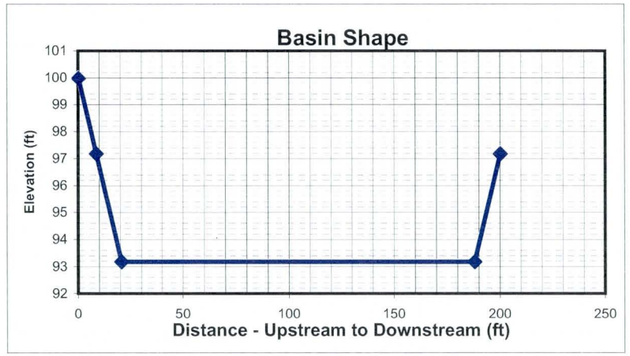
Sediment Volume	0.0	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.014	0.014
Basin Length (ft)	260	310
Basin Width (ft)	200	200
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	4	4
Freeboard (ft)	1	1
Effective Basin Width (ft)	191.6	183.2
Top Area (acres)	1.2	1.4
U/S-D/S Height Difference (ft)	2.8	2.8
Excess Area on Upstream (acres)	0.1	0.1

			Base	LC Enhanced
Bottom Length (ft)	236	Allocated Storage Volume (ac. ft)	3.0	3
Bottom Width (ft)	167.6	Total Available Volume (ac. ft) (incl. Freeboard)	4.1	4.2
		Total Excavation Volume (ac. ft)	5.8	6.2

Stage-Storage-Discharge

Stage (ft)	0	1.6	2.5	3.3	4.5	5	5.7	7.5	8.3	9	9.6	
Inflow (cfs)	0	360	720	1080	1440	1585	1820	2520	2880	3240	3600	
Outflow (cfs)	0	0	0	0	0	0	235	935	1295	1655	2015	



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Peak flow before diversion (cfs)	1321	1703	1703
Peak flow after diversion (cfs)	1321	1585	1585
Diverted Peak Flow (cfs)	0	118	118
Total Diverted Flow Volume (ac. ft)	0.0	3	3.0
Peak Stage	0	ft	

Volume Check			***Stage Check***	
Total Volume needed	3.0	ac. ft	Depth Needed	1.0
Total Volume Provided	3.0	ac. ft	Depth Provided	4

Volume OK?	Yes	Depth OK?	Yes

Culvert at Sta. 195+10

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
Landscape Enhancement	71000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	260	ft
Base Total ROW Width	200	ft
LC Enh. Total ROW Length	410	ft
LC Enh. Total ROW Length	300	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	9357	10003
Excavated Area (sq. Yd)	5778	13667

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	22	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	239	sq. Yd
Material Volume	120	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	444	ft
Unit Cost	160	per ft
Cost per outlet	$71,040	
Other Cost	$ -	
Total Cost	$71,040	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost	
Basin		9,357	cu. Yd	$ 4.00	$ 37,428	5,778	sq. Yd	$ 9.00	$ 52,002	5,778	sq. Yd	$ 8.33	$ 48,150	
Basin - LC Enhanced		646	cu. Yd	$ 4.00	$ 2,584	7,889	sq. Yd	$ 9.00	$ 71,001	7,889	sq. Yd	$ 8.33	$ 65,742	
Inlet	Riprap	120	sq. Yd	$ 75.00	$ 9,000	239	sq. Yd	$ -	$ -	239	sq. Yd	$ 33.33	$ 7,967	
Inlet - LC Enhanced (20%Total)					$ 1,800				$ -				$ 1,593	
Outlet	Pipe	1	EA	$ 71,040	$ 71,040	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217	
Outlet - LC Enhanced (5%Total)					$ 3,552				$ -				$ 111	
Other					$ -				$ -				$ -	
						Base Landscape Cost			$ 52,002	Base Maintenance Cost			$ 58,333	
						LC Enh. Landscape Cost			$ 71,001	LC Enh. Maintenance Cost			$ 67,446	
						Total Landscape Cost			$ 123,003	Total Maintenance Cost			$ 125,779	

Construction Cost Component	Base	LC Enhanced	Total
Construction Cost	$ 117,468	$ 2,584	$ 120,052
Contingency Cost (25% of Construction Cost)	$ 29,367	$ 646	$ 30,013
Engineering Design Cost (5% of Construction Cost)	$ 5,873	$ 129	$ 6,003
Total Construction Cost	$ 152,708	$ 3,359	$ 156,068

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	1.6	$100,000	$ 162,994
Basin	1.2	$100,000	$ 120,000
Other		$100,000	$ -
Total	2.8	$100,000	$ 280,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	1.2	$100,000	$ 119,376
LC Enhancement Cost	acre	1.6	$100,000	$ 160,624
Total Land Cost	acre	2.8	$100,000	$ 280,000

Total Cost

Base Total Cost	$ 382,419
Total LC Enhancement Cost	$ 302,430
Total Cost Including LC Enh.	$ 684,850

Open Channel

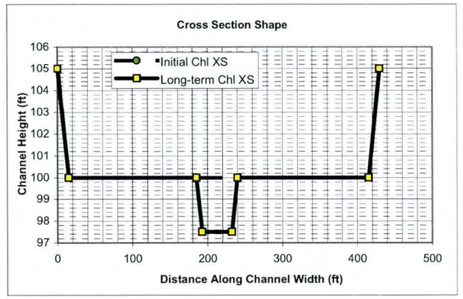
Structure ID	L10	HEC1 ID	L2BL3

Longitudnal Geometry

Length	12870.8	ft
U/S Elev	1238.5	ft
D/S Elev	1119.1	ft
Initial Channel Slope	0.0093	ft/ft
Long-term Channel Slope	0.0040	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	6



Initial Channel XS Geometry

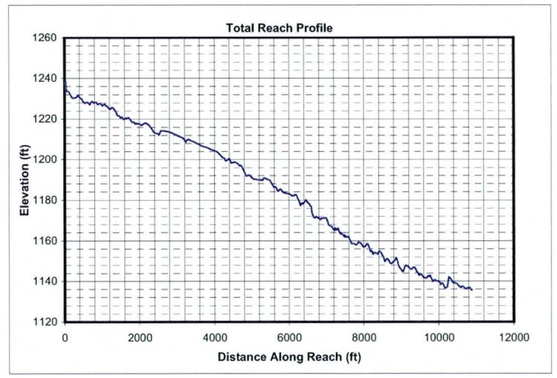
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	400	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	415	415	415	430
Y	105	100	100	100	100	100	100	105

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	170	3	40	7.5	3	175	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	185	192.5	232.5	240	415	430
Y	105	100	100	97.5	97.5	100	100	105



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	L2BL3	L2D-L3	L3						TOTAL
HEC1 Peak-Flow	1443	705	2129						4277
Weighting Factor	1.00	1.00	0.53						
Flow into Channel	1443	705	1122						3270

Reach Sediment Inflow Characteristics

U/S Contributing ID	L2AL2B_L3R10								TOTAL
Flow Volume (ac. ft)	342.00								342
Sediment Conc. (ppm)	1880								
Sediment Volume (ac. ft)	0.24								0.24
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.24								0.24

Hydrology

Drainage Area	13.962	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	3270	cfs	
Long-term Max. Chnl Capacity	13563	cfs	
Q2 Channel	327	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	430	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
327	402.8	177.3	0.4	100.0	100.4	1.8	0.4	402.7	0.4	0.11	0.49
981	405.4	343.5	0.8	100.0	100.9	2.9	0.9	405.1	0.8	0.21	0.55
2453	409.3	597.6	1.5	100.0	101.5	4.1	1.5	408.9	1.5	0.37	0.60
3270	411.1	711.4	1.7	100.0	101.8	4.6	1.8	410.5	1.7	0.44	0.62

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
327	53.9	102.0	1.9	97.5	99.7	3.2	2.2	53.1	1.9	0.55	0.41
981	405.9	442.3	1.1	97.5	100.8	2.2	3.3	404.8	1.1	0.82	0.37
2453	411.0	770.4	1.9	97.5	101.6	3.2	4.1	409.7	1.9	1.03	0.41
3270	413.3	917.5	2.2	97.5	102.0	3.6	4.5	411.8	2.2	1.11	0.42

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
	L2AL2B_L3R10									
327	792									792
981	1816									1816
2453	5893									5893
3270	8631									8631

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
327	1.74	1.1426	1.0854	Erosive	Erosive	Erosive	0.2	Stable	6.2	Stable	Stable
981	1.74	1.3445	1.2773	Erosive	Erosive	Erosive	0.3	Stable	6.9	Stable	Stable
2453	1.74	1.5125	1.4369	Erosive	Erosive	Erosive	0.4	Stable	8.4	Stable	Stable
3270	1.74	1.5650	1.4867	Erosive	Erosive	Erosive	0.4	Stable	9.1	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	327	981	2453	3270	327	981	2453	3270	327	981	2453	3270
Bray - Equation #1	50	90	146	169	1.8	2.6	3.6	3.9	3.6	4.1	4.7	4.9
Bray - Equation #2	66	118	191	223	2.0	2.9	3.9	4.3	2.4	2.8	3.2	3.4
Hey	15	29	48	56	5.8	8.8	12.5	14.0				
Ackers & Charlton/Lacey	41	65	95	108					2.1	2.5	2.9	3.1
Parker	124	215	340	393	1.5	2.4	3.5	4.0				
Chang	82	161	281	335	0.2	-0.1	-0.6	-0.8				
Kellerhals	33	56	89	103	2.8	4.3	6.2	6.9	3.6	4.1	4.5	4.6
AMAFCA/Schumm	53	405	410	412								
Moody & Odem	33	33	33	33	1.4	1.4	1.4	1.4				
BUREC	24.3	36.7	51.7	57.6	6	10	14	15	3.3	4.3	5.4	5.8
Average	52	121	169	189	2.8	4.0	5.5	6.1	3.0	3.6	4.2	4.4
Values As Designed	53	405	410	412	2.2	3.3	4.1	4.5	3.2	2.2	3.2	3.6
Difference with Design	-1	-284	-241	-223	0.6	0.7	1.4	1.7	-0.2	1.4	1.0	0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
327	1512	936	1674	2518	5209	326	327	229	4788	402	1604	1775
981	8270	4097	7082	16235	8568	2136	1580	1758	15798	1900	9437	6987
2453	33926	12340	19168	76571	12297	7979	4416	7048	40574	7296	35868	23408
3270	52819	17199	24757	124510	13685	11912	5960	10576	54339	11176	53615	34595

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
327	1715	1062	1899	2857	5910	370	371	260	5432	456	1820	2014
981	3128	1549	2678	6140	3240	808	597	665	5975	718	3569	2642
2453	5132	1867	2900	11583	1860	1207	668	1066	6138	1104	5426	3541
3270	5993	1951	2809	14126	1553	1352	676	1200	6165	1268	6083	3925

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
327	1399	632	873	2589	1106	255	191	354	1478	281	1670	984
981	2568	1331	2028	4053	5535	411	398	565	4052	537	2944	2220
2453	10523	4611	6604	19083	8403	1915	1447	2658	11064	2090	12536	7358
3270	16371	6629	9014	31004	9479	2935	2040	4116	14960	3226	19285	10823

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
327	1587	718	990	2937	1254	289	216	402	1676	319	1895	1117
981	971	503	767	1533	2093	155	151	214	1533	203	1113	840
2453	1592	698	999	2887	1271	290	219	402	1674	316	1896	1113
3270	1857	752	1023	3518	1075	333	231	467	1697	366	2188	1228

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
327	0.0020	0.0028	119	0.36	0.046	0.0006	29	0.035	0.0004	0.0159	0.0006	0.0014	0.0051	0.0003	0.0021	0.0093	0.0040
981	0.0009	0.0014	165	0.50	0.049	0.0003	30	0.036	0.0002	0.0159	0.0003	0.0007	0.0051	0.0002	0.0009	0.0093	0.0038
2453	0.0005	0.0008	217	0.66	0.051	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0051	0.0001	0.0005	0.0093	0.0037
3270	0.0004	0.0007	236	0.72	0.052	0.0002	31	0.036	0.0001	0.0159	0.0001	0.0003	0.0051	0.0001	0.0004	0.0093	0.0037

Drop Structures

Design Slope	0.0040	ft/ft
Total Drop Needed	67.9	ft
Height of Drop Structure	3	ft
No . of Drop Structures	23	
Distance between structs.	560	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	3.08	sq. mi
Total Sediment Yield Volume	5.86	ac ft

Sedimentation Basins

Length	560 ft	Depth	3 ft
Width	430 ft	Side slope	3 ft/ft
Total Volume per Basin		15.97	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
327	1.1	-0.7	0.1	24.6	2.2	1.9	3.2	0.0040	0.2	1.5	2.5	5.6
981	1.1	-1.1	0.1	24.6	3.3	1.1	2.2	0.0040	0.3	1.5	2.5	5.7
2453	1.1	-1.2	0.1	24.6	4.1	1.9	3.2	0.0040	0.4	1.5	2.5	5.9
3270	1.1	-1.3	0.2	24.6	4.5	2.2	3.6	0.0040	0.5	1.5	2.5	6.0

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	1443	cfs
Stage at Peak Flow	101.1	ft
Volume at Peak Flow	557.0	ac. ft

Freeboard

Max. Flow Depth	1.8	ft
Channel Depth as designed	5.0	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	6.10	ac. ft
Outflowing Sediment Volume	0.26	ac. ft
Deposited(+)/Eroded(-) Volume	5.84	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	12871	12871
Side Slope (?H:1V)	3	3
Channel Width (ft)	430	430
Channel XS Area (sq. ft)	2193.8	2193.8
Channel Perimeter (ft)	432	432

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	12871	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	4290	sq. Yd
Volume	12871	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	12871	12871
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	5	6
Left Levee Surface Area (sq. Yd)	65785	133000
Left Levee Volume (cu. Yd)	69122	160172
Right Levee Length (ft)	12871	12871
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5	6
Right Levee Surface Area (sq. Yd)	65785	133000
Right Levee Volume (cu. Yd)	69122	160172
Total Levee Surface Area (sq. Yd)	131570	266000
Total Levee Volume (cu. Yd)	138244	320344

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	12871	12871
Left Levee Lining Width (ft)	16	36
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	22882	51484
Left Levee Lining Volume (cu. Yd)	11441	25742
Right Levee Length (ft)	12871	12871
Right Levee Lining Width (ft)	16	36
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	22882	51484
Right Levee Lining Volume (cu. Yd)	11441	25742
Total Lining Area (sq. Yd)	45764	102968
Total Lining Volume (cu. Yd)	22882	51484

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	430	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	7.7	ft	
Structure Height	10.7	ft	
Number of Structures	23		
Volume per structure	511	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 38,325		
Area per structure	143	sq. Yd	
Total Area	3,297	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	25765	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 103,060	
Other Cost	$ -	
Total cost per basin	$ 103,060	
Area per basin	26,736	sq. Yd
Total Area	53,472	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	138,244	cu. Yd	$ 7.00	$ 967,708	131,570	sq. Yd	$ 9.00	$ 1,184,130	131,570	sq. Yd	$ 11.67	$ 1,534,983
Levee - LC Enhancement	Fill	182,100	cu. Yd	$ 7.00	$ 1,274,700	134,430	sq. Yd	$ 9.00	$ 1,209,870	182,100	sq. Yd	$ 11.67	$ 2,124,500
Levee Lining	Riprap	22,882	cu. Yd	$ 75.00	$ 1,716,150	45,764	sq. Yd	$ -	$ -	45,764	sq. Yd	$ 20.83	$ 953,407
Levee Lining -LC Enhancement	Riprap	28,602	cu. Yd	$ 75.00	$ 2,145,150	57,204	sq. Yd	$ -	$ -	57,204	sq. Yd	$ 20.83	$ 1,191,759
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	12,871	cu. Yd	$ 75.00	$ 965,325	4,290	sq. Yd	$ -	$ -	4,290	sq. Yd	$ 25.00	$ 107,250
Drop Structures	Riprap	23	EA	$ 38,325.00	$ 881,475	3,297	sq. Yd	$ -	$ -	3,297	sq. Yd	$ 33.33	$ 109,900
Drop Str. - LC Enhancement	Riprap	23	EA	$ 3,832.50	$ 88,148	330	sq. Yd	$ -	$ -	330	sq. Yd	$ 33.33	$ 10,990
Sedimentation Basins		2	EA	$ 103,060.00	$ 206,120	53,472	sq. Yd	$ -	$ -	53,472	sq. Yd	$ 8.33	$ 445,600
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,184,130	Base Maintenance Cost			$ 3,151,141
						LC Enhancement Cost			$ 1,209,870	LC Enhancement Cost			$ 3,327,249
						Total Landscape Cost			$ 2,394,000	Total Maintenance Cost			$ 6,478,390

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 4,736,778	$ 3,507,998	$ 8,244,776
Contingency Cost (25% of Construction Cost)	$ 1,184,195	$ 876,999	$ 2,061,194
Engineering Design Cost (5% of Construction Cost)	$ 236,839	$ 175,400	$ 412,239
Total Construction Cost	$ 6,157,811	$ 4,560,397	$ 10,718,208

Land Cost

Channel Length	12871	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	430	127.1	$100,000	$ 12,710,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	58	17.1	$100,000	$ 1,710,000
Levee LC Enhancement	54	16	$100,000	$ 1,600,000
Other	0	0	$100,000	$ -
Total	542	160.2		$ 16,020,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	144.2	$100,000	$ 14,420,000
LC Enhancement Cost	acre	16	$100,000	$ 1,600,000
Total Land Cost	acre	160.2	$100,000	$ 16,020,000

Total Cost

Base Total Cost	$	24,913,082
Total Landscape Enhancement Cost	$	10,697,516
Total Cost Including LC Enh.	$	35,610,598

Online Basin

HEC1 ID	RRCM1

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	5.7	sq. mi
Total Sediment Yield Volume	10.8	ac ft

Required Minimum Sediment Volume

Sediment Volume	10.8	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.025	0.025
Basin Length (ft)	1980	2320
Basin Width (ft)	800	800
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	11	11
Freeboard (ft)	1	1
Effective Basin Width (ft)	740	680
Top Area (acres)	36.4	42.6
U/S-D/S Height Difference (ft)	20.0	20.0
Excess Area on Upstream (acres)	2.9	6.5

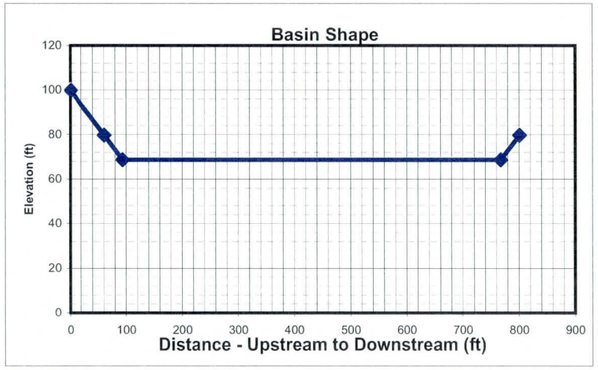
			Base	LC Enhanced
Bottom Length (ft)	1914	Allocated Storage Volume (ac. ft)	314.3	314
Bottom Width (ft)	674	Total Available Volume (ac. ft) (incl. Freeboard)	347.7	349.9
		Total Excavation Volume (ac. ft)	711.5	776.1

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	6.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	3	5	6	7	8	10	12	14
Volume	0.00	29.79	90.46	152.57	184.17	216.13	248.47	314.25	381.52	450.30
Outflow	0.0	136.1	235.8	304.4	333.5	360.2	385.1	430.5	471.6	509.4



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	402.0	469	469.0
Peak Inflow (cfs)	2809	3301	3301.0
Peak Outflow (cfs)	414	422	422.0
Stage at Peak Outflow (ft)	9.3	9.6	9.6
Volume at Peak Outflow (ac. ft)	290.0	301.43	301.4

Volume Check

Total Volume needed	312.2	ac. ft
Total Volume Provided	314.3	ac. ft

Volume OK?	Yes

Stage Check

Depth Needed	10.6	ft
Depth Provided	11	ft

Depth OK?	Yes

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	594000	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	1980	ft
Base Total ROW Width	800	ft
LC Enh. Total ROW Length	2420	ft
LC Enh. Total ROW Length	900	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	1147887	1252108
Excavated Area (sq. Yd)	176000	242000

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	98	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	1089	sq. Yd
Material Volume	545	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	550	ft
Unit Cost	160	per ft
Cost per outlet	$88,000	
Other Cost	$ -	
Total Cost	$88,000	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		1,147,887	cu. Yd	$ 4.00	$ 4,591,548	176,000	sq. Yd	$ 9.00	$ 1,584,000	176,000	sq. Yd	$ 8.33	$ 1,466,667
Basin - LC Enhancement		104,221	cu. Yd	$ 4.00	$ 416,884	66,000	sq. Yd	$ 9.00	$ 594,000	66,000	sq. Yd	$ 8.33	$ 550,000
Inlet	Riprap	545	sq. Yd	$ 75.00	$ 40,875	1,089	sq. Yd	$ -	$ -	1,089	sq. Yd	$ 33.33	$ 36,300
Inlet - LC Enhancement (20%Inlet)					$ 8,175				$ -				$ 7,260
Outlet	Pipe	1	EA	$ 88,000	$ 88,000	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 4,400				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,584,000	Base Maintenance Cost			$ 1,505,183
						LC Enh. Landscape Cost			$ 594,000	LC Enh. Maintenance Cost			$ 557,371
						Total Landscape Cost			$ 2,178,000	Total Maintenance Cost			$ 2,062,554

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 4,720,423	$ 416,884	$ 5,137,307
Contingency Cost (25% of Construction Cost)	$ 1,180,106	$ 104,221	$ 1,284,327
Engineering Design Cost (5% of Construction Cost)	$ 236,021	$ 20,844	$ 256,865
Total Construction Cost	$ 6,136,550	$ 541,949	$ 6,678,499

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	13.6	$100,000	$ 1,360,000
Basin	36.4	$100,000	$ 3,640,000
Other		$100,000	$ -
Total	50.0	$100,000	$ 5,000,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	36.4	$100,000	$ 3,640,000
LC Enhancement Cost	acre	13.6	$100,000	$ 1,360,000
Total Land Cost	acre	50	$100,000	$ 5,000,000

Total Cost

Base Total Cost	$ 12,865,733
Total LC Enhancement Cost	$ 3,053,320
Total Cost Including LC Enh.	$ 15,919,053

Open Channel

Structure ID	M110

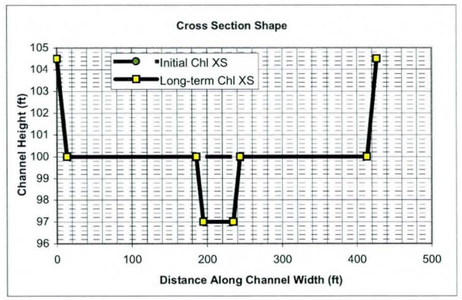
HEC1 ID	M1-M2

Longitudinal Geometry

Length	33722.5	ft
U/S Elev	1558.8	ft
D/S Elev	1078.5	ft
Initial Channel Slope	0.0142	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	18



Initial Channel XS Geometry

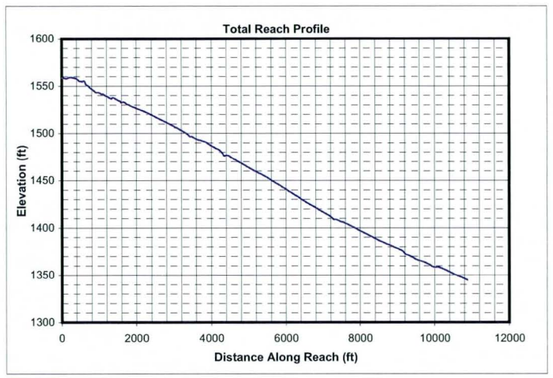
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	400	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	413.5	413.5	413.5	427
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	172	3	40	7.5	3	170	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	185.5	194.5	234.5	243.5	413.5	427
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	M2									TOTAL
HEC1 Peak-Flow	2347									2347
Weighting Factor	1.00									
Flow into Channel	2347									2347

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	13.12	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	2347	cfs	
Long-term Max. Chnl Capacity	13143	cfs	
Q2 Channel	235	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	427	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
235	402.0	127.7	0.3	100.0	100.3	1.8	0.3	401.9	0.3	0.10	0.57
704	403.9	247.1	0.6	100.0	100.6	2.8	0.6	403.7	0.6	0.19	0.64
1760	406.7	429.6	1.1	100.0	101.1	4.1	1.1	406.4	1.1	0.33	0.70
2347	408.0	511.1	1.3	100.0	101.3	4.6	1.3	407.6	1.3	0.39	0.72

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
235	50.7	76.3	1.5	97.0	98.7	3.1	1.7	50.2	1.5	0.53	0.44
704	404.0	338.4	0.8	97.0	100.5	2.1	3.5	402.9	0.8	1.08	0.40
1760	407.9	588.7	1.4	97.0	101.1	3.0	4.1	406.6	1.4	1.28	0.44
2347	409.6	700.8	1.7	97.0	101.4	3.3	4.4	408.2	1.7	1.36	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
235										0
704										0
1760										0
2347										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
235	1.74	1.0419	0.9898	Erosive	Erosive	Erosive	0.2	Stable	5.8	Stable	Stable
704	1.74	1.2441	1.1819	Erosive	Erosive	Erosive	0.3	Stable	7.6	Stable	Stable
1760	1.74	1.4125	1.3419	Erosive	Erosive	Erosive	0.3	Stable	9.0	Stable	Stable
2347	1.74	1.4652	1.3920	Erosive	Erosive	Erosive	0.3	Stable	9.6	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	235	704	1760	2347	235	704	1760	2347	235	704	1760	2347
Bray - Equation #1	42	75	122	142	1.6	2.4	3.2	3.5	3.4	4.0	4.5	4.7
Bray - Equation #2	55	99	161	187	1.8	2.6	3.5	3.9	2.3	2.7	3.1	3.2
Hey	13	24	40	46	5.1	7.8	11.0	12.3				
Ackers & Charlton/Lacey	36	57	83	94					2.0	2.4	2.8	2.9
Parker	105	182	288	333	1.3	2.1	3.1	3.5				
Chang	73	142	247	294	0.1	-0.1	-0.6	-0.8				
Kellerhals	28	48	76	87	2.4	3.7	5.4	6.1	3.5	3.9	4.3	4.4
AMAFCA/Schumm	50	403	407	409								
Moody & Odem	32	32	32	32	1.4	1.4	1.4	1.4				
BUREC	20.6	31.1	43.8	48.8	5	8	12	13	3.3	4.3	5.4	5.8
Average	45	109	150	167	2.4	3.5	4.8	5.4	2.9	3.5	4.0	4.2
Values As Designed	50	403	407	408	1.7	3.5	4.1	4.4	3.1	2.1	3.0	3.3
Difference with Design	-5	-294	-257	-241	0.7	0.0	0.7	1.0	-0.2	1.4	1.0	0.9

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
235	1640	1065	2176	2911	5651	458	437	239	6748	498	1726	2141
704	8989	4492	8500	18791	9156	2751	1934	1803	21784	2226	9942	8215
1760	36936	13306	22174	88785	13025	10136	5276	7169	55619	8300	37127	27078
2347	57544	18473	28767	144485	14461	15116	7087	10736	74417	12619	55195	39900

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
235	2592	1683	3439	4601	8933	724	690	378	10666	786	2728	3384
704	4736	2367	4479	9901	4824	1449	1019	950	11478	1173	5238	4329
1760	7785	2804	4673	18713	2745	2136	1112	1511	11723	1749	7825	5707
2347	9096	2920	4547	22839	2286	2389	1120	1697	11763	1995	8725	6307

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
235	1182	550	814	2218	1037	237	178	285	1484	246	1398	875
704	2099	1101	1826	3345	5332	358	354	415	4046	465	2353	1972
1760	8617	3878	6127	15776	8121	1725	1327	2066	11080	1783	10180	6425
2347	13414	5597	8331	25653	9163	2653	1879	3235	14989	2742	15702	9396

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
235	1869	870	1286	3506	1639	374	281	451	2346	389	2210	1384
704	1106	580	962	1762	2810	189	186	219	2132	245	1240	1039
1760	1816	817	1291	3325	1712	363	280	436	2335	376	2145	1354
2347	2120	885	1317	4055	1448	419	297	511	2369	433	2482	1485

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
235	0.0026	0.0038	125	0.38	0.046	0.0008	29	0.035	0.0006	0.0159	0.0008	0.0020	0.0056	0.0003	0.0027	0.0142	0.0055
704	0.0011	0.0020	174	0.53	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0010	0.0056	0.0002	0.0012	0.0142	0.0053
1760	0.0006	0.0011	228	0.70	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0056	0.0001	0.0006	0.0142	0.0051
2347	0.0005	0.0010	249	0.76	0.053	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0004	0.0056	0.0001	0.0005	0.0142	0.0051

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	311.6	ft
Height of Drop Structure	3	ft
No . of Drop Structures	104	
Distance between structs.	324	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	7.44	sq. mi
Total Sediment Yield Volume	14.14	ac ft

Sedimentation Basins

Length	324 ft	Depth	3 ft
Width	427 ft	Side slope	3 ft/ft
Total Volume per Basin		9.08	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		6	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
235	1.1	-0.5	0.1	24.6	1.7	1.5	3.1	0.0050	0.2	1.5	3.0	6.2
704	1.1	-1.2	0.1	24.6	3.5	0.8	2.1	0.0050	0.3	1.5	3.0	6.3
1760	1.1	-1.2	0.1	24.6	4.1	1.4	3.0	0.0050	0.4	1.5	3.0	6.5
2347	1.1	-1.3	0.2	24.6	4.4	1.7	3.3	0.0050	0.5	1.5	3.0	6.6

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	416	cfs
Stage at Peak Flow	100.4	ft
Volume at Peak Flow	469.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	14.14	ac. ft
Outflowing Sediment Volume	0.26	ac. ft
Deposited(+)/Eroded(-) Volume	13.87	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	33722	33722
Side Slope (?H:1V)	3	3
Channel Width (ft)	427	427
Channel XS Area (sq. ft)	2007.8	2007.8
Channel Perimeter (ft)	429	429

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	33722	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	11241	sq. Yd
Volume	37469	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	33722	33722
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	157369	325979
Left Levee Volume (cu. Yd)	154871	364697
Right Levee Length (ft)	33722	33722
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	157369	325979
Right Levee Volume (cu. Yd)	154871	364697
Total Levee Surface Area (sq. Yd)	314738	651958
Total Levee Volume (cu. Yd)	309742	729394

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	33722	33722
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	52456	123647
Left Levee Lining Volume (cu. Yd)	26228	61824
Right Levee Length (ft)	33722	33722
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	52456	123647
Right Levee Lining Volume (cu. Yd)	26228	61824
Total Lining Area (sq. Yd)	104913	247295
Total Lining Volume (cu. Yd)	52456	123648

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	427	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.4	ft
Structure Height	9.4	ft
Number of Structures	104	
Volume per structure	446	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 33,450	
Area per structure	142	sq. Yd
Total Area	14,803	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	6	
Total Volume per Basin	14649	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 58,596	
Other Cost	$ -	
Total cost per basin	$ 58,596	
Area per basin	15,384	sq. Yd
Total Area	92,304	sq. Yd

Structure Type	Structure Cost											
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	309,742	cu. Yd	$ 7.00	$ 2,168,194	314,738	sq. Yd	$ 9.00	$ 2,832,642	314,738	sq. Yd	$ 11.67	$ 3,671,943
Levee - LC Enhancement	Fill	419,652	cu. Yd	$ 7.00	$ 2,937,564	337,220	sq. Yd	$ 9.00	$ 3,034,980	419,652	sq. Yd	$ 11.67	$ 4,895,940
Levee Lining	Riprap	52,456	cu. Yd	$ 75.00	$ 3,934,200	104,913	sq. Yd	$ -	$ -	104,913	sq. Yd	$ 20.83	$ 2,185,685
Levee Lining -LC Enhancement	Riprap	71,192	cu. Yd	$ 75.00	$ 5,339,400	142,382	sq. Yd	$ -	$ -	142,382	sq. Yd	$ 20.83	$ 2,966,287
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	37,469	cu. Yd	$ 75.00	$ 2,810,175	11,241	sq. Yd	$ -	$ -	11,241	sq. Yd	$ 25.00	$ 281,025
Drop Structures	Riprap	104	EA	$ 33,450.00	$ 3,478,800	14,803	sq. Yd	$ -	$ -	14,803	sq. Yd	$ 33.33	$ 493,433
Drop Str. - LC Enhancement	Riprap	104	EA	$ 3,345.00	$ 347,880	1,480	sq. Yd	$ -	$ -	1,480	sq. Yd	$ 33.33	$ 49,343
Sedimentation Basins		6	EA	$ 58,596.00	$ 351,576	92,304	sq. Yd	$ -	$ -	92,304	sq. Yd	$ 8.33	$ 769,200
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 2,832,642	Base Maintenance Cost			$ 7,401,287
						LC Enhancement Cost			$ 3,034,980	LC Enhancement Cost			$ 7,911,570
						Total Landscape Cost			$ 5,867,622	Total Maintenance Cost			$ 15,312,857

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 12,742,945	$ 8,624,844	$ 21,367,789
Contingency Cost (25% of Construction Cost)	$ 3,185,736	$ 2,156,211	$ 5,341,947
Engineering Design Cost (5% of Construction Cost)	$ 637,147	$ 431,242	$ 1,068,389
Total Construction Cost	$ 16,565,829	$ 11,212,297	$ 27,778,126

Land Cost

Channel Length	33722 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	427	330.6	$100,000	$ 33,060,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	42.6	$100,000	$ 4,260,000
Levee LC Enhancement	51	39.5	$100,000	$ 3,950,000
Other	0	0	$100,000	$ -
Total	533	412.7		$ 41,270,000

Total Cost

Base Total Cost	$ 64,119,757
Total Landscape Enhancement Cost	$ 26,108,848
Total Cost Including LC Enh.	$ 90,228,605

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	373.2	$100,000	$ 37,320,000
LC Enhancement Cost	acre	39.5	$100,000	$ 3,950,000
Total Land Cost	acre	412.7	$100,000	$ 41,270,000

Online Basin

HEC1 ID	RRCN1

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.5	sq. mi
Total Sediment Yield Volume	2.9	ac ft

Required Minimum Sediment Volume

Sediment Volume	2.9	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.021	0.021
Basin Length (ft)	860	1050
Basin Width (ft)	480	480
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	11	11
Freeboard (ft)	1	1
Effective Basin Width (ft)	450	420
Top Area (acres)	9.5	11.6
U/S-D/S Height Difference (ft)	10.1	10.1
Excess Area on Upstream (acres)	0.6	1.5

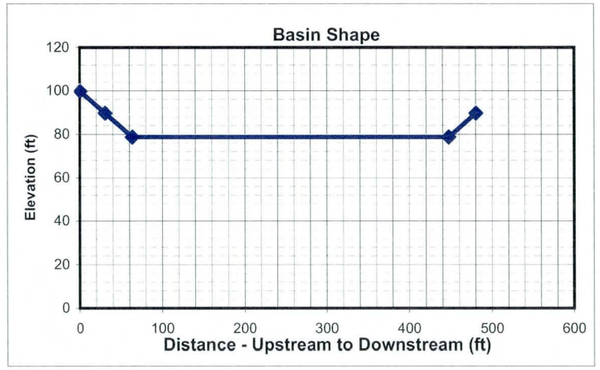
			Base	LC Enhanced
Bottom Length (ft)	794	Allocated Storage Volume (ac. ft)	78.4	78.4
Bottom Width (ft)	384	Total Available Volume (ac. ft) (incl. Freeboard)	87.2	88.3
		Total Excavation Volume (ac. ft)	135.0	146.7

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	4.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	3	5	6	7	8	9	11	13
Volume	0.00	7.08	21.74	37.06	44.98	53.07	61.33	69.77	87.18	105.31
Outflow	0.0	60.5	104.8	135.3	148.2	160.1	171.1	181.5	200.7	218.2



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	105.0	103	105.0
Peak Inflow (cfs)	1253	1211	1253.0
Peak Outflow (cfs)	187	178	187.0
Stage at Peak Outflow (ft)	9.5	8.6	9.5
Volume at Peak Outflow (ac. ft)	74.4	66.71	74.4

Volume Check

Total Volume needed	77.3	ac. ft
Total Volume Provided	78.4	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	10.5	ft
Depth Provided	11	ft
Depth OK?	Yes	

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	254200	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	860	ft
Base Total ROW Width	480	ft
LC Enh. Total ROW Length	1150	ft
LC Enh. Total ROW Length	580	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	217800	236676
Excavated Area (sq. Yd)	45867	74111

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	67	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	741	sq. Yd
Material Volume	371	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	688	ft
Unit Cost	160	per ft
Cost per outlet	$110,080	
Other Cost	$ -	
Total Cost	$110,080	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		217,800	cu. Yd	$ 4.00	$ 871,200	45,867	sq. Yd	$ 9.00	$ 412,803	45,867	sq. Yd	$ 8.33	$ 382,225
Basin - LC Enhancement		18,876	cu. Yd	$ 4.00	$ 75,504	28,244	sq. Yd	$ 9.00	$ 254,196	28,244	sq. Yd	$ 8.33	$ 235,367
Inlet	Riprap	371	sq. Yd	$ 75.00	$ 27,825	741	sq. Yd	$ -	$ -	741	sq. Yd	$ 33.33	$ 24,700
Inlet - LC Enhancement (20%Inlet)					$ 5,565				$ -				$ 4,940
Outlet	Pipe	1	EA	$ 110,080	$ 110,080	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 5,504				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 412,803	Base Maintenance Cost			$ 409,142
						LC Enh. Landscape Cost			$ 254,196	LC Enh. Maintenance Cost			$ 240,418
						Total Landscape Cost			$ 666,999	Total Maintenance Cost			$ 649,559

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,009,105	$ 75,504	$ 1,084,609
Contingency Cost (25% of Construction Cost)	$ 252,276	$ 18,876	$ 271,152
Engineering Design Cost (5% of Construction Cost)	$ 50,455	$ 3,775	$ 54,230
Total Construction Cost	$ 1,311,837	$ 98,155	$ 1,409,992

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	5.8	$100,000	$ 580,000
Basin	9.5	$100,000	$ 950,000
Other		$100,000	$ -
Total	15.3	$100,000	$ 1,530,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	9.5	$100,000	$ 950,000
LC Enhancement Cost	acre	5.8	$100,000	$ 580,000
Total Land Cost	acre	15.3	$100,000	$ 1,530,000

Total Cost

Base Total Cost	$ 3,083,781
Total LC Enhancement Cost	$ 1,172,769
Total Cost Including LC Enh.	$ 4,256,550

Open Channel

Structure ID	N125

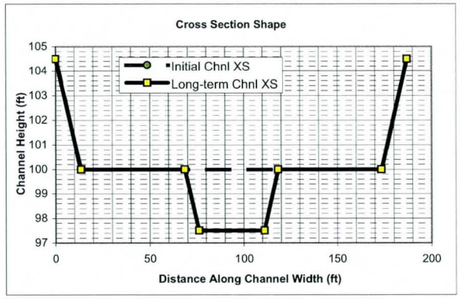
HEC1 ID	N1-P1A

Longitudinal Geometry

Length	8101.2	ft
U/S Elev	1382.8	ft
D/S Elev	1276.4	ft
Initial Channel Slope	0.0131	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	4



Initial Channel XS Geometry

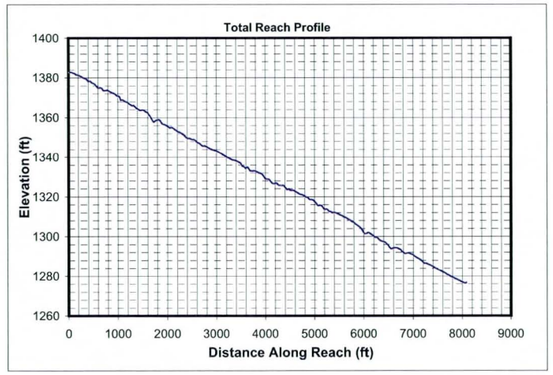
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	160	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	173.5	173.5	173.5	187
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	55	3	35	7	3	55	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	68.5	76	111	118.5	173.5	187
Y	104.5	100	100	97.5	97.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	CN2AR									TOTAL
HEC1 Peak-Flow	1214									1214
Weighting Factor	1.00									
Flow into Channel	1214									1214

Reach Sediment Inflow Characteristics

U/S Contributing ID										TOTAL
Flow Volume (ac. ft)										0
Sediment Conc. (ppm)										
Sediment Volume (ac. ft)										0.00
Weighting Factor										
Weighted Sed. Vol. (ac. ft)										0.00

Hydrology

Drainage Area	3.05	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	1214	cfs	
Long-term Max. Chnl Capacity	5816	cfs	
Q2 Channel	121	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	187	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
121	162.4	61.3	0.4	100.0	100.4	2.0	0.4	162.3	0.4	0.12	0.57
364	164.6	119.1	0.7	100.0	100.7	3.1	0.7	164.4	0.7	0.23	0.63
911	168.0	208.1	1.2	100.0	101.3	4.4	1.3	167.6	1.2	0.40	0.69
1214	169.5	248.2	1.5	100.0	101.5	4.9	1.5	169.1	1.5	0.47	0.71

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
121	42.8	48.0	1.1	97.5	98.7	2.5	1.2	42.4	1.1	0.39	0.42
364	49.8	98.7	2.0	97.5	99.8	3.7	2.3	49.1	2.0	0.73	0.46
911	167.5	277.6	1.7	97.5	101.1	3.3	3.6	166.3	1.7	1.11	0.45
1214	169.5	331.5	2.0	97.5	101.4	3.7	3.9	168.2	2.0	1.21	0.46

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
121										0
364										0
911										0
1214										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
121	1.74	1.0953	1.0405	Erosive	Erosive	Erosive	0.2	Stable	4.8	Stable	Stable
364	1.74	1.2960	1.2312	Erosive	Erosive	Erosive	0.3	Stable	7.2	Stable	Stable
911	1.74	1.4622	1.3890	Erosive	Erosive	Erosive	0.3	Stable	8.6	Stable	Stable
1214	1.74	1.5139	1.4382	Erosive	Erosive	Erosive	0.4	Stable	9.2	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	121	364	911	1214	121	364	911	1214	121	364	911	1214
Bray - Equation #1	30	53	86	100	1.3	1.9	2.6	2.8	3.1	3.6	4.1	4.3
Bray - Equation #2	39	70	113	132	1.4	2.1	2.8	3.1	2.1	2.5	2.8	2.9
Hey	9	16	27	32	4.0	6.1	8.6	9.6				
Ackers & Charlton/Lacey	27	43	63	71					1.8	2.1	2.5	2.6
Parker	76	131	207	239	1.0	1.6	2.3	2.6				
Chang	48	95	166	197	0.2	0.0	-0.2	-0.4				
Kellerhals	20	34	54	63	1.9	2.9	4.1	4.7	3.3	3.7	4.0	4.1
AMAFCA/Schumm	42	49	167	168								
Moody & Odem	19	19	19	19	1.1	1.1	1.1	1.1				
BUREC	16.1	24.3	34.2	38.1	4	6	9	10	2.8	3.6	4.6	4.9
Average	33	53	94	106	1.9	2.8	3.8	4.2	2.6	3.1	3.6	3.8
Values As Designed	42	49	166	168	1.2	2.3	3.6	3.9	2.5	3.7	3.3	3.7
Difference with Design	-10	4	-73	-62	0.7	0.4	0.3	0.3	0.1	-0.6	0.3	0.1

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
121	867	543	1086	1566	2453	245	224	140	3135	246	941	1041
364	4726	2226	4064	10045	3950	1381	929	965	10017	1131	5208	4058
911	19263	6509	10281	47036	5634	5012	2486	3706	25504	4244	19078	13523
1214	29904	9008	13396	76244	6271	7450	3328	5508	34109	6451	28218	19990

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
121	2650	1658	3317	4785	7497	750	685	429	9582	751	2876	3180
364	4814	2268	4140	10233	4024	1407	946	983	10204	1152	5305	4134
911	7849	2652	4189	19166	2296	2042	1013	1510	10392	1729	7774	5510
1214	9139	2753	4094	23300	1916	2277	1017	1683	10424	1971	8624	6109

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
121	468	246	380	813	709	92	79	107	741	100	551	390
364	2343	946	1315	4748	1223	455	297	562	2349	483	2710	1585
911	5035	2154	3202	9610	3663	1000	718	1216	5802	1036	5914	3577
1214	7802	3075	4407	15544	4137	1516	1000	1868	7822	1591	9017	5253

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
121	1431	752	1163	2485	2168	280	241	327	2265	306	1683	1191
364	2387	964	1340	4837	1245	464	303	572	2393	492	2760	1614
911	2051	878	1305	3916	1493	407	293	495	2364	422	2410	1458
1214	2384	940	1347	4750	1264	463	306	571	2391	486	2756	1605

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
121	0.0022	0.0032	131	0.40	0.047	0.0007	30	0.035	0.0005	0.0159	0.0007	0.0016	0.0070	0.0004	0.0024	0.0131	0.0055
364	0.0010	0.0017	181	0.55	0.050	0.0004	31	0.036	0.0003	0.0159	0.0004	0.0008	0.0070	0.0003	0.0011	0.0131	0.0053
911	0.0005	0.0010	237	0.72	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0070	0.0002	0.0005	0.0131	0.0052
1214	0.0004	0.0008	258	0.79	0.053	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0004	0.0070	0.0001	0.0004	0.0131	0.0052

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	65.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	22	
Distance between structs.	368	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.50	sq. mi
Total Sediment Yield Volume	2.85	ac ft

Sedimentation Basins

Length	368 ft	Depth	3 ft
Width	187 ft	Side slope	3 ft/ft
Total Volume per Basin		4.41	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		3	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
121	1.1	-0.4	0.1	24.6	1.2	1.1	2.5	0.0050	0.1	1.5	2.5	5.4
364	1.1	-0.7	0.2	24.6	2.3	2.0	3.7	0.0050	0.3	1.5	2.5	5.7
911	1.1	-1.0	0.1	24.6	3.6	1.7	3.3	0.0050	0.4	1.5	2.5	5.8
1214	1.1	-1.1	0.2	24.6	3.9	2.0	3.7	0.0050	0.4	1.5	2.5	5.9

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	184	cfs
Stage at Peak Flow	100.5	ft
Volume at Peak Flow	105.0	ac. ft

Freeboard

Max. Flow Depth	1.5	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	2.85	ac. ft
Outflowing Sediment Volume	0.06	ac. ft
Deposited(+)/Eroded(-) Volume	2.79	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	8101	8101
Side Slope (?H:1V)	3	3
Channel Width (ft)	187	187
Channel XS Area (sq. ft)	887	887
Channel Perimeter (ft)	189	189

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	8101	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	2700	sq. Yd
Volume	8101	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	8101	8101
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	37805	78310
Left Levee Volume (cu. Yd)	37205	87611
Right Levee Length (ft)	8101	8101
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	37805	78310
Right Levee Volume (cu. Yd)	37205	87611
Total Levee Surface Area (sq. Yd)	75610	156620
Total Levee Volume (cu. Yd)	74410	175222

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	8101	8101
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	12602	29704
Left Levee Lining Volume (cu. Yd)	6301	14852
Right Levee Length (ft)	8101	8101
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	12602	29704
Right Levee Lining Volume (cu. Yd)	6301	14852
Total Lining Area (sq. Yd)	25203	59407
Total Lining Volume (cu. Yd)	12602	29704

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	187	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	7.3	ft	
Structure Height	10.3	ft	
Number of Structures	22		
Volume per structure	214	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 16,050		
Area per structure	62	sq. Yd	
Total Area	1,371	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	3	
Total Volume per Basin	7115	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 28,460	
Other Cost	$ -	
Total cost per basin	$ 28,460	
Area per basin	7,651	sq. Yd
Total Area	22,953	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	74,410	cu. Yd	$ 7.00	$ 520,870	75,610	sq. Yd	$ 9.00	$ 680,490	75,610	sq. Yd	$ 11.67	$ 882,117
Levee - LC Enhancement	Fill	100,812	cu. Yd	$ 7.00	$ 705,684	81,010	sq. Yd	$ 9.00	$ 729,090	100,812	sq. Yd	$ 11.67	$ 1,176,140
Levee Lining	Riprap	12,602	cu. Yd	$ 75.00	$ 945,150	25,203	sq. Yd	$ -	$ -	25,203	sq. Yd	$ 20.83	$ 525,065
Levee Lining -LC Enhancement	Riprap	17,102	cu. Yd	$ 75.00	$ 1,282,650	34,204	sq. Yd	$ -	$ -	34,204	sq. Yd	$ 20.83	$ 712,588
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	8,101	cu. Yd	$ 75.00	$ 607,575	2,700	sq. Yd	$ -	$ -	2,700	sq. Yd	$ 25.00	$ 67,500
Drop Structures	Riprap	22	EA	$ 16,050.00	$ 353,100	1,371	sq. Yd	$ -	$ -	1,371	sq. Yd	$ 33.33	$ 45,700
Drop Str. - LC Enhancement	Riprap	22	EA	$ 1,605.00	$ 35,310	137	sq. Yd	$ -	$ -	137	sq. Yd	$ 33.33	$ 4,570
Sedimentation Basins		3	EA	$ 28,460.00	$ 85,380	22,953	sq. Yd	$ -	$ -	22,953	sq. Yd	$ 8.33	$ 191,275
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 680,490	Base Maintenance Cost			$ 1,711,656
						LC Enhancement Cost			$ 729,090	LC Enhancement Cost			$ 1,893,298
						Total Landscape Cost			$ 1,409,580	Total Maintenance Cost			$ 3,604,954

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 2,512,075	$ 2,023,644	$ 4,535,719
Contingency Cost (25% of Construction Cost)	$ 628,019	$ 505,911	$ 1,133,930
Engineering Design Cost (5% of Construction Cost)	$ 125,604	$ 101,182	$ 226,786
Total Construction Cost	$ 3,265,698	$ 2,630,737	$ 5,896,435

Land Cost

Channel Length	8101 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	187	34.8	$100,000	$ 3,480,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	10.2	$100,000	$ 1,020,000
Levee LC Enhancement	51	9.5	$100,000	$ 950,000
Other	0	0	$100,000	$ -
Total	293	54.5		$ 5,450,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	45	$100,000	$ 4,500,000
LC Enhancement Cost	acre	9.5	$100,000	$ 950,000
Total Land Cost	acre	54.5	$100,000	$ 5,450,000

Total Cost

Base Total Cost	$ 10,157,844
Total Landscape Enhancement Cost	$ 6,203,125
Total Cost Including LC Enh.	$ 16,360,969

Online Basin

HEC1 ID	RRP1A

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.5	sq. mi
Total Sediment Yield Volume	1.0	ac ft

Required Minimum Sediment Volume

Sediment Volume	1.0	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.0222	0.0222
Basin Length (ft)	700	860
Basin Width (ft)	360	360
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	8	8
Freeboard (ft)	1	1
Effective Basin Width (ft)	336	312
Top Area (acres)	5.8	7.1
U/S-D/S Height Difference (ft)	8.0	8.0
Excess Area on Upstream (acres)	0.4	1.0

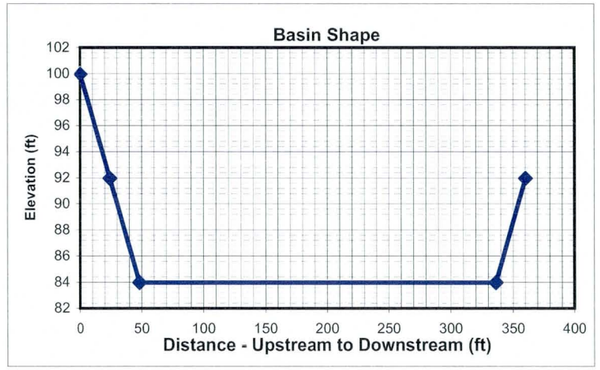
			Base	LC Enhanced
Bottom Length (ft)	652	Allocated Storage Volume (ac. ft)	33.4	33.5
Bottom Width (ft)	288	Total Available Volume (ac. ft) (incl. Freeboard)	38.8	39.5
		Total Excavation Volume (ac. ft)	61.9	67.9

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	3.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	2	3	4	5	6	7	8	10
Volume	0.00	4.38	8.88	13.52	18.30	23.21	28.25	33.44	38.77	49.86
Outflow	0.0	34.0	48.1	59.0	68.1	76.1	83.4	90.0	96.3	107.6



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	44.0	41	44.0
Peak Inflow (cfs)	575	441	575.0
Peak Outflow (cfs)	87	77	87.0
Stage at Peak Outflow (ft)	6.6	5.1	6.6
Volume at Peak Outflow (ac. ft)	31.2	23.93	31.2

Volume Check

Total Volume needed	32.2	ac. ft
Total Volume Provided	33.4	ac. ft

Volume OK?	Yes

Stage Check

Depth Needed	7.6	ft
Depth Provided	8	ft

Depth OK?	Yes

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	189600	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	700	ft
Base Total ROW Width	360	ft
LC Enh. Total ROW Length	960	ft
LC Enh. Total ROW Length	460	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	99865	109545
Excavated Area (sq. Yd)	28000	49067

Inlet			***Outlet***		
Inlet Type	Riprap		Outlet Type	Pipe	
(Riprap, Concrete)			(None, Riprap Weir, Concrete Weir, Pipe)		
			Pipe Length	465	ft
Inlet Length	51	ft	Unit Cost	160	per ft
Inlet Width	100	ft	Cost per outlet	$74,400	
Material Thickness	1.5	ft	Other Cost	$ -	
Inlet Area	562	sq. Yd	Total Cost	$74,400	
Material Volume	281	cu. Yd	Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance				
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		99,865	cu. Yd	$ 4.00	$ 399,460	28,000	sq. Yd	$ 9.00	$ 252,000	28,000	sq. Yd	$ 8.33	$ 233,333
Basin - LC Enhancement		9,680	cu. Yd	$ 4.00	$ 38,720	21,067	sq. Yd	$ 9.00	$ 189,603	21,067	sq. Yd	$ 8.33	$ 175,558
Inlet	Riprap	281	sq. Yd	$ 75.00	$ 21,075	562	sq. Yd	$ -	$ -	562	sq. Yd	$ 33.33	$ 18,733
Inlet - LC Enhancement (20%Inlet)					$ 4,215				$ -				$ 3,747
Outlet	Pipe	1	EA	$ 74,400	$ 74,400	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 3,720				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 252,000	Base Maintenance Cost			$ 254,283
						LC Enh. Landscape Cost			$ 189,603	LC Enh. Maintenance Cost			$ 179,416
						Total Landscape Cost			$ 441,603	Total Maintenance Cost			$ 433,699

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 494,935	$ 38,720	$ 533,655
Contingency Cost (25% of Construction Cost)	$ 123,734	$ 9,680	$ 133,414
Engineering Design Cost (5% of Construction Cost)	$ 24,747	$ 1,936	$ 26,683
Total Construction Cost	$ 643,416	$ 50,336	$ 693,752

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	4.4	$100,000	$ 440,000
Basin	5.8	$100,000	$ 580,000
Other		$100,000	$ -
Total	10.2	$100,000	$ 1,020,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	5.8	$100,000	$ 580,000
LC Enhancement Cost	acre	4.4	$100,000	$ 440,000
Total Land Cost	acre	10.2	$100,000	$ 1,020,000

Total Cost

Base Total Cost	$ 1,729,699
Total LC Enhancement Cost	$ 859,355
Total Cost Including LC Enh.	$ 2,589,054

Open Channel

Structure ID	N130

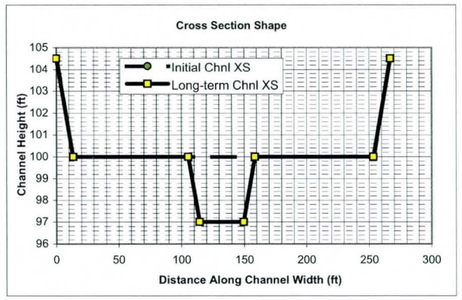
HEC1 ID	P1A-1B

Longitundal Geometry

Length	10853.3	ft
U/S Elev	1276.4	ft
D/S Elev	1133.0	ft
Initial Channel Slope	0.0132	ft/ft
Long-term Channel Slope	0.0050	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	11



Initial Channel XS Geometry

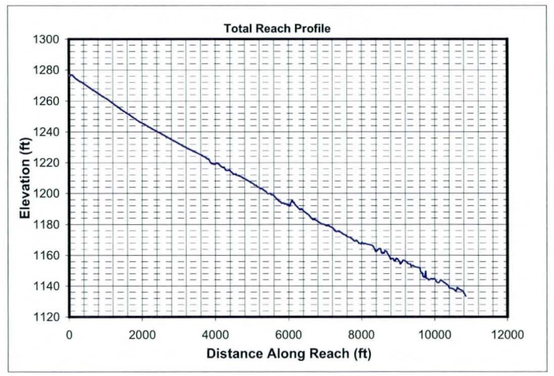
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	240	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	253.5	253.5	253.5	267
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	92	3	35	7.5	3	95	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	105.5	114.5	149.5	158.5	253.5	267
Y	104.5	100	100	97	97	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	P1A-1B	P1B								TOTAL
HEC1 Peak-Flow	851	852								1703
Weighting Factor	1.00	0.64								
Flow into Channel	851	543								1394

Reach Sediment Inflow Characteristics

U/S Contributing ID	N1-P1A_N125	P1A-1B_RRP1A10								TOTAL
Flow Volume (ac. ft)	105.00	245.00								350
Sediment Conc. (ppm)	1614	2874								
Sediment Volume (ac. ft)	0.06	0.27								0.33
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.06	0.27								0.33

Hydrology

Drainage Area	4.428	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	1394	cfs	
Long-term Max. Chnl Capacity	8389	cfs	
Q2 Channel	139	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	267	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
139	242.0	78.0	0.3	100.0	100.3	1.8	0.3	241.9	0.3	0.10	0.55
418	244.0	151.1	0.6	100.0	100.6	2.8	0.6	243.7	0.6	0.19	0.62
1046	246.8	263.2	1.1	100.0	101.1	4.0	1.1	246.5	1.1	0.34	0.68
1394	248.1	313.4	1.3	100.0	101.3	4.4	1.3	247.7	1.3	0.40	0.70

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
139	43.5	52.5	1.2	97.0	98.3	2.7	1.3	43.1	1.2	0.42	0.42
418	51.1	108.2	2.1	97.0	99.5	3.9	2.5	50.2	2.2	0.79	0.46
1046	246.7	352.2	1.4	97.0	100.9	3.0	3.9	245.4	1.4	1.22	0.44
1394	248.4	419.7	1.7	97.0	101.2	3.3	4.2	247.1	1.7	1.30	0.45

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
	N1-P1A_N125	P1A-1B_RRP1A10								
139	390	41								431
418	1585	154								1738
1046	3577	471								4048
1394	5253	674								5927

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
139	1.74	1.0463	0.9940	Erosive	Erosive	Erosive	0.2	Stable	5.0	Stable	Stable
418	1.74	1.2480	1.1856	Erosive	Erosive	Erosive	0.3	Stable	7.6	Stable	Stable
1046	1.74	1.4156	1.3448	Erosive	Erosive	Erosive	0.3	Stable	8.8	Stable	Stable
1394	1.74	1.4680	1.3946	Erosive	Erosive	Erosive	0.3	Stable	9.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	139	418	1046	1394	139	418	1046	1394	139	418	1046	1394
Bray - Equation #1	32	57	93	108	1.4	2.0	2.7	3.0	3.2	3.7	4.2	4.4
Bray - Equation #2	42	75	122	142	1.5	2.2	2.9	3.2	2.2	2.5	2.9	3.0
Hey	9	18	30	35	4.2	6.4	9.0	10.1				
Ackers & Charlton/Lacey	29	45	67	75					1.8	2.2	2.6	2.7
Parker	81	140	222	256	1.1	1.7	2.5	2.8				
Chang	53	103	180	215	0.2	0.0	-0.3	-0.4				
Kellerhals	21	37	58	67	2.0	3.0	4.4	4.9	3.3	3.7	4.1	4.2
AMAFCA/Schumm	43	50	246	247								
Moody & Odem	22	22	22	22	1.2	1.2	1.2	1.2				
BUREC	16.9	25.5	36.0	40.1	5	7	10	11	2.9	3.8	4.7	5.1
Average	35	57	108	121	2.0	2.9	4.0	4.4	2.7	3.2	3.7	3.9
Values As Designed	43	50	245	247	1.3	2.5	3.9	4.2	2.7	3.9	3.0	3.3
Difference with Design	-8	7	-138	-126	0.7	0.4	0.1	0.2	0.0	-0.7	0.7	0.5

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
139	872	566	1140	1515	3240	226	222	122	3535	263	907	1146
418	4772	2435	4577	9756	5302	1425	1033	960	11520	1177	5323	4389
1046	19539	7265	12225	45948	7597	5282	2856	3868	29488	4390	20050	14410
1394	30398	10103	15812	74667	8455	7876	3846	5807	39471	6674	29868	21180

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
139	2320	1506	3035	4031	8624	602	591	324	9408	699	2413	3050
418	4233	2160	4061	8655	4704	1264	916	851	10220	1044	4723	3894
1046	6933	2578	4338	16305	2696	1874	1013	1372	10464	1558	7115	5113
1394	8090	2689	4208	19872	2250	2096	1024	1545	10505	1776	7949	5637

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
139	575	294	458	1018	761	114	95	134	860	122	679	464
418	2860	1111	1531	5908	1309	549	345	680	2707	588	3278	1897
1046	5055	2291	3629	9260	4872	1012	782	1212	6575	1049	5976	3792
1394	7857	3305	4927	15030	5507	1557	1108	1896	8895	1612	9211	5537

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
139	1529	782	1220	2709	2025	304	253	357	2289	325	1807	1236
418	2537	985	1359	5241	1161	487	306	603	2402	521	2908	1683
1046	1794	813	1288	3286	1729	359	278	430	2333	372	2121	1346
1394	2091	880	1311	4000	1466	414	295	505	2367	429	2451	1474

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
139	0.0026	0.0038	121	0.37	0.046	0.0008	29	0.035	0.0006	0.0159	0.0008	0.0019	0.0067	0.0004	0.0028	0.0132	0.0056
418	0.0012	0.0020	168	0.51	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0010	0.0067	0.0002	0.0012	0.0132	0.0053
1046	0.0006	0.0011	221	0.67	0.051	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0067	0.0002	0.0006	0.0132	0.0052
1394	0.0005	0.0010	241	0.73	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0067	0.0001	0.0005	0.0132	0.0051

Drop Structures

Design Slope	0.0050	ft/ft
Total Drop Needed	89.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	30	
Distance between structs.	362	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.40	sq. mi
Total Sediment Yield Volume	2.66	ac ft

Sedimentation Basins

Length	362 ft	Depth	3 ft
Width	267 ft	Side slope	3 ft/ft
Total Volume per Basin		6.27	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
139	1.1	-0.4	0.1	24.6	1.3	1.2	2.7	0.0050	0.1	1.5	1.0	3.5
418	1.1	-0.7	0.2	24.6	2.5	2.2	3.9	0.0050	0.3	1.5	1.0	3.8
1046	1.1	-1.2	0.1	24.6	3.9	1.4	3.0	0.0050	0.4	1.5	1.0	3.9
1394	1.1	-1.2	0.2	24.6	4.2	1.7	3.3	0.0050	0.5	1.5	1.0	3.9

Toe Protection Needed	4.0	ft

HEC1 Results For Open Channel

Peak Flow	851	cfs
Stage at Peak Flow	101.0	ft
Volume at Peak Flow	245.0	ac. ft

Freeboard

Max. Flow Depth	1.3	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.2	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	2.99	ac. ft
Outflowing Sediment Volume	0.16	ac. ft
Deposited(+)/Eroded(-) Volume	2.83	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	10853	10853
Side Slope (?H:1V)	3	3
Channel Width (ft)	267	267
Channel XS Area (sq. ft)	1272.8	1272.8
Channel Perimeter (ft)	269	269

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	10853	ft
Thickness	1.5	ft
Protection Depth	4	ft
Tie-in Length/Depth	3.0	ft
Total Depth	7.0	ft
Area needed	3618	sq. Yd
Volume	8441	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	10853	10853
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	50647	104912
Left Levee Volume (cu. Yd)	49843	117373
Right Levee Length (ft)	10853	10853
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	50647	104912
Right Levee Volume (cu. Yd)	49843	117373
Total Levee Surface Area (sq. Yd)	101294	209824
Total Levee Volume (cu. Yd)	99686	234746

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	10853	10853
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	16882	39794
Left Levee Lining Volume (cu. Yd)	8441	19897
Right Levee Length (ft)	10853	10853
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	16882	39794
Right Levee Lining Volume (cu. Yd)	8441	19897
Total Lining Area (sq. Yd)	33765	79589
Total Lining Volume (cu. Yd)	16882	39794

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	267	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	6.3	ft	
Structure Height	9.3	ft	
Number of Structures	30		
Volume per structure	277	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 20,775		
Area per structure	89	sq. Yd	
Total Area	2,670	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	10116	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 40,464	
Other Cost	$ -	
Total cost per basin	$ 40,464	
Area per basin	10,733	sq. Yd
Total Area	21,466	sq. Yd

Structure Type	Structure Cost											
	Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	99,686	cu. Yd	$ 7.00	$ 697,802	101,294	sq. Yd	$ 9.00	$ 911,646	101,294	sq. Yd	$ 11.67	$ 1,181,763
Levee - LC Enhancement	Fill	135,060	cu. Yd	$ 7.00	$ 945,420	108,530	sq. Yd	$ 9.00	$ 976,770	135,060	sq. Yd	$ 11.67	$ 1,575,700
Levee Lining	Riprap	16,882	cu. Yd	$ 75.00	$ 1,266,150	33,765	sq. Yd	$ -	$ -	33,765	sq. Yd	$ 20.83	$ 703,435
Levee Lining -LC Enhancement	Riprap	22,912	cu. Yd	$ 75.00	$ 1,718,400	45,824	sq. Yd	$ -	$ -	45,824	sq. Yd	$ 20.83	$ 954,662
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	8,441	cu. Yd	$ 75.00	$ 633,075	3,618	sq. Yd	$ -	$ -	3,618	sq. Yd	$ 25.00	$ 90,450
Drop Structures	Riprap	30	EA	$ 20,775.00	$ 623,250	2,670	sq. Yd	$ -	$ -	2,670	sq. Yd	$ 33.33	$ 89,000
Drop Str. - LC Enhancement	Riprap	30	EA	$ 2,077.50	$ 62,325	267	sq. Yd	$ -	$ -	267	sq. Yd	$ 33.33	$ 8,900
Sedimentation Basins		2	EA	$ 40,464.00	$ 80,928	21,466	sq. Yd	$ -	$ -	21,466	sq. Yd	$ 8.33	$ 178,883
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 911,646	Base Maintenance Cost			$ 2,243,532
						LC Enhancement Cost			$ 976,770	LC Enhancement Cost			$ 2,539,262
						Total Landscape Cost			$ 1,888,416	Total Maintenance Cost			$ 4,782,794

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,301,205	$ 2,726,145	$ 6,027,350
Contingency Cost (25% of Construction Cost)	$ 825,301	$ 681,536	$ 1,506,838
Engineering Design Cost (5% of Construction Cost)	$ 165,060	$ 136,307	$ 301,368
Total Construction Cost	$ 4,291,567	$ 3,543,989	$ 7,835,555

Land Cost

Channel Length	10853 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	267	66.5	$100,000	$ 6,650,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	13.7	$100,000	$ 1,370,000
Levee LC Enhancement	51	12.7	$100,000	$ 1,270,000
Other	0	0	$100,000	$ -
Total	373	92.9		$ 9,290,000

Total Cost

Base Total Cost	$ 15,466,744
Total Landscape Enhancement Cost	$ 8,330,021
Total Cost Including LC Enh.	$ 23,796,765

Right of Way

Preservation Corridor Width	0 ft
Maintenance Access	0 ft
Landscape Enhancement Buffer	0 ft
Other	0 ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	80.2	$100,000	$ 8,020,000
LC Enhancement Cost	acre	12.7	$100,000	$ 1,270,000
Total Land Cost	acre	92.9	$100,000	$ 9,290,000

Open Channel

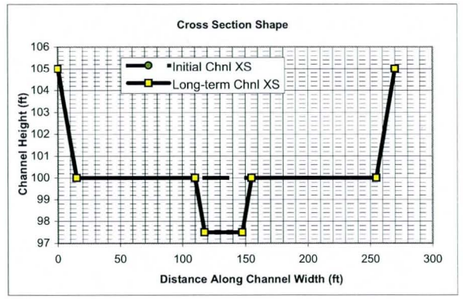
Structure ID	N140	HEC1 ID	P1A-1B

Longitundal Geometry

Length	5668.0	ft
U/S Elev	1133.0	ft
D/S Elev	1092.0	ft
Initial Channel Slope	0.0072	ft/ft
Long-term Channel Slope	0.0040	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	11



Initial Channel XS Geometry

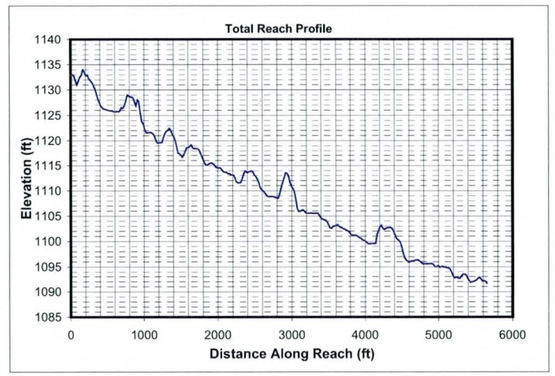
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	240	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	255	255	255	270
Y	105	100	100	100	100	100	100	105

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	95	3	30	7.5	3	100	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	110	117.5	147.5	155	255	270
Y	105	100	100	97.5	97.5	100	100	105



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	P								TOTAL
HEC1 Peak-Flow	1467								1467
Weighting Factor	1.00								
Flow into Channel	1467								1467

Reach Sediment Inflow Characteristics

U/S Contributing ID	P1A-1B_N130	Q1A-P_P1B10							TOTAL
Flow Volume (ac. ft)	245.00	97.00							342
Sediment Conc. (ppm)	1683	1891							
Sediment Volume (ac. ft)	0.16	0.07							0.22
Weighting Factor	1	1							
Weighted Sed. Vol. (ac. ft)	0.16	0.07							0.22

Hydrology

Drainage Area		sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	1467	cfs	
Long-term Max. Chnl Capacity	8408	cfs	
Q2 Channel	147	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	270	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (ib/sq. ft)	Froude Number
147	242.5	96.5	0.4	100.0	100.4	1.5	0.4	242.4	0.4	0.10	0.42
440	244.9	187.1	0.8	100.0	100.8	2.4	0.8	244.6	0.8	0.19	0.47
1100	248.5	326.1	1.3	100.0	101.3	3.4	1.3	248.0	1.3	0.33	0.52
1467	250.0	388.6	1.6	100.0	101.6	3.8	1.6	249.5	1.6	0.40	0.53

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
147	40.2	56.1	1.4	97.5	99.1	2.6	1.6	39.7	1.4	0.40	0.39
440	244.2	223.1	0.9	97.5	100.5	2.0	3.0	243.2	0.9	0.76	0.36
1100	248.5	389.4	1.6	97.5	101.2	2.8	3.7	247.3	1.6	0.93	0.40
1467	250.4	464.2	1.9	97.5	101.5	3.2	4.0	249.1	1.9	1.00	0.41

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
	P1A-1B_N130	Q1A-P_P1B10								
147	464	112								576
440	1897	333								2230
1100	3792	1064								4856
1467	5537	1544								7081

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
147	1.74	1.1114	1.0558	Erosive	Erosive	Erosive	0.2	Stable	5.0	Stable	Stable
440	1.74	1.3128	1.2471	Erosive	Erosive	Erosive	0.3	Stable	6.4	Stable	Stable
1100	1.74	1.4799	1.4059	Erosive	Erosive	Erosive	0.3	Stable	7.8	Stable	Stable
1467	1.74	1.5320	1.4554	Erosive	Erosive	Erosive	0.4	Stable	8.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	147	440	1100	1467	147	440	1100	1467	147	440	1100	1467
Bray - Equation #1	33	59	95	111	1.4	2.0	2.7	3.0	3.2	3.7	4.2	4.4
Bray - Equation #2	43	77	125	146	1.5	2.2	3.0	3.3	2.2	2.5	2.9	3.0
Hey	10	18	31	36	4.3	6.5	9.2	10.3				
Ackers & Charlton/Lacey	29	46	68	77					1.8	2.2	2.6	2.7
Parker	83	144	228	263	1.1	1.7	2.5	2.9				
Chang	50	99	173	206	0.2	0.1	-0.1	-0.3				
Kellerhals	22	38	60	69	2.0	3.1	4.5	5.0	3.4	3.7	4.1	4.2
AMAFCA/Schumm	40	244	248	249								
Moody & Odem	0	0	0	0	0.0	0.0	0.0	0.0				
BUREC	18.0	27.2	38.3	42.6	5	7	10	11	2.7	3.5	4.4	4.7
Average	33	75	107	120	1.9	2.9	4.0	4.5	2.7	3.1	3.6	3.8
Values As Designed	40	243	247	249	1.6	3.0	3.7	4.0	2.6	2.0	2.8	3.2
Difference with Design	-7	-168	-141	-129	0.3	-0.2	0.3	0.4	0.0	1.2	0.8	0.7

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
147	408	241	330	609	2301	34	52	42	1283	111	374	526
440	2227	1236	2112	3915	4015	507	442	455	4674	513	2557	2059
1100	9112	3962	6124	18405	5954	2073	1395	2045	12308	1956	10371	6700
1467	14167	5596	8467	29885	6680	3127	1923	3138	16550	2998	15745	9843

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
147	1031	610	834	1539	5818	86	131	105	3244	282	945	1330
440	1878	1042	1781	3300	3385	428	372	384	3940	432	2156	1736
1100	3072	1336	2065	6206	2008	699	470	690	4150	660	3497	2259
1467	3583	1415	2141	7558	1689	791	486	794	4185	758	3982	2489

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
147	475	243	352	813	663	85	73	116	638	98	565	375
440	980	516	715	1482	2875	130	140	191	1723	209	1073	912
1100	4001	1886	2875	6953	4473	726	596	996	4865	806	4775	2996
1467	6217	2741	3939	11280	5078	1132	859	1571	6612	1239	7412	4371

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
147	1201	615	891	2057	1676	214	184	293	1614	247	1428	947
440	826	435	603	1249	2423	110	118	161	1452	176	904	769
1100	1349	636	969	2345	1508	245	201	336	1641	272	1610	1010
1467	1572	693	996	2853	1284	286	217	397	1672	313	1875	1105

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
147	0.0025	0.0030	100	0.30	0.044	0.0006	29	0.035	0.0005	0.0159	0.0006	0.0017	0.0066	0.0004	0.0028	0.0072	0.0040
440	0.0011	0.0016	138	0.42	0.047	0.0003	30	0.036	0.0002	0.0159	0.0003	0.0008	0.0066	0.0002	0.0012	0.0072	0.0037
1100	0.0006	0.0009	181	0.55	0.050	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0005	0.0066	0.0002	0.0006	0.0072	0.0036
1467	0.0005	0.0008	197	0.60	0.050	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0066	0.0001	0.0005	0.0072	0.0036

Drop Structures

Design Slope	0.0040	ft/ft
Total Drop Needed	18.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	7	
Distance between structs.	810	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	2.00	sq. mi
Total Sediment Yield Volume	3.80	ac ft

Sedimentation Basins

Length	810 ft	Depth	3 ft
Width	270 ft	Side slope	3 ft/ft
Total Volume per Basin		14.39	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
147	1.1	-0.5	0.1	24.6	1.6	1.4	2.6	0.0040	0.2	1.5	2.5	5.5
440	1.1	-1.1	0.1	24.6	3.0	0.9	2.0	0.0040	0.3	1.5	2.5	5.6
1100	1.1	-1.2	0.1	24.6	3.7	1.6	2.8	0.0040	0.4	1.5	2.5	5.8
1467	1.1	-1.2	0.1	24.6	4.0	1.9	3.2	0.0040	0.4	1.5	2.5	5.9

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	851	cfs
Stage at Peak Flow	101.0	ft
Volume at Peak Flow	245.0	ac. ft

Freeboard

Max. Flow Depth	1.6	ft
Channel Depth as designed	5.0	ft
Available Freeboard	3.4	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	4.02	ac. ft
Outflowing Sediment Volume	0.10	ac. ft
Deposited(+)/Eroded(-) Volume	3.92	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5668	5668
Side Slope (?H:1V)	3	3
Channel Width (ft)	270	270
Channel XS Area (sq. ft)	1368.8	1368.8
Channel Perimeter (ft)	272	272

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5668	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1889	sq. Yd
Volume	5668	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5668	5668
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	5	6
Left Levee Surface Area (sq. Yd)	28970	58569
Left Levee Volume (cu. Yd)	30439	70535
Right Levee Length (ft)	5668	5668
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5	6
Right Levee Surface Area (sq. Yd)	28970	58569
Right Levee Volume (cu. Yd)	30439	70535
Total Levee Surface Area (sq. Yd)	57940	117138
Total Levee Volume (cu. Yd)	60878	141070

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5668	5668
Left Levee Lining Width (ft)	16	36
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	10076	22672
Left Levee Lining Volume (cu. Yd)	5038	11336
Right Levee Length (ft)	5668	5668
Right Levee Lining Width (ft)	16	36
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	10076	22672
Right Levee Lining Volume (cu. Yd)	5038	11336
Total Lining Area (sq. Yd)	20153	45344
Total Lining Volume (cu. Yd)	10076	22672

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	270	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	6.5	ft
Structure Height	9.5	ft
Number of Structures	7	
Volume per structure	285	cu. Yd
Unit Cost	$ 75.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 21,375	
Area per structure	90	sq. Yd
Total Area	630	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	23216	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 92,864	
Other Cost	$ -	
Total cost per basin	$ 92,864	
Area per basin	24,291	sq. Yd
Total Area	24,291	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	60,878	cu. Yd	$ 7.00	$ 426,146	57,940	sq. Yd	$ 9.00	$ 521,460	57,940	sq. Yd	$ 11.67	$ 675,967
Levee - LC Enhancement	Fill	80,192	cu. Yd	$ 7.00	$ 561,344	59,198	sq. Yd	$ 9.00	$ 532,782	80,192	sq. Yd	$ 11.67	$ 935,573
Levee Lining	Riprap	10,076	cu. Yd	$ 75.00	$ 755,700	20,153	sq. Yd	$ -	$ -	20,153	sq. Yd	$ 20.83	$ 419,852
Levee Lining -LC Enhancement	Riprap	12,596	cu. Yd	$ 75.00	$ 944,700	25,191	sq. Yd	$ -	$ -	25,191	sq. Yd	$ 20.83	$ 524,815
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	5,668	cu. Yd	$ 75.00	$ 425,100	1,889	sq. Yd	$ -	$ -	1,889	sq. Yd	$ 25.00	$ 47,225
Drop Structures	Riprap	7	EA	$ 21,375.00	$ 149,625	630	sq. Yd	$ -	$ -	630	sq. Yd	$ 33.33	$ 21,000
Drop Str. - LC Enhancement	Riprap	7	EA	$ 2,137.50	$ 14,963	63	sq. Yd	$ -	$ -	63	sq. Yd	$ 33.33	$ 2,100
Sedimentation Basins		1	EA	$ 92,864.00	$ 92,864	24,291	sq. Yd	$ -	$ -	24,291	sq. Yd	$ 8.33	$ 202,425
Other					$ -				$ -				$ -

Base Landscape Cost	$ 521,460	Base Maintenance Cost	$ 1,366,469
LC Enhancement Cost	$ 532,782	LC Enhancement Cost	$ 1,462,488
Total Landscape Cost	$ 1,054,242	Total Maintenance Cost	$ 2,828,957

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,849,435	$ 1,521,007	$ 3,370,442
Contingency Cost (25% of Construction Cost)	$ 462,359	$ 380,252	$ 842,610
Engineering Design Cost (5% of Construction Cost)	$ 92,472	$ 76,050	$ 168,522
Total Construction Cost	$ 2,404,266	$ 1,977,308	$ 4,381,574

Land Cost

Channel Length	5668 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	270	35.1	$100,000	$ 3,510,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	58	7.5	$100,000	$ 750,000
Levee LC Enhancement	54	7	$100,000	$ 700,000
Other	0	0	$100,000	$ -
Total	382	49.6		$ 4,960,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	42.6	$100,000	$ 4,260,000
LC Enhancement Cost	acre	7	$100,000	$ 700,000
Total Land Cost	acre	49.6	$100,000	$ 4,960,000

Total Cost

Base Total Cost	$ 8,552,194
Total Landscape Enhancement Cost	$ 4,672,579
Total Cost Including LC Enh.	$ 13,224,773

Online Basin

HEC1 ID	RRQ1A

HEC1 Results Used to Determine Sediment Volume From Upstream

Contributing HEC1 ID							Total Volume (ac. ft)
Inflow Volume (ac. ft)							0
Volume Fraction							
Weighted Volume							0
Sediment Conc. (ppm)							
Sediment Volume (ac. ft)							0.00
Weighting Factor							
Weighted Sed. Vol. (ac. ft)							0.00

Sediment Yield

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.3	sq. mi
Total Sediment Yield Volume	2.5	ac ft

Required Minimum Sediment Volume

Sediment Volume	2.5	ac. ft

Geometry	Base	LC Enhanced
Topography slope (ft/ft)	0.03	0.03
Basin Length (ft)	1000	1290
Basin Width (ft)	420	420
Side Slope (?H:1V) (ft/ft)	3	6
Total Depth (ft)	11	11
Freeboard (ft)	1	1
Effective Basin Width (ft)	382	344
Top Area (acres)	9.6	12.4
U/S-D/S Height Difference (ft)	12.6	12.6
Excess Area on Upstream (acres)	0.9	2.3

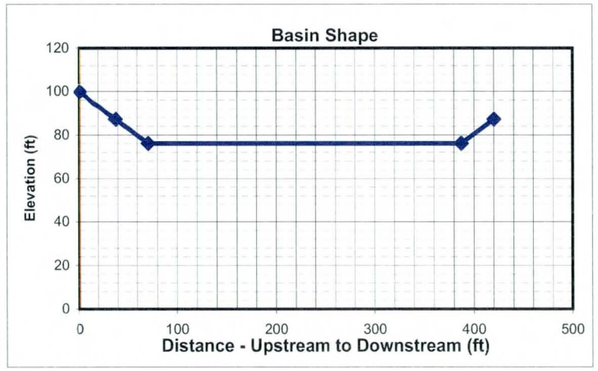
			Base	LC Enhanced
Bottom Length (ft)	934	Allocated Storage Volume (ac. ft)	76.6	76.3
Bottom Width (ft)	316	Total Available Volume (ac. ft) (incl. Freeboard)	85.3	86.3
		Total Excavation Volume (ac. ft)	146.1	164.7

Basin Outlet

Outlet Coeff	0.60	(0.6 for Orifice, 3.0 for Weir)
D (Orifice) or W (Weir)	3.00	ft
Invert Elevation	0.00	ft
Number of pipes	1	

Stage-Storage-Discharge

Elevation	0	1	3	5	7	8	9	10	11	13
Volume	0.00	6.86	21.11	36.06	51.74	59.86	68.15	76.64	85.31	103.24
Outflow	0.0	34.0	59.0	76.1	90.0	96.3	102.1	107.6	112.9	122.7



HEC1 Results

	6-hr Event	24-hr Event	Maximum
Total Flow Volume entering Basin (ac. ft)	97.0	95	97.0
Peak Inflow (cfs)	990	915	990.0
Peak Outflow (cfs)	106	100	106.0
Stage at Peak Outflow (ft)	9.7	8.7	9.7
Volume at Peak Outflow (ac. ft)	73.8	65.43	73.8

Volume Check

Total Volume needed	76.3	ac. ft
Total Volume Provided	76.6	ac. ft
Volume OK?	Yes	

Stage Check

Depth Needed	10.7	ft
Depth Provided	11	ft
Depth OK?	Yes	

Right of Way

Preservation Corridor Area		sq. ft
Maintenance Access		sq. ft
LC Enhancement Buffer	302800	sq. ft
Other		sq. ft

Additional ROW Length	0	ft
Additional ROW Width	0	ft
Landscaping Buffer Length	100	ft
Landscaping Buffer Width	100	ft

Base Total ROW Length	1000	ft
Base Total ROW Width	420	ft
LC Enh. Total ROW Length	1390	ft
LC Enh. Total ROW Length	520	ft

Cost Estimates

Storage Basin Excavation	Base	LC Enhanced
Excavation Volume (cu Yd)	235708	265716
Excavated Area (sq. Yd)	46667	80311

Inlet

Inlet Type	Riprap	
(Riprap, Concrete)		
Inlet Length	75	ft
Inlet Width	100	ft
Material Thickness	1.5	ft
Inlet Area	829	sq. Yd
Material Volume	415	cu. Yd

Outlet

Outlet Type	Pipe	
(None, Riprap Weir, Concrete Weir, Pipe)		
Pipe Length	440	ft
Unit Cost	160	per ft
Cost per outlet	$70,400	
Other Cost	$ -	
Total Cost	$70,400	
Outlet Area	133	sq. Yd

Structure Type	Structure Cost													
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Basin		235,708	cu. Yd	$ 4.00	$ 942,832	46,667	sq. Yd	$ 9.00	$ 420,003	46,667	sq. Yd	$ 8.33	$ 388,892
Basin - LC Enhancement		30,008	cu. Yd	$ 4.00	$ 120,032	33,644	sq. Yd	$ 9.00	$ 302,796	33,644	sq. Yd	$ 8.33	$ 280,367
Inlet	Riprap	415	sq. Yd	$ 75.00	$ 31,125	829	sq. Yd	$ -	$ -	829	sq. Yd	$ 33.33	$ 27,633
Inlet - LC Enhancement (20%Inlet)					$ 6,225				$ -				$ 5,527
Outlet	Pipe	1	EA	$ 70,400	$ 70,400	133	sq. Yd	$ -	$ -	133	sq. Yd	$ 16.67	$ 2,217
Outlet - LC Enhancement (5% Outlet)					$ 3,520				$ -				$ 111
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 420,003	Base Maintenance Cost			$ 418,742
						LC Enh. Landscape Cost			$ 302,796	LC Enh. Maintenance Cost			$ 286,004
						Total Landscape Cost			$ 722,799	Total Maintenance Cost			$ 704,746

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,044,357	$ 120,032	$ 1,164,389
Contingency Cost (25% of Construction Cost)	$ 261,089	$ 30,008	$ 291,097
Engineering Design Cost (5% of Construction Cost)	$ 52,218	$ 6,002	$ 58,219
Total Construction Cost	$ 1,357,664	$ 156,042	$ 1,513,706

Land Cost

Land Cost Component	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0.0	$100,000	$ -
LC Enhancement Buffer	7.0	$100,000	$ 700,000
Basin	9.6	$100,000	$ 960,000
Other		$100,000	$ -
Total	16.6	$100,000	$ 1,660,000

	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	9.6	$100,000	$ 960,000
LC Enhancement Cost	acre	7.0	$100,000	$ 700,000
Total Land Cost	acre	16.6	$100,000	$ 1,660,000

Total Cost

Base Total Cost	$ 3,156,409
Total LC Enhancement Cost	$ 1,444,842
Total Cost Including LC Enh.	$ 4,601,251

Open Channel

Structure ID	P1B10

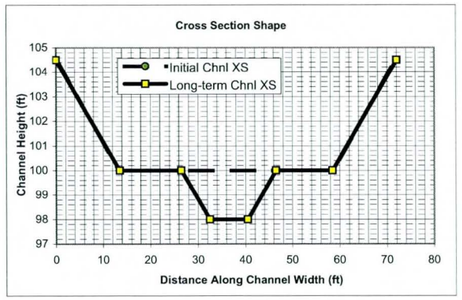
HEC1 ID	Q1A-P

Longitudal Geometry

Length	5122.9	ft
U/S Elev	1190.4	ft
D/S Elev	1133.0	ft
Initial Channel Slope	0.0112	ft/ft
Long-term Channel Slope	0.0060	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	7



Initial Channel XS Geometry

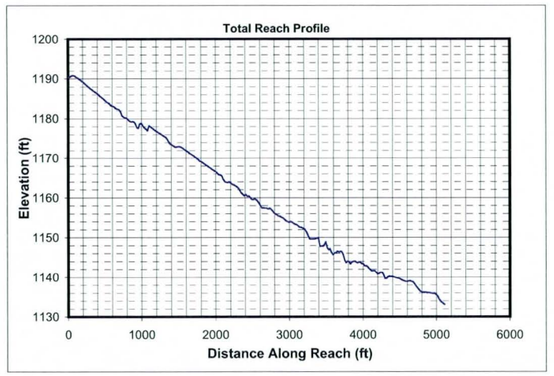
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	45	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	58.5	58.5	58.5	72
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	13	3	8	6.5	3	12	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	26.5	32.5	40.5	46.5	58.5	72
Y	104.5	100	100	98	98	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RRQ1A	P1B							TOTAL
HEC1 Peak-Flow	106	852							958
Weighting Factor	1.00	0.23							
Flow into Channel	106	197							303

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	1.384	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	303	cfs	
Long-term Max. Chnl Capacity	1860	cfs	
Q2 Channel	30	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	72	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
30	47.3	17.1	0.4	100.0	100.4	1.8	0.4	47.2	0.4	0.14	0.52
91	49.5	33.6	0.7	100.0	100.7	2.7	0.7	49.3	0.7	0.27	0.58
227	52.8	59.7	1.1	100.0	101.2	3.8	1.2	52.4	1.1	0.46	0.63
303	54.2	71.7	1.3	100.0	101.5	4.2	1.5	53.7	1.3	0.54	0.64

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
30	15.2	13.1	0.9	98.0	99.1	2.3	1.1	14.9	0.9	0.43	0.44
91	47.3	39.8	0.8	98.0	100.3	2.3	2.3	46.5	0.9	0.84	0.44
227	51.4	71.2	1.4	98.0	100.9	3.2	2.9	50.4	1.4	1.09	0.47
303	53.2	85.8	1.6	98.0	101.2	3.5	3.2	52.1	1.6	1.19	0.48

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
30										0
91										0
227										0
303										0

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
30	1.74	1.0818	1.0277	Erosive	Erosive	Erosive	0.2	Stable	4.8	Stable	Stable
91	1.74	1.2772	1.2133	Erosive	Erosive	Erosive	0.3	Stable	6.7	Stable	Stable
227	1.74	1.4359	1.3641	Erosive	Erosive	Erosive	0.3	Stable	8.3	Stable	Stable
303	1.74	1.4845	1.4103	Erosive	Erosive	Erosive	0.3	Stable	8.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	30	91	227	303	30	91	227	303	30	91	227	303
Bray - Equation #1	14	26	42	48	0.8	1.2	1.6	1.8	2.5	3.0	3.4	3.5
Bray - Equation #2	19	34	54	63	0.9	1.3	1.8	2.0	1.8	2.0	2.3	2.4
Hey	4	7	12	15	2.4	3.6	5.1	5.7				
Ackers & Charlton/Lacey	15	24	35	40					1.4	1.7	2.0	2.1
Parker	38	65	104	120	0.6	0.9	1.3	1.5				
Chang	22	43	76	90	0.2	0.1	0.0	0.0				
Kellerhals	10	17	27	31	1.1	1.7	2.4	2.7	2.9	3.2	3.5	3.6
AMAFCA/Schumm	15	47	51	52								
Moody & Odem	14	14	14	14	1.0	1.0	1.0	1.0				
BUREC	9.2	13.9	19.6	21.9	2	4	5	6	2.1	2.8	3.5	3.7
Average	16	29	43	50	1.2	1.7	2.3	2.6	2.1	2.5	2.9	3.1
Values As Designed	15	47	50	52	1.1	2.3	2.9	3.2	2.3	2.3	3.2	3.5
Difference with Design	1	-17	-7	-3	0.0	-0.6	-0.6	-0.6	-0.2	0.2	-0.3	-0.5

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
30	159	101	190	270	607	37	37	22	591	46	166	202
91	852	439	812	1698	1021	239	179	174	1942	206	965	775
227	3383	1310	2230	7720	1518	876	502	695	4987	758	3594	2507
303	5195	1820	2876	12364	1715	1298	678	1038	6679	1144	5330	3649

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
30	1951	1241	2323	3309	7431	451	454	272	7232	560	2026	2477
91	3478	1792	3314	6930	4169	975	731	710	7928	841	3937	3164
227	5523	2139	3641	12604	2479	1431	819	1134	8141	1238	5868	4092
303	6361	2229	3521	15138	2100	1589	830	1271	8177	1401	6527	4468

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
30	122	66	109	216	236	25	22	26	241	28	141	112
91	362	190	327	629	722	74	67	75	719	82	418	333
227	1423	622	978	2821	1123	306	218	332	1908	307	1663	1064
303	2177	882	1341	4493	1284	459	302	507	2569	464	2507	1544

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
30	1489	813	1340	2640	2886	308	273	313	2949	342	1726	1371
91	1479	775	1335	2567	2945	303	273	308	2936	337	1705	1360
227	2324	1016	1596	4605	1833	499	355	543	3114	501	2715	1736
303	2666	1080	1642	5501	1573	562	370	620	3145	568	3070	1891

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
30	0.0024	0.0034	118	0.36	0.046	0.0007	29	0.035	0.0005	0.0159	0.0007	0.0018	0.0112	0.0008	0.0033	0.0111	0.0062
91	0.0011	0.0018	162	0.49	0.049	0.0004	30	0.036	0.0003	0.0159	0.0004	0.0009	0.0112	0.0005	0.0015	0.0111	0.0059
227	0.0006	0.0011	210	0.64	0.051	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0005	0.0112	0.0003	0.0007	0.0111	0.0058
303	0.0005	0.0009	227	0.69	0.052	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0112	0.0003	0.0006	0.0111	0.0057

Drop Structures

Design Slope	0.0060	ft/ft
Total Drop Needed	26.7	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	569	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.45	sq. mi
Total Sediment Yield Volume	0.85	ac ft

Sedimentation Basins

Length	569 ft	Depth	3 ft
Width	72 ft	Side slope	3 ft/ft
Total Volume per Basin		2.43	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
30	1.1	-0.4	0.1	24.6	1.1	0.9	2.3	0.0060	0.1	1.5	2.0	4.7
91	1.1	-0.8	0.1	24.6	2.3	0.9	2.3	0.0060	0.2	1.5	2.0	4.9
227	1.1	-0.9	0.1	24.6	2.9	1.4	3.2	0.0060	0.3	1.5	2.0	5.0
303	1.1	-0.9	0.2	24.6	3.2	1.6	3.5	0.0060	0.3	1.5	2.0	5.1

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	106	cfs
Stage at Peak Flow	100.8	ft
Volume at Peak Flow	97.0	ac. ft

Freeboard

Max. Flow Depth	1.5	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.0	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.85	ac. ft
Outflowing Sediment Volume	0.07	ac. ft
Deposited(+)/Eroded(-) Volume	0.78	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	5123	5123
Side Slope (?H:1V)	3	3
Channel Width (ft)	72	72
Channel XS Area (sq. ft)	291.2	291.2
Channel Perimeter (ft)	74	74

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5123	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1708	sq. Yd
Volume	5123	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	5123	5123
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	23907	49522
Left Levee Volume (cu. Yd)	23528	55404
Right Levee Length (ft)	5123	5123
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	23907	49522
Right Levee Volume (cu. Yd)	23528	55404
Total Levee Surface Area (sq. Yd)	47814	99044
Total Levee Volume (cu. Yd)	47056	110808

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5123	5123
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	7969	18784
Left Levee Lining Volume (cu. Yd)	3985	9392
Right Levee Length (ft)	5123	5123
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	7969	18784
Right Levee Lining Volume (cu. Yd)	3985	9392
Total Lining Area (sq. Yd)	15938	37569
Total Lining Volume (cu. Yd)	7970	18784

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	72	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	6.4	ft	
Structure Height	9.4	ft	
Number of Structures	9		
Volume per structure	75	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 5,625		
Area per structure	24	sq. Yd	
Total Area	216	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	3920	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 15,680	
Other Cost	$ -	
Total cost per basin	$ 15,680	
Area per basin	4,554	sq. Yd
Total Area	9,108	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	47,056	cu. Yd	$ 7.00	$ 329,392	47,814	sq. Yd	$ 9.00	$ 430,326	47,814	sq. Yd	$ 11.67	$ 557,830
Levee - LC Enhancement	Fill	63,752	cu. Yd	$ 7.00	$ 446,264	51,230	sq. Yd	$ 9.00	$ 461,070	63,752	sq. Yd	$ 11.67	$ 743,773
Levee Lining	Riprap	7,970	cu. Yd	$ 75.00	$ 597,750	15,938	sq. Yd	$ -	$ -	15,938	sq. Yd	$ 20.83	$ 332,046
Levee Lining -LC Enhancement	Riprap	10,814	cu. Yd	$ 75.00	$ 811,050	21,630	sq. Yd	$ -	$ -	21,630	sq. Yd	$ 20.83	$ 450,634
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	5,123	cu. Yd	$ 75.00	$ 384,225	1,708	sq. Yd	$ -	$ -	1,708	sq. Yd	$ 25.00	$ 42,700
Drop Structures	Riprap	9	EA	$ 5,625.00	$ 50,625	216	sq. Yd	$ -	$ -	216	sq. Yd	$ 33.33	$ 7,200
Drop Str. - LC Enhancement	Riprap	9	EA	$ 562.50	$ 5,063	22	sq. Yd	$ -	$ -	22	sq. Yd	$ 33.33	$ 720
Sedimentation Basins		2	EA	$ 15,680.00	$ 31,360	9,108	sq. Yd	$ -	$ -	9,108	sq. Yd	$ 8.33	$ 75,900
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 430,326	Base Maintenance Cost			$ 1,015,676
						LC Enhancement Cost			$ 461,070	LC Enhancement Cost			$ 1,195,128
						Total Landscape Cost			$ 891,396	Total Maintenance Cost			$ 2,210,804

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 1,393,352	$ 1,262,377	$ 2,655,729
Contingency Cost (25% of Construction Cost)	$ 348,338	$ 315,594	$ 663,932
Engineering Design Cost (5% of Construction Cost)	$ 69,668	$ 63,119	$ 132,786
Total Construction Cost	$ 1,811,358	$ 1,641,089	$ 3,452,447

Land Cost

Channel Length	5123 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	72	8.5	$100,000	$ 850,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	6.5	$100,000	$ 650,000
Levee LC Enhancement	51	6	$100,000	$ 600,000
Other	0	0	$100,000	$ -
Total	178	21		$ 2,100,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	15	$100,000	$ 1,500,000
LC Enhancement Cost	acre	6	$100,000	$ 600,000
Total Land Cost	acre	21	$100,000	$ 2,100,000

Total Cost

Base Total Cost	$ 4,757,360
Total Landscape Enhancement Cost	$ 3,897,287
Total Cost Including LC Enh.	$ 8,654,647

Open Channel

Structure ID	L20

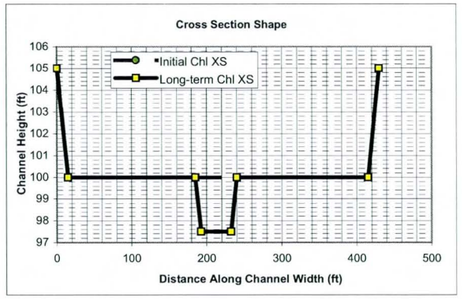
HEC1 ID	L20

Longitudnal Geometry

Length	4691.2	ft
U/S Elev	1119.1	ft
D/S Elev	1079.7	ft
Initial Channel Slope	0.0084	ft/ft
Long-term Channel Slope	0.0040	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	



Initial Channel XS Geometry

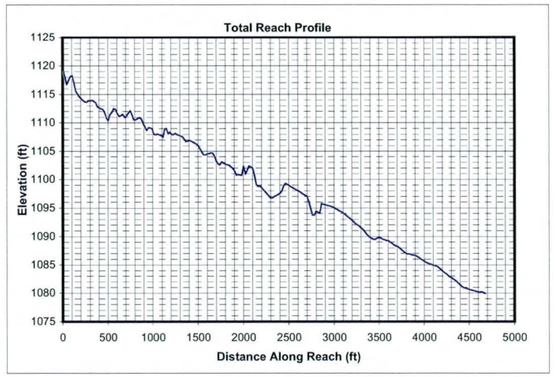
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	400	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	415	415	415	430
Y	105	100	100	100	100	100	100	105

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	170	3	40	7.5	3	175	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	185	192.5	232.5	240	415	430
Y	105	100	100	97.5	97.5	100	100	105



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	L								TOTAL
HEC1 Peak-Flow	3021								3021
Weighting Factor	1.00								
Flow into Channel	3021								3021

Reach Sediment Inflow Characteristics

U/S Contributing ID	L2BL3_L10								TOTAL
Flow Volume (ac. ft)	557.00								557
Sediment Conc. (ppm)	1228								
Sediment Volume (ac. ft)	0.26								0.26
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.26								0.26

Hydrology

Drainage Area	16.73	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	3021	cfs	
Long-term Max. Chnl Capacity	13563	cfs	
Q2 Channel	302	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	430	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
302	402.7	174.3	0.4	100.0	100.4	1.7	0.4	402.6	0.4	0.11	0.46
906	405.3	337.6	0.8	100.0	100.8	2.7	0.8	405.0	0.8	0.21	0.52
2266	409.2	587.3	1.4	100.0	101.5	3.9	1.5	408.7	1.4	0.36	0.57
3021	410.9	699.2	1.7	100.0	101.7	4.3	1.7	410.4	1.7	0.43	0.58

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
302	53.2	96.8	1.8	97.5	99.6	3.1	2.1	52.6	1.8	0.52	0.41
906	405.6	421.7	1.0	97.5	100.8	2.1	3.3	404.5	1.0	0.81	0.37
2266	410.4	734.2	1.8	97.5	101.5	3.1	4.0	409.1	1.8	1.00	0.41
3021	412.6	874.4	2.1	97.5	101.9	3.5	4.4	411.2	2.1	1.09	0.42

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
	L2BL3_L10									
302	984									984
906	2220									2220
2266	7358									7358
3021	10823									10823

Allowable Velocity

Channel Lining	Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
302	1.74	1.1373	1.0804	Erosive	Erosive	Erosive	0.2	Stable	6.0	Stable	Stable
906	1.74	1.3393	1.2723	Erosive	Erosive	Erosive	0.3	Stable	6.8	Stable	Stable
2266	1.74	1.5072	1.4319	Erosive	Erosive	Erosive	0.4	Stable	8.3	Stable	Stable
3021	1.74	1.5598	1.4818	Erosive	Erosive	Erosive	0.4	Stable	8.9	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	302	906	2266	3021	302	906	2266	3021	302	906	2266	3021
Bray - Equation #1	48	86	140	162	1.8	2.6	3.5	3.8	3.5	4.1	4.7	4.9
Bray - Equation #2	63	113	183	214	2.0	2.8	3.8	4.2	2.4	2.8	3.2	3.3
Hey	15	27	46	53	5.6	8.6	12.1	13.5				
Ackers & Charlton/Lacey	40	63	92	104					2.1	2.5	2.9	3.0
Parker	119	207	327	378	1.5	2.3	3.4	3.9				
Chang	78	154	268	319	0.2	-0.1	-0.5	-0.7				
Kellerhals	31	54	86	99	2.7	4.1	6.0	6.7	3.6	4.0	4.4	4.5
AMAFCA/Schumm	53	405	410	412								
Moody & Odem	35	35	35	35	1.4	1.4	1.4	1.4				
BUREC	23.6	35.6	50.2	55.9	6	10	13	15	3.2	4.2	5.3	5.7
Average	51	118	164	183	2.7	3.9	5.4	6.0	3.0	3.5	4.1	4.3
Values As Designed	53	405	409	411	2.1	3.3	4.0	4.4	3.1	2.1	3.1	3.5
Difference with Design	-2	-286	-245	-228	0.6	0.7	1.4	1.6	-0.2	1.4	1.0	0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
302	1162	717	1149	1863	4714	209	225	160	3666	310	1191	1397
906	6359	3284	5758	12014	7892	1581	1237	1351	12408	1456	7322	5515
2266	26100	10082	15830	56673	11427	6043	3577	5603	32080	5600	28421	18312
3021	40634	14110	20775	92158	12742	9046	4857	8463	43009	8587	42707	27008

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
302	1428	880	1411	2288	5789	256	276	197	4502	380	1463	1716
906	2603	1344	2357	4918	3231	647	506	553	5079	596	2997	2257
2266	4274	1651	2592	9280	1871	990	586	917	5253	917	4654	2999
3021	4990	1733	2551	11318	1565	1111	596	1039	5282	1055	5245	3317

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
302	1246	574	804	2280	1063	227	173	315	1360	251	1490	889
906	2273	1186	1793	3545	5323	351	348	487	3697	465	2579	2004
2266	9320	4166	6079	16695	8123	1699	1312	2350	10174	1855	11116	6626
3021	14497	6005	8255	27128	9173	2613	1859	3656	13774	2862	17145	9724

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
302	1530	705	987	2801	1305	279	213	387	1670	308	1829	1092
906	930	485	734	1451	2179	144	142	199	1513	190	1056	820
2266	1526	682	995	2734	1330	278	215	385	1666	304	1820	1085
3021	1780	737	1014	3332	1127	321	228	449	1691	351	2105	1194

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
302	0.0022	0.0028	112	0.34	0.045	0.0006	29	0.035	0.0004	0.0159	0.0006	0.0015	0.0052	0.0003	0.0023	0.0084	0.0038
906	0.0010	0.0015	156	0.47	0.048	0.0003	30	0.036	0.0002	0.0159	0.0003	0.0007	0.0052	0.0002	0.0010	0.0084	0.0036
2266	0.0005	0.0008	204	0.62	0.051	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0004	0.0052	0.0001	0.0005	0.0084	0.0035
3021	0.0004	0.0007	222	0.68	0.052	0.0002	31	0.036	0.0001	0.0159	0.0001	0.0003	0.0052	0.0001	0.0004	0.0084	0.0035

Drop Structures

Design Slope	0.0040	ft/ft
Total Drop Needed	20.6	ft
Height of Drop Structure	3	ft
No . of Drop Structures	7	
Distance between structs.	670	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	2.77	sq. mi
Total Sediment Yield Volume	5.26	ac ft

Sedimentation Basins

Length	670 ft	Depth	3 ft
Width	430 ft	Side slope	3 ft/ft
Total Volume per Basin		19.17	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
302	1.1	-0.6	0.1	24.6	2.1	1.8	3.1	0.0040	0.2	1.5	2.5	5.6
906	1.1	-1.1	0.1	24.6	3.3	1.0	2.1	0.0040	0.3	1.5	2.5	5.7
2266	1.1	-1.2	0.1	24.6	4.0	1.8	3.1	0.0040	0.4	1.5	2.5	5.8
3021	1.1	-1.2	0.2	24.6	4.4	2.1	3.5	0.0040	0.5	1.5	2.5	5.9

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	1703	cfs
Stage at Peak Flow	0.0	ft
Volume at Peak Flow	560.0	ac. ft

Freeboard

Max. Flow Depth	1.7	ft
Channel Depth as designed	5.0	ft
Available Freeboard	3.3	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	5.52	ac. ft
Outflowing Sediment Volume	0.25	ac. ft
Deposited(+)/Eroded(-) Volume	5.26	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	4691	4691
Side Slope (?H:1V)	3	3
Channel Width (ft)	430	430
Channel XS Area (sq. ft)	2193.8	2193.8
Channel Perimeter (ft)	432	432

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	4691	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	1564	sq. Yd
Volume	4691	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	4691	4691
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	5	6
Left Levee Surface Area (sq. Yd)	23976	48474
Left Levee Volume (cu. Yd)	25192	58377
Right Levee Length (ft)	4691	4691
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	5	6
Right Levee Surface Area (sq. Yd)	23976	48474
Right Levee Volume (cu. Yd)	25192	58377
Total Levee Surface Area (sq. Yd)	47952	96948
Total Levee Volume (cu. Yd)	50384	116754

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	4691	4691
Left Levee Lining Width (ft)	16	36
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	8340	18764
Left Levee Lining Volume (cu. Yd)	4170	9382
Right Levee Length (ft)	4691	4691
Right Levee Lining Width (ft)	16	36
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	8340	18764
Right Levee Lining Volume (cu. Yd)	4170	9382
Total Lining Area (sq. Yd)	16679	37528
Total Lining Volume (cu. Yd)	8340	18764

Drop Structures			
Structure Type	Riprap		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	430	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	3	ft	
Drop Height	3	ft	
Scour Depth	7.4	ft	
Structure Height	10.4	ft	
Number of Structures	7		
Volume per structure	495	cu. Yd	
Unit Cost	$ 75.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 37,125		
Area per structure	143	sq. Yd	
Total Area	1,003	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	30928	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 123,712	
Other Cost	$ -	
Total cost per basin	$ 123,712	
Area per basin	32,019	sq. Yd
Total Area	32,019	sq. Yd

Structure Type	Structure Cost												
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	50,384	cu. Yd	$ 7.00	$ 352,688	47,952	sq. Yd	$ 9.00	$ 431,568	47,952	sq. Yd	$ 11.67	$ 559,440
Levee - LC Enhancement	Fill	66,370	cu. Yd	$ 7.00	$ 464,590	48,996	sq. Yd	$ 9.00	$ 440,964	66,370	sq. Yd	$ 11.67	$ 774,317
Levee Lining	Riprap	8,340	cu. Yd	$ 75.00	$ 625,500	16,679	sq. Yd	$ -	$ -	16,679	sq. Yd	$ 20.83	$ 347,481
Levee Lining -LC Enhancement	Riprap	10,424	cu. Yd	$ 75.00	$ 781,800	20,849	sq. Yd	$ -	$ -	20,849	sq. Yd	$ 20.83	$ 434,352
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	4,691	cu. Yd	$ 75.00	$ 351,825	1,564	sq. Yd	$ -	$ -	1,564	sq. Yd	$ 25.00	$ 39,100
Drop Structures	Riprap	7	EA	$ 37,125.00	$ 259,875	1,003	sq. Yd	$ -	$ -	1,003	sq. Yd	$ 33.33	$ 33,433
Drop Str. - LC Enhancement	Riprap	7	EA	$ 3,712.50	$ 25,988	100	sq. Yd	$ -	$ -	100	sq. Yd	$ 33.33	$ 3,343
Sedimentation Basins		1	EA	$ 123,712.00	$ 123,712	32,019	sq. Yd	$ -	$ -	32,019	sq. Yd	$ 8.33	$ 266,825
Other					$ -				$ -				$ -

Base Landscape Cost	$ 431,568	Base Maintenance Cost	$ 1,246,280
LC Enhancement Cost	$ 440,964	LC Enhancement Cost	$ 1,212,012
Total Landscape Cost	$ 872,532	Total Maintenance Cost	$ 2,458,292

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 1,713,600	$ 1,272,378	$ 2,985,978
Contingency Cost (25% of Construction Cost)	$ 428,400	$ 318,094	$ 746,494
Engineering Design Cost (5% of Construction Cost)	$ 85,680	$ 63,619	$ 149,299
Total Construction Cost	$ 2,227,680	$ 1,654,091	$ 3,881,771

Land Cost

Channel Length	4691 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	430	46.3	$100,000	$ 4,630,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	58	6.2	$100,000	$ 620,000
Levee LC Enhancement	54	5.8	$100,000	$ 580,000
Other	0	0	$100,000	$ -
Total	542	58.3		$ 5,830,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	52.5	$100,000	$ 5,250,000
LC Enhancement Cost	acre	5.8	$100,000	$ 580,000
Total Land Cost	acre	58.3	$100,000	$ 5,830,000

Total Cost

Base Total Cost	$ 9,155,528
Total Landscape Enhancement Cost	$ 3,887,067
Total Cost Including LC Enh.	$ 13,042,594

Note: Unit land cost increased to reflect existing homes in area.

Open Channel

Structure ID	RRP1A10

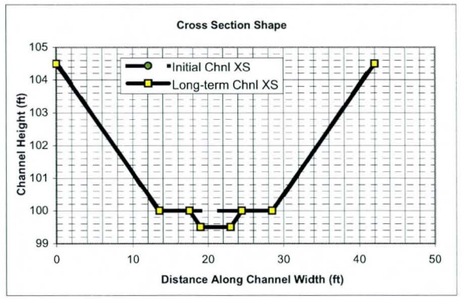
HEC1 ID	RRP1A10

Longitundal Geometry

Length	1465.1	ft
U/S Elev	1276.4	ft
D/S Elev	1305.2	ft
Initial Channel Slope	0.0196	ft/ft
Long-term Channel Slope	0.0090	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	



Initial Channel XS Geometry

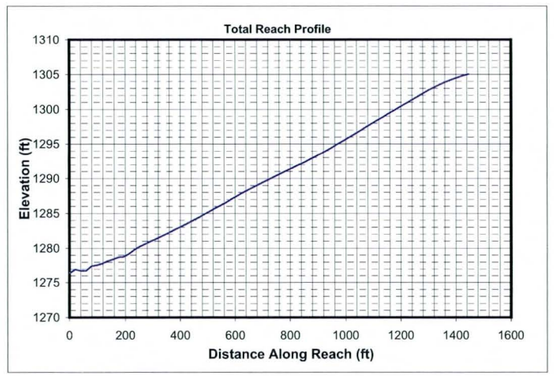
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	0	3	15	4.5	3	0	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	13.5	13.5	28.5	28.5	28.5	42
Y	104.5	100	100	100	100	100	100	104.5

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4.5	4	3	4	5	3	4	4.5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	13.5	17.5	19	23	24.5	28.5	42
Y	104.5	100	100	99.5	99.5	100	100	104.5



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.045	0.045	0.045	0.045	0.045	0.045

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	RRP1A								TOTAL
HEC1 Peak-Flow	87								87
Weighting Factor	1.00								
Flow into Channel	87								87

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	0.5	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	87	cfs	
Long-term Max. Chnl Capacity	857	cfs	
Q2 Channel	9	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	42	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (ib/sq. ft)	Froude Number
9	16.8	4.5	0.3	100.0	100.3	1.9	0.3	16.7	0.3	0.16	0.65
26	18.4	9.0	0.5	100.0	100.5	2.9	0.5	18.3	0.5	0.31	0.72
65	20.9	16.5	0.8	100.0	100.9	4.0	0.9	20.6	0.8	0.52	0.78
87	21.9	20.0	0.9	100.0	101.1	4.4	1.1	21.6	0.9	0.61	0.80

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
9	16.3	5.6	0.3	99.5	100.2	1.5	0.7	16.1	0.3	0.38	0.46
26	18.5	11.4	0.6	99.5	100.5	2.3	1.0	18.1	0.6	0.57	0.51
65	21.6	21.1	1.0	99.5	101.0	3.1	1.5	21.1	1.0	0.85	0.55
87	22.9	25.7	1.1	99.5	101.2	3.4	1.7	22.4	1.1	0.97	0.56

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
9										0
26										0
65										0
87										0

Allowable Velocity

Channel Lining: Natural - Fine Gravel

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
9	1.74	0.9917	0.9421	Erosive	Erosive	Erosive	0.2	Stable	3.9	Stable	Stable
26	1.74	1.1787	1.1198	Erosive	Erosive	Erosive	0.2	Stable	5.3	Stable	Stable
65	1.74	1.3270	1.2607	Erosive	Erosive	Erosive	0.3	Stable	6.9	Stable	Stable
87	1.74	1.3717	1.3031	Erosive	Erosive	Erosive	0.3	Stable	7.6	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	5

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	9	26	65	87	9	26	65	87	9	26	65	87
Bray - Equation #1	7	13	22	25	0.5	0.8	1.1	1.2	2.1	2.5	2.8	3.0
Bray - Equation #2	10	17	28	33	0.6	0.9	1.2	1.3	1.5	1.7	1.9	2.0
Hey	2	3	6	7	1.5	2.2	3.2	3.5				
Ackers & Charlton/Lacey	9	14	21	23					1.1	1.4	1.6	1.7
Parker	20	35	55	64	0.3	0.5	0.8	0.9				
Chang	12	23	40	48	0.1	0.1	0.0	0.0				
Kellerhals	5	9	15	17	0.6	1.0	1.4	1.6	2.5	2.8	3.1	3.2
AMAFCA/Schumm	16	18	21	22								
Moody & Odem	9	9	9	9	0.9	0.9	0.9	0.9				
BUREC	5.4	8.1	11.4	12.7	1	2	3	3	1.8	2.3	3.0	3.2
Average	10	15	23	26	0.8	1.1	1.5	1.6	1.8	2.2	2.5	2.6
Values As Designed	16	18	21	22	0.7	1.0	1.5	1.7	1.5	2.3	3.1	3.4
Difference with Design	-7	-3	2	4	0.1	0.0	-0.1	-0.1	0.3	-0.1	-0.6	-0.8

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
9	88	58	128	169	266	30	27	14	417	29	94	120
26	458	226	462	1026	445	159	105	89	1315	121	493	445
65	1757	644	1169	4479	676	550	279	331	3339	417	1723	1397
87	2663	884	1521	7065	772	805	373	486	4463	617	2508	2014

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
9	3758	2455	5473	7197	11329	1286	1140	582	17774	1241	3994	5112
26	6515	3214	6564	14585	6324	2254	1498	1271	18693	1719	7010	6332
65	9987	3659	6647	25470	3844	3128	1585	1881	18983	2374	9795	7941
87	11355	3771	6487	30127	3293	3431	1591	2072	19033	2631	10696	8590

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
9	30	17	28	48	166	4	5	3	111	9	28	41
26	154	84	160	284	304	39	33	30	388	38	175	154
65	579	263	453	1214	489	147	101	126	1013	134	661	471
87	873	368	619	1900	567	217	139	189	1361	199	981	674

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
9	1289	744	1201	2039	7086	166	210	134	4751	377	1207	1746
26	2185	1198	2277	4044	4318	547	471	424	5514	541	2489	2183
65	3291	1494	2574	6903	2779	834	576	714	5759	760	3756	2676
87	3721	1571	2641	8103	2418	925	594	808	5803	847	4182	2874

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
9	0.0028	0.0045	135	0.41	0.047	0.0009	30	0.036	0.0007	0.0159	0.0009	0.0022	0.0170	0.0014	0.0057	0.0194	0.0100
26	0.0013	0.0024	183	0.56	0.050	0.0005	31	0.036	0.0004	0.0159	0.0005	0.0012	0.0170	0.0009	0.0025	0.0194	0.0096
65	0.0007	0.0015	232	0.71	0.052	0.0004	31	0.036	0.0002	0.0159	0.0003	0.0007	0.0170	0.0006	0.0013	0.0193	0.0094
87	0.0006	0.0013	249	0.76	0.053	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0006	0.0170	0.0005	0.0010	0.0192	0.0093

Drop Structures

Design Slope	0.0090	ft/ft
Total Drop Needed	15.6	ft
Height of Drop Structure	3	ft
No . of Drop Structures	6	
Distance between structs.	244	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.00	sq. mi
Total Sediment Yield Volume	0.00	ac ft

Sedimentation Basins

Length	244 ft	Depth	3 ft
Width	42 ft	Side slope	3 ft/ft
Total Volume per Basin		0.54	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
9	1.1	-0.3	0.0	24.6	0.7	0.3	1.5	0.0090	0.1	1.5	0.5	2.7
26	1.1	-0.4	0.1	24.6	1.0	0.6	2.3	0.0090	0.1	1.5	0.5	2.8
65	1.1	-0.5	0.1	24.6	1.5	1.0	3.1	0.0090	0.2	1.5	0.5	2.9
87	1.1	-0.5	0.2	24.6	1.7	1.1	3.4	0.0090	0.2	1.5	0.5	2.9

Toe Protection Needed	3.0	ft

HEC1 Results For Open Channel

Peak Flow	87	cfs
Stage at Peak Flow	6.6	ft
Volume at Peak Flow	44.0	ac. ft

Freeboard

Max. Flow Depth	1.1	ft
Channel Depth as designed	4.5	ft
Available Freeboard	3.4	ft
Required Freeboard	3	ft

Sediment Volume

Inflowing Sediment Volume	0.00	ac. ft
Outflowing Sediment Volume	0.05	ac. ft
Deposited(+)/Eroded(-) Volume	-0.05	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Leveed	Leveed
Channel Length (ft)	1465	1465
Side Slope (?H:1V)	3	3
Channel Width (ft)	42	42
Channel XS Area (sq. ft)	131	131
Channel Perimeter (ft)	44	44

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	0	0
Excavated Area (sq. Yd)	0	0

Bank And Channel Lining	Base	LC Enhanced
Lining Type	None	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	0	0
Lining Width (ft)	0	0
Lining Thickness (ft)	0	0
Lining Area (sq. Yd)	0	0
Lining Volume (cu. Yd)	0	0

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1465	ft
Thickness	1.5	ft
Protection Depth	3	ft
Tie-in Length/Depth	3.0	ft
Total Depth	6.0	ft
Area needed	488	sq. Yd
Volume	977	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	Fill	Fill
Left Levee Length (ft)	1465	1465
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	3	6
Left Levee Height (ft)	4.5	5.5
Left Levee Surface Area (sq. Yd)	6837	14162
Left Levee Volume (cu. Yd)	6728	15844
Right Levee Length (ft)	1465	1465
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	3	6
Right Levee Height (ft)	4.5	5.5
Right Levee Surface Area (sq. Yd)	6837	14162
Right Levee Volume (cu. Yd)	6728	15844
Total Levee Surface Area (sq. Yd)	13674	28324
Total Levee Volume (cu. Yd)	13456	31688

Levee Lining	Base	LC Enhanced
Lining Type	Riprap	Riprap
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1465	1465
Left Levee Lining Width (ft)	14	33
Left Levee Lining Thickness (ft)	1.5	1.5
Left Levee Lining Area (sq. Yd)	2279	5372
Left Levee Lining Volume (cu. Yd)	1139	2686
Right Levee Length (ft)	1465	1465
Right Levee Lining Width (ft)	14	33
Right Levee Lining Thickness (ft)	1.5	1.5
Right Levee Lining Area (sq. Yd)	2279	5372
Right Levee Lining Volume (cu. Yd)	1139	2686
Total Lining Area (sq. Yd)	4558	10743
Total Lining Volume (cu. Yd)	2278	5372

Drop Structures		
Structure Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	42	ft
LC Enhancement Ratio	1.1	
Structure Thickness	3	ft
Drop Height	3	ft
Scour Depth	5.1	ft
Structure Height	8.1	ft
Number of Structures	6	
Volume per structure	38	cu. Yd
Other Cost	$ -	
Cost per structure	$ 2,850	
Area per structure	14	sq. Yd
Total Area	84	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	871	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 3,484	
Other Cost	$ -	
Total cost per basin	$ 3,484	
Area per basin	1,140	sq. Yd
Total Area	1,140	sq. Yd

Structure Type	Structure Cost											
	Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	Fill	13,456	cu. Yd	$ 7.00	$ 94,192	13,674	sq. Yd	$ 9.00	$ 123,066	13,674	sq. Yd	$ 11.67	$ 159,530
Levee - LC Enhancement	Fill	18,232	cu. Yd	$ 7.00	$ 127,624	14,650	sq. Yd	$ 9.00	$ 131,850	18,232	sq. Yd	$ 11.67	$ 212,707
Levee Lining	Riprap	2,278	cu. Yd	$ 75.00	$ 170,850	4,558	sq. Yd	$ -	$ -	4,558	sq. Yd	$ 20.83	$ 94,954
Levee Lining -LC Enhancement	Riprap	3,094	cu. Yd	$ 75.00	$ 232,050	6,186	sq. Yd	$ -	$ -	6,186	sq. Yd	$ 20.83	$ 128,866
Excavated Channel	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Exc. Chl - LC Enhancement	Leveed	0	cu. Yd	$ 10.00	$ -	0	sq. Yd	$ 9.00	$ -	0	sq. Yd	$ 8.33	$ -
Channel Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Channel Lining - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Toe Protection	Riprap	977	cu. Yd	$ 75.00	$ 73,275	488	sq. Yd	$ -	$ -	488	sq. Yd	$ 25.00	$ 12,200
Drop Structures	Riprap	6	EA	$ 2,850.00	$ 17,100	84	sq. Yd	$ -	$ -	84	sq. Yd	$ 33.33	$ 2,800
Drop Str. - LC Enhancement	Riprap	6	EA	$ 285.00	$ 1,710	8	sq. Yd	$ -	$ -	8	sq. Yd	$ 33.33	$ 280
Sedimentation Basins		1	EA	$ 3,484.00	$ 3,484	1,140	sq. Yd	$ -	$ -	1,140	sq. Yd	$ 8.33	$ 9,500
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 123,066	Base Maintenance Cost			$ 278,984
						LC Enhancement Cost			$ 131,850	LC Enhancement Cost			$ 341,852
						Total Landscape Cost			$ 254,916	Total Maintenance Cost			$ 620,836

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 358,901	$ 361,384	$ 720,285
Contingency Cost (25% of Construction Cost)	$ 89,725	$ 90,346	$ 180,071
Engineering Design Cost (5% of Construction Cost)	$ 17,945	$ 18,069	$ 36,014
Total Construction Cost	$ 466,571	$ 469,799	$ 936,371

Land Cost

Channel Length	1465	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	0	0	$100,000	$ -
LC Enhancement Buffer	0	0	$100,000	$ -
Channel	42	1.4	$100,000	$ 140,000
Channel LC Enhancement	0	0	$100,000	$ -
Levee	55	1.8	$100,000	$ 180,000
Levee LC Enhancement	51	1.7	$100,000	$ 170,000
Other	0	0	$100,000	$ -
Total	148	4.9		$ 490,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	0	ft
Landscape Enhancement Buffer	0	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	3.2	$100,000	$ 320,000
LC Enhancement Cost	acre	1.7	$100,000	$ 170,000
Total Land Cost	acre	4.9	$100,000	$ 490,000

Total Cost

Base Total Cost	$ 1,188,621
Total Landscape Enhancement Cost	$ 1,113,502
Total Cost Including LC Enh.	$ 2,302,123

SUN VALLEY ADMP
Step 2 - Alt. C
FRS No. 1

FRS No. 1 Sub-area

FEMA Floodplains

Floodplain

Floodway

Alluvial Fan Apices

Concentration Point

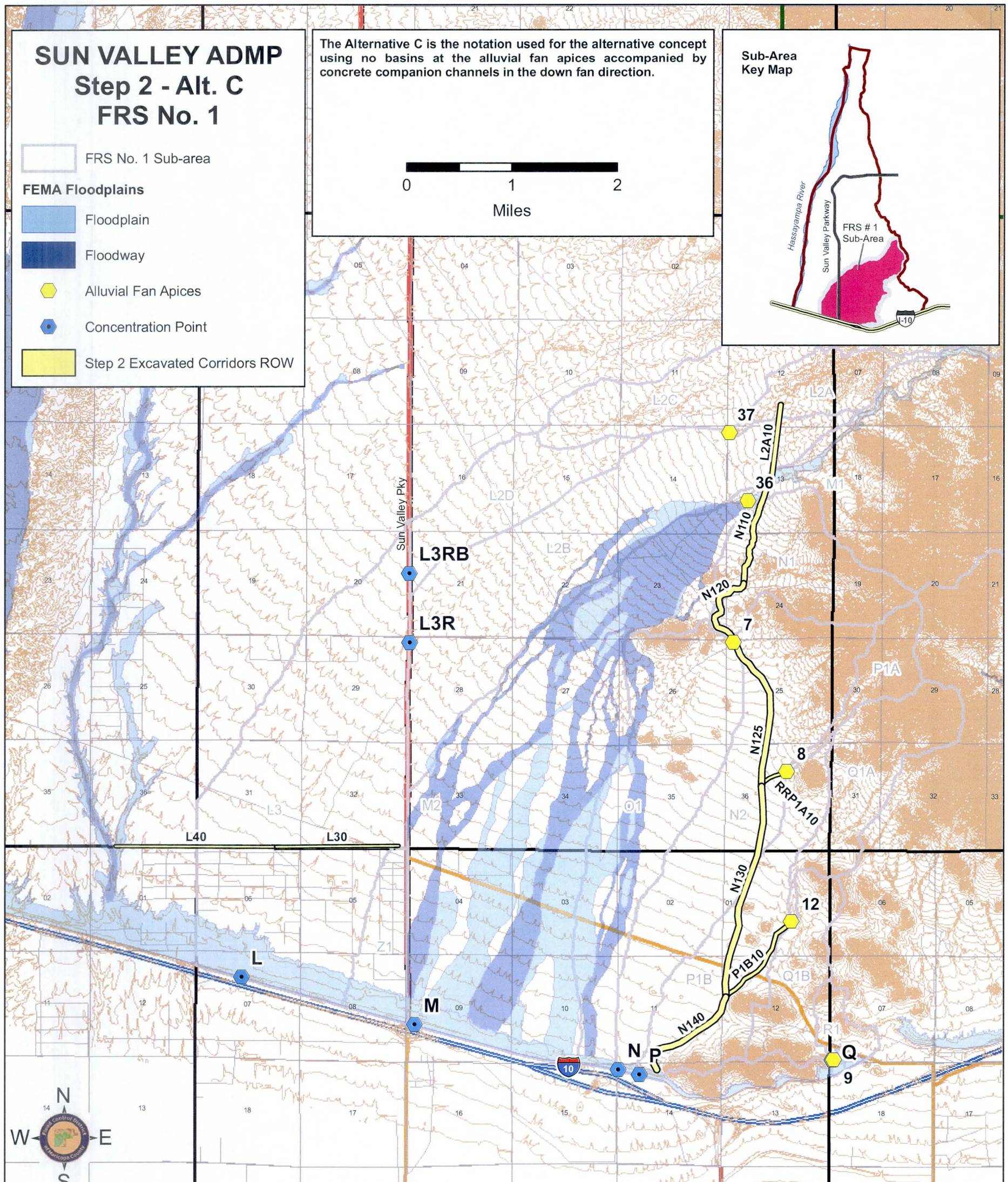
Step 2 Excavated Corridors ROW

The Alternative C is the notation used for the alternative concept using no basins at the alluvial fan apices accompanied by concrete companion channels in the down fan direction.

0 1 2

Miles

Sub-Area Key Map



Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs (in $1000): Land Cost	Constr. Cost	Lndscp Cost	50 Yr Maint. Cost	Total Cost	Base Cost Percentages: Land Cost %	Constr. Cost %	Lndscp Cost %	50 Yr Maint. Cost %	% of Total Cost
L2A10	Excavated Chl.	2604	23	250	0	0.7	171	6	$ 2,270	$ 5,907	$ 469	$ 936	$ 9,582	24%	62%	5%	10%	4%
N110	Excavated Chl.	6169	37	1267	0	1	212	7	$ 3,690	$ 28,062	$ 882	$ 1,703	$ 34,336	11%	82%	3%	5%	15%
N120	Excavated Chl.	6078	29	434	0	0.8	212	7	$ 2,870	$ 10,111	$ 684	$ 1,409	$ 15,075	19%	67%	5%	9%	6%
N125	Excavated Chl.	6376	58	1621	0	1.5	228	8	$ 5,800	$ 36,078	$ 1,442	$ 2,944	$ 46,264	13%	78%	3%	6%	20%
N130	Excavated Chl.	6941	78	2841	0	2.1	228	8	$ 7,770	$ 62,500	$ 1,932	$ 3,989	$ 76,190	10%	82%	3%	5%	33%
N140	Excavated Chl.	7456	41	447	0	1.1	228	8	$ 4,060	$ 10,715	$ 1,009	$ 2,062	$ 17,847	23%	60%	6%	12%	8%
P1B10	Excavated Chl.	1187	25	214	0	1	125	5	$ 2,460	$ 5,231	$ 384	$ 1,020	$ 9,095	27%	58%	4%	11%	4%
L30	Excavated Chl.	2162	23	190	0	1.2	198	6	$ 2,270	$ 5,140	$ 903	$ 2,027	$ 10,340	22%	50%	9%	20%	4%
L40	Excavated Chl.	2162	30	204	0	1.5	198	6	$ 3,000	$ 5,737	$ 1,192	$ 2,583	$ 12,512	24%	46%	10%	21%	5%
RRP1A10	Excavated Chl.	575	6	21	0	0.3	90	5	$ 580	$ 718	$ 59	$ 339	$ 1,695	34%	42%	3%	20%	1%
	TOTAL	350	7489	0					$34,770	$170,198	$ 8,956	$ 19,012	**$ 232,936**	15%	73%	4%	8%	100%
All Channels		350	7489	0	11.2				$34,770	$170,198	$ 8,956	$ 19,012	$ 232,936	15%	73%	4%	8%	100%
All Online Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%

Channel Cost per mile (in $1000)	$20,798	Basins Cost per ac. ft. (in $1000)	$0.00

Cost Increase for Landscape Compatibility Enhancement over Base Costs

All Channels % increase	34%	26%	0%				35%	28%	27%	51%	31%
All Online Basins % increase	0%	0%	0%				0%	0%	0%	0%	0%
All Offline Basins % increase	0%	0%	0%				0%	0%	0%	0%	0%
Total % increase	34%	26%	0%				35%	28%	27%	51%	31%

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SUN VALLEY AREA DRAINAGE MASTER PLAN

Costs Summary

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	Base Design Geometry: Length (stor-ft; chl-mi)	Base Design Geometry: ROW Width (ft)	Base Design Geometry: Depth (ft)	Base Costs (in $1000): Land Cost	Base Costs (in $1000): Constr. Cost	Base Costs (in $1000): Lndscp Cost	Base Costs (in $1000): 50 Yr Maint. Cost	Base Costs (in $1000): Total Cost	Base Cost Percentages: Land Cost %	Base Cost Percentages: Constr. Cost %	Base Cost Percentages: Lndscp Cost %	Base Cost Percentages: 50 Yr Maint. Cost %	Base Cost Percentages: % of Total Cost
L2A10	Excavated Chl.	2604	23	250	0	0.7	171	6	$ 2,270	$ 5,907	$ 469	$ 936	$ 9,582	24%	62%	5%	10%	4%
N110	Excavated Chl.	6169	37	1267	0	1	212	7	$ 3,690	$ 28,062	$ 882	$ 1,703	$ 34,336	11%	82%	3%	5%	15%
N120	Excavated Chl.	6078	29	434	0	0.8	212	7	$ 2,870	$ 10,111	$ 684	$ 1,409	$ 15,075	19%	67%	5%	9%	6%
N125	Excavated Chl.	6376	58	1621	0	1.5	228	8	$ 5,800	$ 36,078	$ 1,442	$ 2,944	$ 46,264	13%	78%	3%	6%	20%
N130	Excavated Chl.	6941	78	2841	0	2.1	228	8	$ 7,770	$ 62,500	$ 1,932	$ 3,989	$ 76,190	10%	82%	3%	5%	33%
N140	Excavated Chl.	7456	41	447	0	1.1	228	8	$ 4,060	$ 10,715	$ 1,009	$ 2,062	$ 17,847	23%	60%	6%	12%	8%
P1B10	Excavated Chl.	1187	25	214	0	1	125	5	$ 2,460	$ 5,231	$ 384	$ 1,020	$ 9,095	27%	58%	4%	11%	4%
L30	Excavated Chl.	2162	23	190	0	1.2	198	6	$ 2,270	$ 5,140	$ 903	$ 2,027	$ 10,340	22%	50%	9%	20%	4%
L40	Excavated Chl.	2162	30	204	0	1.5	198	6	$ 3,000	$ 5,737	$ 1,192	$ 2,583	$ 12,512	24%	46%	10%	21%	5%
RRP1A10	Excavated Chl.	575	6	21	0	0.3	90	5	$ 580	$ 718	$ 59	$ 339	$ 1,695	34%	42%	3%	20%	1%
	TOTAL	350	7489	0					$ 34,770	$ 170,198	$ 8,956	$ 19,012	**$ 232,936**	15%	73%	4%	8%	100%
All Channels		350	7489	0	11.2				$ 34,770	$ 170,198	$ 8,956	$ 19,012	$ 232,936	15%	73%	4%	8%	100%
All Online Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)		$20,798		Basins Cost per ac. ft. (in $1000)					$0.00									

Cost Summary - Landscape Compatibility Enhanced (LCE)

Structure ID	Type	Flow Rate (cfs)	ROW Area (acres)	Exc. Vol. (ac. ft)	Fill Vol. (ac. ft)	LCE Design Geometry: Length (stor-ft; chl-mi)	LCE Design Geometry: ROW Width (ft)	LCE Design Geometry: Depth (ft)	LCE Costs (in $1000): Land Cost	LCE Costs (in $1000): Constr. Cost	LCE Costs (in $1000): Lndscp Cost	LCE Costs (in $1000): 50 Yr Maint. Cost	LCE Costs (in $1000): Total Cost	LCE Cost Percentages: Land Cost %	LCE Cost Percentages: Constr. Cost %	LCE Cost Percentages: Lndscp Cost %	LCE Cost Percentages: 50 Yr Maint. Cost %	LCE Cost Percentages: % of Total Cost
L2A10	Excavated Chl.	2604	30	320	0	0.7	341	6	$ 3,030	$ 7,747	$ 608	$ 1,496	$ 12,881	24%	60%	5%	12%	4%
N110	Excavated Chl.	6169	48	1584	0	1	388	7	$ 4,830	$ 35,361	$ 1,111	$ 2,647	$ 43,948	11%	80%	3%	6%	14%
N120	Excavated Chl.	6078	38	538	0	0.8	388	7	$ 3,760	$ 12,769	$ 862	$ 2,141	$ 19,532	19%	65%	4%	11%	6%
N125	Excavated Chl.	6376	76	2041	0	1.5	410	8	$ 7,620	$ 45,986	$ 1,831	$ 4,618	$ 60,055	13%	77%	3%	8%	20%
N130	Excavated Chl.	6941	102	3585	0	2.1	410	8	$ 10,220	$ 79,567	$ 2,453	$ 6,231	$ 98,471	10%	81%	2%	6%	32%
N140	Excavated Chl.	7456	53	555	0	1.1	410	8	$ 5,330	$ 13,747	$ 1,281	$ 3,233	$ 23,591	23%	58%	5%	14%	8%
P1B10	Excavated Chl.	1187	34	297	0	1	289	5	$ 3,400	$ 7,303	$ 538	$ 1,566	$ 12,806	27%	57%	4%	12%	4%
L30	Excavated Chl.	2162	34	228	0	1.2	245	6	$ 3,430	$ 6,342	$ 1,105	$ 2,694	$ 13,571	25%	47%	8%	20%	4%
L40	Excavated Chl.	2162	45	245	0	1.5	245	6	$ 4,530	$ 7,103	$ 1,458	$ 3,463	$ 16,554	27%	43%	9%	21%	5%
RRP1A10	Excavated Chl.	575	9	35	0	0.3	254	5	$ 850	$ 1,189	$ 103	$ 576	$ 2,717	31%	44%	4%	21%	1%
	TOTAL	469	9428	0					$ 47,000	$ 217,113	$ 11,348	$ 28,666	**$ 304,127**	15%	71%	4%	9%	100%
All Channels		469	9428	0	11.2				$ 47,000	$ 217,113	$ 11,348	$ 28,666	$ 304,127	15%	71%	4%	9%	100%
All Online Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
All Offline Basins		0	0	0					$ -	$ -	$ -	$ -	$ -	0%	0%	0%	0%	0%
Channel Cost per mile (in $1000)		$27,154		Basins Cost per ac. ft. (in $1000)					$0.00									
All Channels % increase		34%	26%	0%					35%	28%	27%	51%	31%					
All Online Basins % increase		0%	0%	0%					0%	0%	0%	0%	0%					
All Offline Basins % increase		0%	0%	0%					0%	0%	0%	0%	0%					
Total % increase		34%	26%	0%					35%	28%	27%	51%	31%					

Hydrology - 6-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
R1	BASIN	506			4.2	0.28	47	12	4	2	1.525	1.527	1.527	1.527	23	23	23	23
Q1B	BASIN	851			4.5	0.94	155	39	13	6	1.533	1.544	1.544	1.544	77	77	77	77
DUMMY	COMBINE	1020			4.5	1.22	192	48	16	7	1.459	1.469	1.469	1.469	95	96	96	96
L1	BASIN	2128			4.7	3.55	543	139	46	20	1.424	1.453	1.453	1.453	269	275	275	275
L1-L2A	ROUTE	2066	14.4	40.14	4.9	3.55	543	139	46	20	1.423	1.453	1.453	1.453	269	275	275	275
L2A	BASIN	692			4.5	0.69	113	28	9	4	1.516	1.516	1.516	1.516	56	56	56	56
L2BR	COMBINE	2391			4.9	4.24	623	159	53	23	1.366	1.391	1.391	1.391	309	314	314	314
L2A-M1	ROUTE	2378	101.1	15.7	4.9	4.24	623	159	53	23	1.366	1.391	1.391	1.391	309	314	314	314
M1	BASIN	2809			4.8	5.69	790	203	68	29	1.291	1.327	1.327	1.327	392	402	402	402
CM1	COMBINE	4598			4.9	9.92	1291	332	111	48	1.209	1.243	1.243	1.243	640	658	658	658
M1-N1	ROUTE	4551	100.6	57.22	5	9.92	1290	332	111	48	1.209	1.243	1.243	1.243	640	658	658	658
N1	BASIN	1253			4.5	1.52	210	53	18	8	1.281	1.286	1.286	1.286	104	105	105	105
CN1	COMBINE	4841			5	11.45	1408	362	121	52	1.144	1.177	1.177	1.177	698	719	719	719
N1-P1A	ROUTE	4794	101.5	58.58	5	11.45	1408	362	121	52	1.143	1.177	1.177	1.177	698	719	719	719
N2A	BASIN	1253			4.5	1.52	210	53	18	8	1.281	1.286	1.286	1.286	104	105	105	105
CN2AR	COMBINE	5025			5	12.97	1521	392	131	56	1.09	1.124	1.124	1.124	754	777	777	777
P1A	BASIN	575			4.4	0.5	89	22	7	3	1.655	1.663	1.663	1.663	44	44	44	44
CN2A	COMBINE	5119			5	13.47	1568	404	135	58	1.082	1.116	1.116	1.116	777	802	802	802
P1A-1B	ROUTE	5049	101.7	130.91	5.2	13.47	1567	404	135	58	1.081	1.116	1.116	1.116	777	802	802	802
P1B	BASIN	852			5	1.94	244	62	21	9	1.172	1.194	1.194	1.194	121	123	123	123
PR	COMBINE	5396			5.2	15.41	1694	437	146	63	1.022	1.055	1.055	1.055	840	867	867	867
Q1A	BASIN	990			4.5	1.3	193	49	16	7	1.385	1.396	1.396	1.396	96	97	97	97
Q1A-P	ROUTE	961	100.7	9.89	4.7	1.3	193	49	16	7	1.384	1.396	1.396	1.396	96	97	97	97
P	COMBINE	5629			5.2	16.71	1795	464	155	67	0.999	1.032	1.032	1.032	890	920	920	920
N2B	BASIN	1193			5.1	3.33	366	93	31	13	1.023	1.045	1.045	1.045	181	185	185	185
O1	BASIN	1057			5.3	3.09	343	88	29	13	1.033	1.059	1.059	1.059	170	174	174	174
M2	BASIN	1849			5.4	7.44	633	159	53	23	0.791	0.795	0.795	0.795	314	315	315	315
Z1	BASIN	694			4.5	0.66	100	25	8	4	1.405	1.406	1.406	1.406	50	50	50	50
L2B	BASIN	1532			5	4.08	418	104	35	15	0.952	0.952	0.952	0.952	207	207	207	207
L2B-L3	ROUTE	1196	12.8	208.54	6.9	4.08	416	104	35	15	0.948	0.952	0.952	0.952	206	207	207	207
L2C	BASIN	754			4.8	1.33	161	40	13	6	1.125	1.125	1.125	1.125	80	80	80	80
L2C-2D	ROUTE	712	13	29.17	5.2	1.33	161	40	13	6	1.125	1.125	1.125	1.125	80	80	80	80
L2D	BASIN	706			4.7	1.23	136	34	11	5	1.025	1.025	1.025	1.025	67	67	67	67
L3RB	COMBINE	1043			5	2.56	260	65	22	9	0.945	0.946	0.946	0.946	129	129	129	129
L2D-L3	ROUTE	650	12.5	187.08	8.3	2.56	258	65	22	9	0.936	0.946	0.946	0.946	128	129	129	129
L3	BASIN	1832			5.2	5.85	581	146	49	21	0.923	0.926	0.926	0.926	288	289	289	289
L	COMBINE	1638			5.3	12.49	963	250	83	36	0.717	0.745	0.745	0.745	478	496	496	496

Hydrology - 24-hr Storm HEC1 Model Results

KK CARD	Type	Peak Flow	Peak Stage (ft)	Peak Storage	Time	Cum.Area (sq. miles)	MAX. Average Flow (cfs)				MAX. Average Rainfall Depth (Inches)				Total Runoff Volume (ac. ft)			
							6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR	6-HR	24-HR	72-HR	MAX-HR
R1	BASIN	387			12.2	0.28	37	10	3	1	1.223	1.322	1.322	1.322	19	20	20	20
Q1B	BASIN	740			12.5	0.94	134	38	13	5	1.325	1.498	1.5	1.5	66	75	75	75
DUMMY	COMBINE	902			12.5	1.22	170	48	16	7	1.294	1.448	1.45	1.45	84	94	94	94
L1	BASIN	2267			12.7	3.55	527	150	50	22	1.382	1.572	1.576	1.576	261	297	298	298
L1-L2A	ROUTE	2154	14.4	41.37	12.9	3.55	527	150	50	22	1.381	1.571	1.576	1.576	261	297	298	298
L2A	BASIN	570			12.5	0.69	92	23	8	3	1.236	1.236	1.236	1.236	46	46	46	46
L2BR	COMBINE	2519			12.9	4.24	616	172	57	25	1.351	1.509	1.513	1.513	305	341	342	342
L2A-M1	ROUTE	2504	101.2	16.27	12.9	4.24	616	172	57	25	1.351	1.509	1.513	1.513	305	341	342	342
M1	BASIN	3301			12.8	5.69	825	236	79	34	1.349	1.543	1.548	1.548	409	468	469	469
CM1	COMBINE	5718			12.9	9.92	1429	405	135	59	1.339	1.517	1.522	1.522	709	803	806	806
M1-N1	ROUTE	5639	100.9	66.49	13	9.92	1428	405	135	59	1.338	1.517	1.522	1.522	708	803	806	806
N1	BASIN	1211			12.5	1.52	192	52	17	7	1.172	1.269	1.27	1.27	95	103	103	103
CN1	COMBINE	6078			13	11.45	1599	451	151	65	1.299	1.466	1.471	1.471	793	895	898	898
N1-P1A	ROUTE	6014	101.9	68.37	13	11.45	1599	451	151	65	1.298	1.465	1.471	1.471	793	895	898	898
N2A	BASIN	1211			12.5	1.52	192	52	17	7	1.172	1.269	1.27	1.27	95	103	103	103
CN2AR	COMBINE	6376			13	12.97	1766	497	166	72	1.266	1.424	1.43	1.43	876	986	989	989
P1A	BASIN	441			12.4	0.5	73	21	7	3	1.351	1.542	1.545	1.545	36	41	41	41
CN2A	COMBINE	6501			13	13.47	1829	515	172	74	1.262	1.422	1.427	1.427	907	1022	1026	1026
P1A-1B	ROUTE	6396	102.1	153.34	13.2	13.47	1828	515	172	74	1.262	1.421	1.427	1.427	907	1021	1026	1026
P1B	BASIN	842			13	1.94	231	61	20	9	1.108	1.174	1.175	1.175	114	121	121	121
PR	COMBINE	7049			13.2	15.41	2028	568	190	82	1.224	1.37	1.376	1.376	1006	1126	1131	1131
Q1A	BASIN	915			12.5	1.3	173	48	16	7	1.242	1.372	1.374	1.374	86	95	95	95
Q1A-P	ROUTE	875	100.6	9.23	12.7	1.3	173	48	16	7	1.241	1.371	1.374	1.374	86	95	95	95
P	COMBINE	7456			13.1	16.71	2177	609	204	88	1.211	1.356	1.362	1.362	1079	1208	1213	1213
N2B	BASIN	1331			13.1	3.33	378	99	33	14	1.057	1.102	1.103	1.103	187	195	196	196
O1	BASIN	1163			13.3	3.09	349	91	30	13	1.05	1.095	1.096	1.096	173	180	180	180
M2	BASIN	2347			13.4	7.44	786	198	66	29	0.983	0.989	0.99	0.99	390	392	392	392
Z1	BASIN	558			12.5	0.66	80	21	7	3	1.127	1.161	1.161	1.161	40	41	41	41
L2B	BASIN	1700			13	4.08	449	112	37	16	1.024	1.024	1.024	1.024	223	223	223	223
L2B-L3	ROUTE	1323	12.9	226.51	14.8	4.08	447	112	37	16	1.02	1.024	1.024	1.024	222	223	223	223
L2C	BASIN	692			12.8	1.33	145	36	12	5	1.013	1.013	1.013	1.013	72	72	72	72
L2C-2D	ROUTE	651	12.9	27.24	13.2	1.33	145	36	12	5	1.013	1.013	1.013	1.013	72	72	72	72
L2D	BASIN	655			12.7	1.23	124	31	10	4	0.934	0.934	0.934	0.934	61	61	61	61
L3RB	COMBINE	1104			13	2.56	266	66	22	10	0.965	0.965	0.965	0.965	132	132	132	132
L2D-L3	ROUTE	705	12.5	201.22	16.1	2.56	263	66	22	10	0.956	0.965	0.965	0.965	130	132	132	132
L3	BASIN	2129			13.2	5.85	658	166	56	24	1.045	1.058	1.058	1.058	326	330	330	330
L	COMBINE	2162			13.3	12.49	1287	335	112	48	0.958	0.997	0.997	0.997	638	664	664	664

Channels Hydraulics Summary

Structure ID	Type	Design Geometry						Hydraulics									
		Initial Slope (ft/ft)	Long-term Slope (ft/ft)	Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Chnl Mannings n	Flow Rate (cfs)	Wetted Perimeter (ft)	Wetted XS Area (ft)	Hydraulic Radius (ft)	Hydraulic Depth (ft)	Flow Depth (ft)	Freeboard (ft)	Top Width (ft)	Velocity (ft/s)	Froude Number	Shear Stress (lb/sq. ft)
L2A10	Excavated	0.0128	0.0030	0.70	3	6.0	0.020	2604	113.3	319.6	2.8	2.9	4.5	1.5	112	8.1	0.85	0.84
N110	Excavated	0.0234	0.0025	1.00	3	7.0	0.020	6169	153.5	639.6	4.2	4.2	5.3	1.7	152	9.6	0.83	0.83
N120	Excavated	0.0129	0.0025	0.80	3	7.0	0.020	6078	153.2	633.5	4.1	4.2	5.3	1.7	152	9.6	0.83	0.82
N125	Excavated	0.0131	0.0025	1.50	3	8.0	0.020	6376	166.7	674.2	4.0	4.1	5.8	2.2	165	9.5	0.82	0.90
N130	Excavated	0.0132	0.0025	2.10	3	8.0	0.020	6941	168.1	711.9	4.2	4.3	6.0	2.0	166	9.8	0.83	0.94
N140	Excavated	0.0072	0.0025	1.10	3	8.0	0.020	7456	169.4	745.3	4.4	4.5	6.2	1.8	167	10.0	0.84	0.97
P1B10	Excavated	0.0112	0.0030	1.00	3	5.0	0.020	1187	70.0	164.5	2.4	2.4	3.9	1.1	69	7.2	0.82	0.74
L30	Excavated	0.0048	0.0030	1.20	3	5.5	0.020	2162	140.5	311.5	2.2	2.2	4.0	1.5	139	6.9	0.82	0.75
L40	Excavated	0.0040	0.0030	1.50	3	5.5	0.020	2162	140.5	311.5	2.2	2.2	4.0	1.5	139	6.9	0.82	0.75
RRP1A10	Excavated	0.0196	0.0030	0.30	3	5.0	0.020	575	33.7	79.5	2.4	2.4	3.7	1.3	32	7.2	0.81	0.70

Basins Hydraulics Summary

Structure ID	Type	Adjacent Topo. Slope	Design Geometry				Hydraulics					
			Length (stor-ft; chl-mi)	Width (ft)	Depth (ft)	Storage Volume Provided	Peak Storage (ac. Ft)	Total Vol. Entering Basin (ac.	Peak Inflow into Basin (cfs)	Peak Outflow (cfs)	Peak Stage (ft)	Freeboard (ft)

Open Channel

Structure ID	L2A10

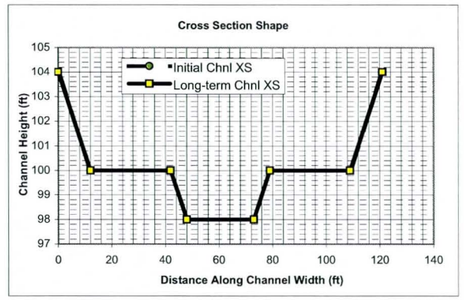
HEC1 ID	L2A-M1

Longitudal Geometry

Length	3875.0	ft
U/S Elev	1616.0	ft
D/S Elev	1566.2	ft
Initial Channel Slope	0.0128	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	2



Initial Channel XS Geometry

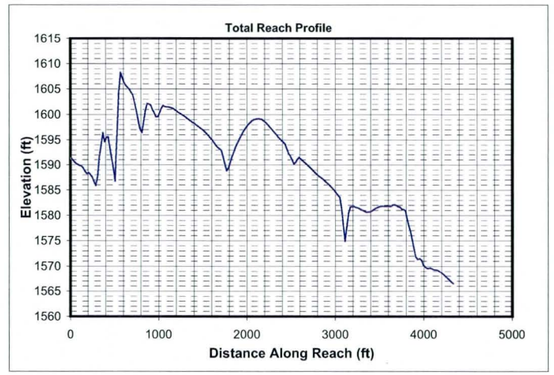
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	30	3	25	6	3	30	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	42	48	73	79	109	121
Y	104	100	100	98	98	100	100	104

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	4	30	3	25	6	3	30	4	3

PT. ID	1	2	3	4	5	6	7	8
X	0	12	42	48	73	79	109	121
Y	104	100	100	98	98	100	100	104



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	L2BR	L2B							TOTAL
HEC1 Peak-Flow	2519	1700							4219
Weighting Factor	1.00	0.05							
Flow into Channel	2519	85							2604

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	4.24	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	2604	cfs	
Long-term Max. Chnl Capacity	5164	cfs	
Q2 Channel	260	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	121	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
260	35.6	50.5	1.4	98.0	99.7	5.2	1.7	35.1	1.4	0.31	0.76
781	103.2	149.5	1.4	98.0	100.9	5.2	2.9	102.3	1.5	0.54	0.76
1953	110.2	266.0	2.4	98.0	102.0	7.3	4.0	108.9	2.4	0.75	0.83
2604	113.3	319.6	2.8	98.0	102.5	8.1	4.5	111.8	2.9	0.84	0.85

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
260	35.6	50.5	1.4	98.0	99.7	5.2	1.7	35.1	1.4	0.31	0.76
781	103.2	149.5	1.4	98.0	100.9	5.2	2.9	102.3	1.5	0.54	0.76
1953	110.2	266.0	2.4	98.0	102.0	7.3	4.0	108.9	2.4	0.75	0.83
2604	113.3	319.6	2.8	98.0	102.5	8.1	4.5	111.8	2.9	0.84	0.85

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
260										0
781										0
1953										0
2604										0

Allowable Velocity

Channel Lining: Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
260	1.74	1.5080	1.4326	Erosive	Erosive	Erosive	0.4	Erosive	4.5	Stable	Stable
781	1.74	1.5126	1.4369	Erosive	Erosive	Erosive	0.4	Erosive	5.9	Stable	Stable
1953	1.74	1.6708	1.5873	Erosive	Erosive	Erosive	0.4	Erosive	7.5	Stable	Stable
2604	1.74	1.7193	1.6333	Erosive	Erosive	Erosive	0.4	Erosive	8.2	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	260	781	1953	2604	260	781	1953	2604	260	781	1953	2604
Bray - Equation #1	45	80	129	150	1.7	2.4	3.3	3.6	3.4	4.0	4.6	4.8
Bray - Equation #2	59	105	170	197	1.9	2.7	3.6	4.0	2.4	2.8	3.1	3.3
Hey	14	25	42	49	5.3	8.1	11.5	12.8				
Ackers & Charlton/Lacey	37	59	87	98					2.0	2.4	2.8	3.0
Parker	111	192	304	351	1.4	2.2	3.2	3.6				
Chang	65	127	223	266	0.3	0.2	-0.1	-0.3				
Kellerhals	29	50	80	92	2.5	3.9	5.6	6.3	3.6	4.0	4.4	4.5
AMAFCA/Schumm	35	102	109	112								
Moody & Odem	21	21	21	21	1.2	1.2	1.2	1.2				
BUREC	17.4	26.2	37.0	41.2	5	7	10	11	5.1	6.7	8.4	9.0
Average	43	79	120	138	2.4	3.5	4.8	5.3	3.3	4.0	4.7	4.9
Values As Designed	35	102	109	112	1.7	2.9	4.0	4.5	5.2	5.2	7.3	8.1
Difference with Design	8	-23	11	26	0.7	0.6	0.8	0.8	-1.9	-1.3	-2.7	-3.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
260	1859	2153	3113	16513	1271	1803	830	1376	7082	1457	6219	3971
781	5732	6303	9380	50619	3737	5510	2513	4210	21252	4450	19014	12065
1953	22766	17403	23932	229892	5319	20791	6102	13786	53406	7213	62655	42115
2604	34957	23755	32275	367953	5952	32658	8015	19774	71271	7737	90088	63130

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
260	2649	3067	4435	23527	1811	2569	1183	1961	10090	2077	8861	5657
781	2722	2993	4455	24040	1775	2617	1194	1999	10093	2113	9030	5730
1953	4325	3306	4546	43671	1010	3950	1159	2619	10145	1370	11902	8000
2604	4980	3384	4598	52423	848	4653	1142	2817	10154	1102	12835	8994

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
260	1859	1780	1793	1864	475	795	830	1376	755	111	1766	1219
781	5732	5222	5390	5713	1402	2424	2513	4210	2270	323	5420	3693
1953	22766	14733	12733	25947	2193	7535	6102	13786	5890	301	19539	11957
2604	34957	20214	17054	41529	2508	10761	8015	19774	7903	299	28867	17444

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
260	2649	2536	2554	2655	677	1133	1183	1961	1076	158	2516	1736
781	2722	2480	2560	2713	666	1151	1194	1999	1078	154	2574	1754
1953	4325	2799	2419	4929	417	1431	1159	2619	1119	57	3712	2271
2604	4980	2880	2430	5917	357	1533	1142	2817	1126	43	4113	2485

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
260	0.0004	0.0002	251	0.77	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0002	0.0055	0.0003	0.0010	0.0029	0.0022
781	0.0004	0.0002	254	0.77	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0002	0.0055	0.0002	0.0004	0.0030	0.0022
1953	0.0002	0.0001	328	1.00	0.055	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0001	0.0055	0.0001	0.0002	0.0030	0.0022
2604	0.0002	0.0001	354	1.08	0.056	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0001	0.0055	0.0001	0.0002	0.0030	0.0022

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	38.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	13	
Distance between structs.	298	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.21	sq. mi
Total Sediment Yield Volume	0.40	ac ft

Sedimentation Basins

Length	298 ft	Depth	3 ft
Width	121 ft	Side slope	3 ft/ft
Total Volume per Basin		2.23	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
260	1.1	0.4	0.4	24.6	1.7	1.4	5.2	0.0030	0.3	0.0	1.0	2.5
781	1.1	0.8	0.4	24.6	2.9	1.5	5.2	0.0030	0.6	0.0	1.0	3.2
1953	1.1	1.4	0.7	24.6	4.0	2.4	7.3	0.0030	0.8	0.0	1.0	4.7
2604	1.1	1.7	0.9	24.6	4.5	2.9	8.1	0.0030	0.9	0.0	1.0	5.3

Toe Protection Needed	6.0	ft

HEC1 Results For Open Channel

Peak Flow	2504	cfs
Stage at Peak Flow	101.2	ft
Volume at Peak Flow	342.0	ac. ft

Freeboard

Max. Flow Depth	4.5	ft
Channel Depth as designed	6.0	ft
Available Freeboard	1.5	ft
Required Freeboard	1.4	ft

Sediment Volume

Inflowing Sediment Volume	0.40	ac. ft
Outflowing Sediment Volume	0.32	ac. ft
Deposited(+)/Eroded(-) Volume	0.08	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	3875	3875
Side Slope (?H:1V)	3	6
Channel Width (ft)	121	157
Channel XS Area (sq. ft)	498	606
Channel Perimeter (ft)	123	158

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	402735	516792
Excavated Area (sq. Yd)	52097	67597

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	3875	3875
Lining Width (ft)	25	49
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	10764	21097
Lining Volume (cu. Yd)	1794	3516

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	3875	ft
Thickness	1.5	ft
Protection Depth	6	ft
Tie-in Length/Depth	3.0	ft
Total Depth	9.0	ft
Area needed	646	sq. Yd
Volume	1938	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	3875	3875
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	3875	3875
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	121	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	14.2	ft
Structure Height	17.2	ft
Number of Structures	13	
Volume per structure	39	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 6,045	
Area per structure	7	sq. Yd
Total Area	87	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	3598	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 14,392	
Other Cost	$ -	
Total cost per basin	$ 14,392	
Area per basin	4,007	sq. Yd
Total Area	4,007	sq. Yd

Structure Type	Structure Cost											
	Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	402,735	cu. Yd	$ 10.00	$ 4,027,350	52,097	sq. Yd	$ 9.00	$ 468,873	52,097	sq. Yd	$ 8.33	$ 434,142
Exc. Chl - LC Enhancement	Excavated	114,057	cu. Yd	$ 10.00	$ 1,140,570	15,500	sq. Yd	$ 9.00	$ 139,500	15,500	sq. Yd	$ 8.33	$ 129,167
Channel Lining	Concrete	1,794	cu. Yd	$ 155.00	$ 278,070	10,764	sq. Yd	$ -	$ -	10,764	sq. Yd	$ 41.67	$ 448,500
Channel Lining - LC Enhancement	Concrete	1,722	cu. Yd	$ 155.00	$ 266,910	10,333	sq. Yd	$ -	$ -	10,333	sq. Yd	$ 41.67	$ 430,542
Toe Protection	Riprap	1,938	cu. Yd	$ 75.00	$ 145,350	646	sq. Yd	$ -	$ -	646	sq. Yd	$ 25.00	$ 16,150
Drop Structures	Concrete	13	EA	$ 6,045.00	$ 78,585	87	sq. Yd	$ -	$ -	87	sq. Yd	$ 41.67	$ 3,625
Drop Str. - LC Enhancement	Concrete	13	EA	$ 604.50	$ 7,859	9	sq. Yd	$ -	$ -	9	sq. Yd	$ 41.67	$ 363
Sedimentation Basins		1	EA	$ 14,392.00	$ 14,392	4,007	sq. Yd	$ -	$ -	4,007	sq. Yd	$ 8.33	$ 33,392
Other					$ -				$ -				$ -

Base Landscape Cost	$ 468,873	Base Maintenance Cost	$ 935,808
LC Enhancement Cost	$ 139,500	LC Enhancement Cost	$ 560,071
Total Landscape Cost	$ 608,373	Total Maintenance Cost	$ 1,495,879

Construction Cost Component	**Base**	**LC Enhancement**	**Total**
Construction Cost	$ 4,543,747	$ 1,415,339	$ 5,959,086
Contingency Cost (25% of Construction Cost)	$ 1,135,937	$ 353,835	$ 1,489,771
Engineering Design Cost (5% of Construction Cost)	$ 227,187	$ 70,767	$ 297,954
Total Construction Cost	$ 5,906,871	$ 1,839,940	$ 7,746,811

Land Cost

Channel Length	3875 ft

Land Cost Component	**Width (ft)**	**Area (acre)**	**Unit Cost**	**Cost**
Misc. Right of Way	134	11.9	$100,000	$ 1,190,000
LC Enhancement Buffer	50	4.4	$100,000	$ 440,000
Channel	121	10.8	$100,000	$ 1,080,000
Channel LC Enhancement	36	3.2	$100,000	$ 320,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	341	30.3		$ 3,030,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	**Units**	**Quantity**	**Unit Cost**	**Cost Subtotal**
Base Land Cost	acre	22.7	$100,000	$ 2,270,000
LC Enhancement Cost	acre	7.6	$100,000	$ 760,000
Total Land Cost	acre	30.3	$100,000	$ 3,030,000

Total Cost

Base Total Cost	$ 9,581,552
Total Landscape Enhancement Cost	$ 3,299,511
Total Cost Including LC Enh.	$ 12,881,063

Open Channel

Structure ID	N110

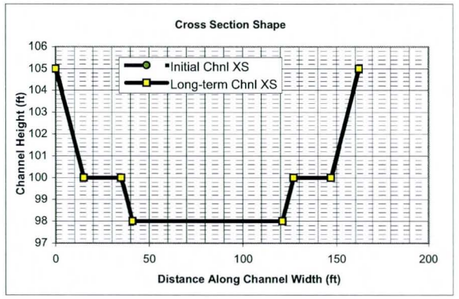
HEC1 ID	M1-N1

Longitudal Geometry

Length	5444.1	ft
U/S Elev	1565.0	ft
D/S Elev	1437.4	ft
Initial Channel Slope	0.0234	ft/ft
Long-term Channel Slope	0.0025	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	3



Initial Channel XS Geometry

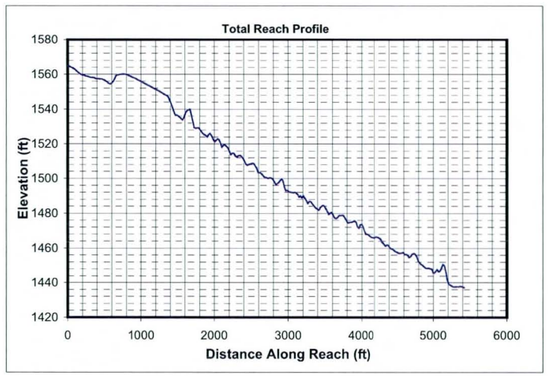
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	20	3	80	7	3	20	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	35	41	121	127	147	162
Y	105	100	100	98	98	100	100	105

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	20	3	80	7	3	20	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	35	41	121	127	147	162
Y	105	100	100	98	98	100	100	105



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	CM1	N1								TOTAL
HEC1 Peak-Flow	5718	1253								6971
Weighting Factor	1.00	0.36								
Flow into Channel	5718	451								6169

Reach Sediment Inflow Characteristics

U/S Contributing ID	L2A-M1_L2A10									TOTAL
Flow Volume (ac. ft)	342.00									342
Sediment Conc. (ppm)	2485									
Sediment Volume (ac. ft)	0.32									0.32
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.32									0.32

Hydrology

Drainage Area	11.45	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	6169	cfs	
Long-term Max. Chnl Capacity	10554	cfs	
Q2 Channel	617	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	162	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
617	89.7	129.6	1.4	98.0	99.5	4.8	1.5	89.2	1.5	0.24	0.70
1851	138.6	298.1	2.2	98.0	100.9	6.2	2.9	137.6	2.2	0.46	0.74
4627	148.9	531.7	3.6	98.0	102.6	8.7	4.6	147.4	3.6	0.71	0.81
6169	153.5	639.6	4.2	98.0	103.3	9.6	5.3	151.8	4.2	0.83	0.83

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
617	89.7	129.6	1.4	98.0	99.5	4.8	1.5	89.2	1.5	0.24	0.70
1851	138.6	298.1	2.2	98.0	100.9	6.2	2.9	137.6	2.2	0.46	0.74
4627	148.9	531.7	3.6	98.0	102.6	8.7	4.6	147.4	3.6	0.71	0.81
6169	153.5	639.6	4.2	98.0	103.3	9.6	5.3	151.8	4.2	0.83	0.83

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
	L2A-M1_L2A10									
617	1219									1219
1851	3693									3693
4627	11957									11957
6169	17444									17444

Allowable Velocity

Channel Lining: Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
617	1.74	1.5106	1.4351	Erosive	Erosive	Erosive	0.4	Erosive	3.9	Stable	Stable
1851	1.74	1.6338	1.5521	Erosive	Erosive	Erosive	0.4	Erosive	5.8	Stable	Stable
4627	1.74	1.7922	1.7026	Erosive	Erosive	Erosive	0.5	Erosive	7.8	Stable	Stable
6169	1.74	1.8526	1.7599	Erosive	Erosive	Erosive	0.5	Erosive	8.7	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	617	1851	4627	6169	617	1851	4627	6169	617	1851	4627	6169
Bray - Equation #1	70	125	203	237	2.3	3.3	4.4	4.9	3.9	4.5	5.1	5.4
Bray - Equation #2	92	165	267	311	2.5	3.6	4.8	5.3	2.7	3.1	3.5	3.7
Hey	22	41	67	79	7.4	11.2	15.9	17.8				
Ackers & Charlton/Lacey	53	85	125	141					2.3	2.8	3.3	3.4
Parker	171	296	467	540	2.0	3.1	4.6	5.2				
Chang	103	203	355	423	0.3	0.1	-0.4	-0.7				
Kellerhals	45	77	122	141	3.6	5.5	8.0	8.9	3.9	4.3	4.7	4.9
AMAFCA/Schumm	89	138	148	152								
Moody & Odem	31	31	31	31	1.4	1.4	1.4	1.4				
BUREC	24.8	37.5	52.9	58.9	7	10	14	16	5.9	7.7	9.7	10.5
Average	70	120	184	211	3.3	4.8	6.6	7.3	3.7	4.5	5.3	5.6
Values As Designed	89	138	147	152	1.5	2.9	4.6	5.3	4.8	6.2	8.7	9.6
Difference with Design	-19	-18	36	59	1.7	1.8	2.0	2.0	-1.0	-1.7	-3.4	-4.1

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
617	3352	4721	8322	89460	4556	6129	1613	2641	41536	4877	21240	17131
1851	14441	14926	25162	427342	8719	28610	4799	9981	124880	19256	77689	68710
4627	57100	40009	68589	1932026	12208	122373	11504	31918	312612	35361	239985	260335
6169	87536	54230	98013	3086848	13621	191503	15073	45542	416909	37394	338645	398665

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
617	2016	2839	5005	53801	2740	3686	970	1588	24980	2933	12774	10303
1851	2895	2992	5044	85667	1748	5735	962	2001	25034	3860	15574	13774
4627	4579	3208	5500	154921	979	9813	922	2559	25067	2835	19243	20875
6169	5264	3261	5894	185641	819	11517	906	2739	25073	2249	20366	23975

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
617	3352	3499	3541	3118	1045	1435	1613	2641	1326	237	3225	2276
1851	14441	11407	10016	14892	2225	5097	4799	9981	4165	323	13154	8227
4627	57100	31402	24749	67328	3420	15875	11504	31918	10694	476	46544	27364
6169	87536	42836	33739	107572	3897	22705	15073	45542	14323	648	68423	40208

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
617	2016	2104	2130	1875	628	863	970	1588	798	143	1939	1369
1851	2895	2287	2008	2985	446	1022	962	2001	835	65	2637	1649
4627	4579	2518	1985	5399	274	1273	922	2559	858	38	3732	2194
6169	5264	2576	2029	6469	234	1365	906	2739	861	39	4115	2418

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
617	0.0004	0.0002	343	1.04	0.056	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0002	0.0041	0.0002	0.0006	0.0025	0.0018
1851	0.0002	0.0002	418	1.27	0.058	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0041	0.0001	0.0003	0.0025	0.0017
4627	0.0001	0.0001	538	1.64	0.058	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0041	0.0001	0.0001	0.0025	0.0017
6169	0.0001	0.0001	582	1.77	0.058	0.0001	33	0.036	0.0000	0.0159	0.0001	0.0001	0.0041	0.0001	0.0001	0.0025	0.0017

Drop Structures

Design Slope	0.0025	ft/ft
Total Drop Needed	114.0	ft
Height of Drop Structure	3	ft
No . of Drop Structures	38	
Distance between structs.	143	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.54	sq. mi
Total Sediment Yield Volume	1.03	ac ft

Sedimentation Basins

Length	143 ft	Depth	3 ft
Width	162 ft	Side slope	3 ft/ft
Total Volume per Basin		1.42	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
617	1.1	0.4	0.3	24.6	1.5	1.5	4.8	0.0025	0.3	0.0	1.0	2.4
1851	1.1	0.9	0.5	24.6	2.9	2.2	6.2	0.0025	0.6	0.0	1.0	3.6
4627	1.1	1.8	1.0	24.6	4.6	3.6	8.7	0.0025	1.0	0.0	1.0	5.6
6169	1.1	2.3	1.3	24.6	5.3	4.2	9.6	0.0025	1.2	0.0	1.0	6.6

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	5639	cfs
Stage at Peak Flow	100.9	ft
Volume at Peak Flow	806.0	ac. ft

Freeboard

Max. Flow Depth	5.3	ft
Channel Depth as designed	7.0	ft
Available Freeboard	1.7	ft
Required Freeboard	1.7	ft

Sediment Volume

Inflowing Sediment Volume	1.35	ac. ft
Outflowing Sediment Volume	0.74	ac. ft
Deposited(+)/Eroded(-) Volume	0.62	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	5444	5444
Side Slope (?H:1V)	3	6
Channel Width (ft)	162	204
Channel XS Area (sq. ft)	907	1054
Channel Perimeter (ft)	164	205

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	2044010	2556165
Excavated Area (sq. Yd)	97992	123397

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	5444	5444
Lining Width (ft)	32	61
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	19356	36898
Lining Volume (cu. Yd)	3226	6150

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5444	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	907	sq. Yd
Volume	3024	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5444	5444
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	5444	5444
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures			
Structure Type	Concrete		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	162	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	0.5	ft	
Drop Height	3	ft	
Scour Depth	19.5	ft	
Structure Height	22.5	ft	
Number of Structures	38		
Volume per structure	68	cu. Yd	
Unit Cost	$ 155.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 10,540		
Area per structure	9	sq. Yd	
Total Area	342	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	2291	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 9,164	
Other Cost	$ -	
Total cost per basin	$ 9,164	
Area per basin	2,579	sq. Yd
Total Area	5,158	sq. Yd

Structure Type	Structure Cost											
	Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	2,044,010	cu. Yd	$ 10.00	$ 20,440,100	97,992	sq. Yd	$ 9.00	$ 881,928	97,992	sq. Yd	$ 8.33	$ 816,600
Exc. Chl - LC Enhancement	Excavated	512,155	cu. Yd	$ 10.00	$ 5,121,550	25,405	sq. Yd	$ 9.00	$ 228,645	25,405	sq. Yd	$ 8.33	$ 211,708
Channel Lining	Concrete	3,226	cu. Yd	$ 155.00	$ 500,030	19,356	sq. Yd	$ -	$ -	19,356	sq. Yd	$ 41.67	$ 806,500
Channel Lining - LC Enhancement	Concrete	2,924	cu. Yd	$ 155.00	$ 453,220	17,542	sq. Yd	$ -	$ -	17,542	sq. Yd	$ 41.67	$ 730,917
Toe Protection	Riprap	3,024	cu. Yd	$ 75.00	$ 226,800	907	sq. Yd	$ -	$ -	907	sq. Yd	$ 25.00	$ 22,675
Drop Structures	Concrete	38	EA	$ 10,540.00	$ 400,520	342	sq. Yd	$ -	$ -	342	sq. Yd	$ 41.67	$ 14,250
Drop Str. - LC Enhancement	Concrete	38	EA	$ 1,054.00	$ 40,052	34	sq. Yd	$ -	$ -	34	sq. Yd	$ 41.67	$ 1,425
Sedimentation Basins		2	EA	$ 9,164.00	$ 18,328	5,158	sq. Yd	$ -	$ -	5,158	sq. Yd	$ 8.33	$ 42,983
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 881,928	Base Maintenance Cost			$ 1,703,008
						LC Enhancement Cost			$ 228,645	LC Enhancement Cost			$ 944,050
						Total Landscape Cost			$ 1,110,573	Total Maintenance Cost			$ 2,647,058

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 21,585,778	$ 5,614,822	$ 27,200,600
Contingency Cost (25% of Construction Cost)	$ 5,396,445	$ 1,403,706	$ 6,800,150
Engineering Design Cost (5% of Construction Cost)	$ 1,079,289	$ 280,741	$ 1,360,030
Total Construction Cost	$ 28,061,511	$ 7,299,269	$ 35,360,780

Land Cost

Channel Length	5444	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	16.7	$100,000	$ 1,670,000
LC Enhancement Buffer	50	6.2	$100,000	$ 620,000
Channel	162	20.2	$100,000	$ 2,020,000
Channel LC Enhancement	42	5.2	$100,000	$ 520,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	388	48.3		$ 4,830,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	36.9	$100,000	$ 3,690,000
LC Enhancement Cost	acre	11.4	$100,000	$ 1,140,000
Total Land Cost	acre	48.3	$100,000	$ 4,830,000

Total Cost

Base Total Cost	$ 34,336,448
Total Landscape Enhancement Cost	$ 9,611,964
Total Cost Including LC Enh.	$ 43,948,411

Open Channel

Structure ID	N120

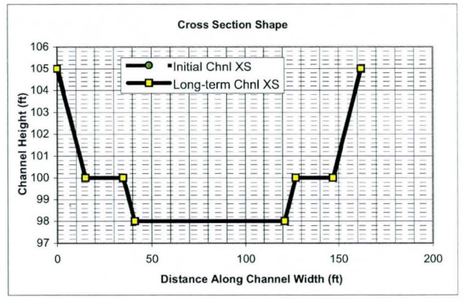
HEC1 ID	M1-N1

Longitudinal Geometry

Length	4224.1	ft
U/S Elev	1437.4	ft
D/S Elev	1382.8	ft
Initial Channel Slope	0.0129	ft/ft
Long-term Channel Slope	0.0025	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	3



Initial Channel XS Geometry

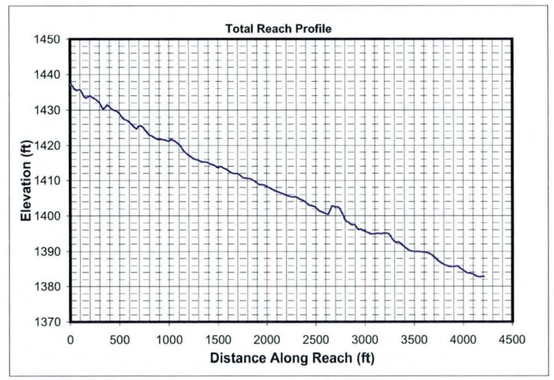
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	20	3	80	7	3	20	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	35	41	121	127	147	162
Y	105	100	100	98	98	100	100	105

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	20	3	80	7	3	20	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	35	41	121	127	147	162
Y	105	100	100	98	98	100	100	105



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	CN1								TOTAL
HEC1 Peak-Flow	6078								6078
Weighting Factor	1.00								
Flow into Channel	6078								6078

Reach Sediment Inflow Characteristics

U/S Contributing ID	M1-N1_N110								TOTAL
Flow Volume (ac. ft)	806.00								806
Sediment Conc. (ppm)	2418								
Sediment Volume (ac. ft)	0.74								0.74
Weighting Factor	1								
Weighted Sed. Vol. (ac. ft)	0.74								0.74

Hydrology

Drainage Area	11.45	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	6078	cfs	
Long-term Max. Chnl Capacity	10554	cfs	
Q2 Channel	608	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	162	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
608	89.6	128.4	1.4	98.0	99.5	4.7	1.5	89.1	1.4	0.24	0.70
1823	138.4	295.4	2.1	98.0	100.9	6.2	2.9	137.5	2.1	0.45	0.74
4559	148.7	526.7	3.5	98.0	102.5	8.7	4.5	147.2	3.6	0.71	0.81
6078	153.2	633.5	4.1	98.0	103.3	9.6	5.3	151.5	4.2	0.82	0.83

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
608	89.6	128.4	1.4	98.0	99.5	4.7	1.5	89.1	1.4	0.24	0.70
1823	138.4	295.4	2.1	98.0	100.9	6.2	2.9	137.5	2.1	0.45	0.74
4559	148.7	526.7	3.5	98.0	102.5	8.7	4.5	147.2	3.6	0.71	0.81
6078	153.2	633.5	4.1	98.0	103.3	9.6	5.3	151.5	4.2	0.82	0.83

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
	M1-N1_N110									
608	2276									2276
1823	8227									8227
4559	27364									27364
6078	40208									40208

Allowable Velocity

Channel Lining	Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
608	1.74	1.5080	1.4326	Erosive	Erosive	Erosive	0.4	Erosive	3.9	Stable	Stable
1823	1.74	1.6312	1.5497	Erosive	Erosive	Erosive	0.4	Erosive	5.7	Stable	Stable
4559	1.74	1.7891	1.6996	Erosive	Erosive	Erosive	0.5	Erosive	7.8	Stable	Stable
6078	1.74	1.8495	1.7570	Erosive	Erosive	Erosive	0.5	Erosive	8.6	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	608	1823	4559	6078	608	1823	4559	6078	608	1823	4559	6078
Bray - Equation #1	70	124	202	235	2.2	3.2	4.4	4.8	3.9	4.5	5.1	5.4
Bray - Equation #2	92	164	265	309	2.5	3.5	4.8	5.3	2.7	3.1	3.5	3.7
Hey	22	40	67	78	7.4	11.2	15.8	17.7				
Ackers & Charlton/Lacey	53	84	124	140					2.3	2.8	3.3	3.4
Parker	169	293	464	536	2.0	3.1	4.6	5.1				
Chang	102	201	352	419	0.3	0.1	-0.4	-0.7				
Kellerhals	44	77	122	140	3.5	5.5	7.9	8.9	3.9	4.3	4.7	4.9
AMAFCA/Schumm	89	138	147	152								
Moody & Odem	31	31	31	31	1.4	1.4	1.4	1.4				
BUREC	24.7	37.3	52.6	58.5	7	10	14	16	5.9	7.7	9.7	10.4
Average	70	119	183	210	3.2	4.8	6.6	7.3	3.7	4.5	5.3	5.6
Values As Designed	89	137	147	152	1.5	2.9	4.5	5.3	4.7	6.2	8.7	9.6
Difference with Design	-19	-19	35	58	1.7	1.8	2.0	2.0	-1.0	-1.7	-3.4	-4.0

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
608	3278	4304	6510	35782	3241	3483	1589	2588	16683	3051	13488	8545
1823	14121	13708	19139	170921	6278	13517	4730	9790	50295	9570	50816	32989
4559	55849	36993	50653	773019	8878	60278	11344	31334	126108	11745	162875	120825
6078	85631	50223	70757	1235250	9927	94350	14864	44717	168229	12523	232404	183534

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
608	2001	2627	3974	21841	1978	2126	970	1580	10183	1862	8233	5216
1823	2873	2789	3894	34777	1277	2750	962	1992	10233	1947	10339	6712
4559	4545	3011	4122	62913	723	4906	923	2550	10264	956	13256	9834
6078	5227	3066	4319	75399	606	5759	907	2730	10269	764	14186	11203

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
608	3278	3439	3482	3042	1036	1409	1589	2588	1305	238	3156	2233
1823	14121	11217	9879	14530	2209	5004	4730	9790	4101	324	12881	8071
4559	55849	30899	24363	65713	3397	15584	11344	31334	10533	468	45620	26828
6078	85631	42157	33233	105007	3871	22289	14864	44717	14109	637	67083	39418

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
608	2001	2099	2125	1857	633	860	970	1580	797	145	1926	1363
1823	2873	2282	2010	2956	450	1018	962	1992	834	66	2621	1642
4559	4545	2515	1983	5348	276	1268	923	2550	857	38	3713	2183
6078	5227	2573	2029	6410	236	1360	907	2730	861	39	4095	2406

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
608	0.0004	0.0002	253	0.77	0.053	0.0002	31	0.036	0.0001	0.0159	0.0002	0.0002	0.0041	0.0002	0.0006	0.0025	0.0018
1823	0.0003	0.0002	309	0.94	0.055	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0041	0.0001	0.0003	0.0025	0.0017
4559	0.0001	0.0001	398	1.21	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0041	0.0001	0.0001	0.0025	0.0017
6078	0.0001	0.0001	430	1.31	0.058	0.0001	33	0.036	0.0000	0.0159	0.0001	0.0001	0.0041	0.0001	0.0001	0.0025	0.0017

Drop Structures

Design Slope	0.0025	ft/ft
Total Drop Needed	44.1	ft
Height of Drop Structure	3	ft
No . of Drop Structures	15	
Distance between structs.	282	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.98	sq. mi
Total Sediment Yield Volume	1.87	ac ft

Sedimentation Basins

Length	282 ft	Depth	3 ft
Width	162 ft	Side slope	3 ft/ft
Total Volume per Basin		2.87	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		3	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
608	1.1	0.4	0.3	24.6	1.5	1.4	4.7	0.0025	0.3	0.0	1.0	2.3
1823	1.1	0.9	0.5	24.6	2.9	2.1	6.2	0.0025	0.6	0.0	1.0	3.6
4559	1.1	1.8	1.0	24.6	4.5	3.6	8.7	0.0025	1.0	0.0	1.0	5.6
6078	1.1	2.2	1.3	24.6	5.3	4.2	9.6	0.0025	1.1	0.0	1.0	6.5

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	5639	cfs
Stage at Peak Flow	100.9	ft
Volume at Peak Flow	806.0	ac. ft

Freeboard

Max. Flow Depth	5.3	ft
Channel Depth as designed	7.0	ft
Available Freeboard	1.7	ft
Required Freeboard	1.7	ft

Sediment Volume

Inflowing Sediment Volume	2.60	ac. ft
Outflowing Sediment Volume	0.73	ac. ft
Deposited(+)/Eroded(-) Volume	1.87	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	4224	4224
Side Slope (?H:1V)	3	6
Channel Width (ft)	162	204
Channel XS Area (sq. ft)	907	1054
Channel Perimeter (ft)	164	205

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	700230	867981
Excavated Area (sq. Yd)	76032	95744

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	4224	4224
Lining Width (ft)	32	61
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	15019	28629
Lining Volume (cu. Yd)	2503	4772

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	4224	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	704	sq. Yd
Volume	2347	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	4224	4224
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	4224	4224
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	162	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	19.4	ft
Structure Height	22.4	ft
Number of Structures	15	
Volume per structure	67	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 10,385	
Area per structure	9	sq. Yd
Total Area	135	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	3	
Total Volume per Basin	4630	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 18,520	
Other Cost	$ -	
Total cost per basin	$ 18,520	
Area per basin	5,069	sq. Yd
Total Area	15,207	sq. Yd

Structure Type	Structure Cost											
	Excavation/Construction					Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	700,230	cu. Yd	$ 10.00	$ 7,002,300	76,032	sq. Yd	$ 9.00	$ 684,288	76,032	sq. Yd	$ 8.33	$ 633,600
Exc. Chl - LC Enhancement	Excavated	167,751	cu. Yd	$ 10.00	$ 1,677,510	19,712	sq. Yd	$ 9.00	$ 177,408	19,712	sq. Yd	$ 8.33	$ 164,267
Channel Lining	Concrete	2,503	cu. Yd	$ 155.00	$ 387,965	15,019	sq. Yd	$ -	$ -	15,019	sq. Yd	$ 41.67	$ 625,792
Channel Lining - LC Enhancement	Concrete	2,269	cu. Yd	$ 155.00	$ 351,695	13,610	sq. Yd	$ -	$ -	13,610	sq. Yd	$ 41.67	$ 567,083
Toe Protection	Riprap	2,347	cu. Yd	$ 75.00	$ 176,025	704	sq. Yd	$ -	$ -	704	sq. Yd	$ 25.00	$ 17,600
Drop Structures	Concrete	15	EA	$ 10,385.00	$ 155,775	135	sq. Yd	$ -	$ -	135	sq. Yd	$ 41.67	$ 5,625
Drop Str. - LC Enhancement	Concrete	15	EA	$ 1,038.50	$ 15,578	14	sq. Yd	$ -	$ -	14	sq. Yd	$ 41.67	$ 563
Sedimentation Basins		3	EA	$ 18,520.00	$ 55,560	15,207	sq. Yd	$ -	$ -	15,207	sq. Yd	$ 8.33	$ 126,725
Other					$ -				$ -				$ -
Base Landscape Cost									$ 684,288	Base Maintenance Cost			$ 1,409,342
LC Enhancement Cost									$ 177,408	LC Enhancement Cost			$ 731,913
Total Landscape Cost									$ 861,696	Total Maintenance Cost			$ 2,141,254

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 7,777,625	$ 2,044,783	$ 9,822,408
Contingency Cost (25% of Construction Cost)	$ 1,944,406	$ 511,196	$ 2,455,602
Engineering Design Cost (5% of Construction Cost)	$ 388,881	$ 102,239	$ 491,120
Total Construction Cost	$ 10,110,913	$ 2,658,217	$ 12,769,130

Land Cost

Channel Length	4224 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	13	$100,000	$ 1,300,000
LC Enhancement Buffer	50	4.8	$100,000	$ 480,000
Channel	162	15.7	$100,000	$ 1,570,000
Channel LC Enhancement	42	4.1	$100,000	$ 410,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	388	37.6		$ 3,760,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	28.7	$100,000	$ 2,870,000
LC Enhancement Cost	acre	8.9	$100,000	$ 890,000
Total Land Cost	acre	37.6	$100,000	$ 3,760,000

Total Cost

Base Total Cost	$ 15,074,542
Total Landscape Enhancement Cost	$ 4,457,538
Total Cost Including LC Enh.	$ 19,532,080

Open Channel

Structure ID	N125

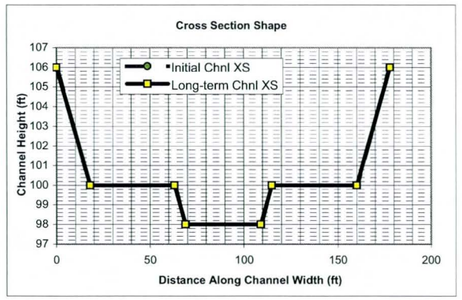
HEC1 ID	N1-P1A

Longitundal Geometry

Length	8101.2	ft
U/S Elev	1382.8	ft
D/S Elev	1276.4	ft
Initial Channel Slope	0.0131	ft/ft
Long-term Channel Slope	0.0025	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	3



Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	6	45	3	40	8	3	45	6	3

PT. ID	1	2	3	4	5	6	7	8
X	0	18	63	69	109	115	160	178
Y	106	100	100	98	98	100	100	106

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	6	45	3	40	8	3	45	6	3

PT. ID	1	2	3	4	5	6	7	8
X	0	18	63	69	109	115	160	178
Y	106	100	100	98	98	100	100	106

Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	CN2AR									TOTAL
HEC1 Peak-Flow	6376									6376
Weighting Factor	1.00									
Flow into Channel	6376									6376

Reach Sediment Inflow Characteristics

U/S Contributing ID	M1-N1_N120									TOTAL
Flow Volume (ac. ft)	806.00									806
Sediment Conc. (ppm)	2406									
Sediment Volume (ac. ft)	0.73									0.73
Weighting Factor	1									
Weighted Sed. Vol. (ac. ft)	0.73									0.73

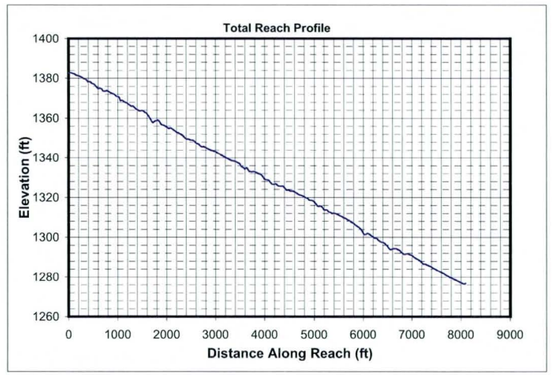
Hydrology

Drainage Area	12.97	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	6376	cfs	
Long-term Max. Chnl Capacity	12687	cfs	
Q2 Channel	638	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	178	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			



Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
638	145.7	160.5	1.1	98.0	100.5	4.0	2.5	144.9	1.1	0.39	0.67
1913	152.3	315.8	2.1	98.0	101.5	6.1	3.5	151.2	2.1	0.55	0.74
4782	162.3	561.3	3.5	98.0	103.1	8.5	5.1	160.6	3.5	0.80	0.80
6376	166.7	674.2	4.0	98.0	103.8	9.5	5.8	164.8	4.1	0.90	0.82

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
638	145.7	160.5	1.1	98.0	100.5	4.0	2.5	144.9	1.1	0.39	0.67
1913	152.3	315.8	2.1	98.0	101.5	6.1	3.5	151.2	2.1	0.55	0.74
4782	162.3	561.3	3.5	98.0	103.1	8.5	5.1	160.6	3.5	0.80	0.80
6376	166.7	674.2	4.0	98.0	103.8	9.5	5.8	164.8	4.1	0.90	0.82

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
	M1-N1_N120									
638	2233									2233
1913	8071									8071
4782	26828									26828
6376	39418									39418

Allowable Velocity

Channel Lining: Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
638	1.74	1.4270	1.3556	Erosive	Erosive	Erosive	0.3	Erosive	4.7	Stable	Stable
1913	1.74	1.6226	1.5415	Erosive	Erosive	Erosive	0.4	Erosive	6.3	Stable	Stable
4782	1.74	1.7801	1.6911	Erosive	Erosive	Erosive	0.5	Erosive	8.2	Stable	Stable
6376	1.74	1.8411	1.7491	Erosive	Erosive	Erosive	0.5	Erosive	9.0	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	638	1913	4782	6376	638	1913	4782	6376	638	1913	4782	6376
Bray - Equation #1	72	128	207	241	2.3	3.3	4.5	4.9	3.9	4.6	5.2	5.4
Bray - Equation #2	94	168	272	317	2.5	3.6	4.9	5.4	2.7	3.1	3.6	3.7
Hey	23	42	68	80	7.5	11.4	16.1	18.0				
Ackers & Charlton/Lacey	54	86	126	143					2.4	2.8	3.3	3.5
Parker	173	300	475	549	2.0	3.2	4.7	5.3				
Chang	105	207	362	431	0.3	0.1	-0.5	-0.7				
Kellerhals	45	79	124	144	3.6	5.6	8.1	9.0	3.9	4.3	4.8	4.9
AMAFCA/Schumm	145	151	161	165								
Moody & Odem	32	32	32	32	1.4	1.4	1.4	1.4				
BUREC	25.1	38.0	53.5	59.6	7	10	14	16	5.9	7.8	9.8	10.6
Average	77	123	188	216	3.3	4.8	6.7	7.4	3.8	4.5	5.3	5.6
Values As Designed	145	151	161	165	2.5	3.5	5.1	5.8	4.0	6.1	8.5	9.5
Difference with Design	-68	-28	28	51	0.8	1.3	1.6	1.6	-0.2	-1.5	-3.2	-3.9

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
638	2705	4019	7171	28256	4547	3098	1643	2266	17808	2646	12086	7840
1913	14418	14131	20170	177458	6853	14061	4963	10105	53961	10774	53032	34539
4782	57321	38436	53215	807094	9641	62772	11922	32509	135315	13140	170675	126549
6376	88052	52282	74166	1292535	10758	98473	15625	46457	180513	13974	243830	192424

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
638	1574	2338	4172	16441	2646	1803	956	1318	10362	1540	7032	4562
1913	2797	2741	3912	34419	1329	2727	963	1960	10466	2090	10286	6699
4782	4447	2982	4129	62616	748	4870	925	2522	10498	1019	13241	9818
6376	5123	3042	4316	75209	626	5730	909	2703	10504	813	14188	11197

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
638	2705	3147	3445	2348	1327	1316	1643	2266	1296	421	2647	2051
1913	14418	11532	10395	14748	2378	5182	4963	10105	4292	359	13221	8327
4782	57321	32035	25489	67074	3648	16170	11922	32509	11041	489	47110	27710
6376	88052	43796	34738	107417	4151	23143	15625	46457	14792	666	69406	40749

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
638	1574	1831	2005	1366	772	765	956	1318	754	245	1540	1193
1913	2797	2237	2016	2860	461	1005	963	1960	832	70	2564	1615
4782	4447	2485	1978	5204	283	1255	925	2522	857	38	3655	2150
6376	5123	2548	2021	6250	242	1347	909	2703	861	39	4039	2371

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
638	0.0006	0.0003	224	0.68	0.052	0.0003	31	0.036	0.0002	0.0159	0.0002	0.0003	0.0040	0.0002	0.0007	0.0025	0.0018
1913	0.0003	0.0002	307	0.94	0.055	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0040	0.0001	0.0003	0.0025	0.0017
4782	0.0001	0.0001	397	1.21	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0040	0.0001	0.0001	0.0025	0.0017
6376	0.0001	0.0001	429	1.31	0.058	0.0001	33	0.036	0.0000	0.0159	0.0001	0.0001	0.0040	0.0001	0.0001	0.0025	0.0017

Drop Structures

Design Slope	0.0025	ft/ft
Total Drop Needed	86.1	ft
Height of Drop Structure	3	ft
No . of Drop Structures	29	
Distance between structs.	279	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.48	sq. mi
Total Sediment Yield Volume	2.81	ac ft

Sedimentation Basins

Length	279 ft	Depth	3 ft
Width	178 ft	Side slope	3 ft/ft
Total Volume per Basin		3.15	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		3	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
638	1.1	0.5	0.2	24.6	2.5	1.1	4.0	0.0025	0.5	0.0	1.0	2.7
1913	1.1	1.1	0.5	24.6	3.5	2.1	6.1	0.0025	0.7	0.0	1.0	3.9
4782	1.1	2.0	1.0	24.6	5.1	3.5	8.5	0.0025	1.1	0.0	1.0	6.0
6376	1.1	2.4	1.2	24.6	5.8	4.1	9.5	0.0025	1.3	0.0	1.0	6.9

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	6014	cfs
Stage at Peak Flow	101.9	ft
Volume at Peak Flow	898.0	ac. ft

Freeboard

Max. Flow Depth	5.8	ft
Channel Depth as designed	8.0	ft
Available Freeboard	2.2	ft
Required Freeboard	1.8	ft

Sediment Volume

Inflowing Sediment Volume	3.54	ac. ft
Outflowing Sediment Volume	0.80	ac. ft
Deposited(+)/Eroded(-) Volume	2.74	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	8101	8101
Side Slope (?H:1V)	3	6
Channel Width (ft)	178	226
Channel XS Area (sq. ft)	1052	1244
Channel Perimeter (ft)	181	228

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	2614648	3292212
Excavated Area (sq. Yd)	160220	203425

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	8101	8101
Lining Width (ft)	38	73
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	34204	65708
Lining Volume (cu. Yd)	5701	10951

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	8101	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	1350	sq. Yd
Volume	4501	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	8101	8101
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	8101	8101
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	178	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	19.0	ft
Structure Height	22.0	ft
Number of Structures	29	
Volume per structure	72	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 11,160	
Area per structure	10	sq. Yd
Total Area	287	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	3	
Total Volume per Basin	5082	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 20,328	
Other Cost	$ -	
Total cost per basin	$ 20,328	
Area per basin	5,525	sq. Yd
Total Area	16,575	sq. Yd

Structure Type	Structure Cost											
	Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	2,614,648	cu. Yd	$ 10.00	$ 26,146,480	160,220	sq. Yd	$ 9.00	$ 1,441,980	160,220	sq. Yd	$ 8.33	$ 1,335,167
Exc. Chl - LC Enhancement	Excavated	677,564	cu. Yd	$ 10.00	$ 6,775,640	43,205	sq. Yd	$ 9.00	$ 388,845	43,205	sq. Yd	$ 8.33	$ 360,042
Channel Lining	Concrete	5,701	cu. Yd	$ 155.00	$ 883,655	34,204	sq. Yd	$ -	$ -	34,204	sq. Yd	$ 41.67	$ 1,425,167
Channel Lining - LC Enhancement	Concrete	5,250	cu. Yd	$ 155.00	$ 813,750	31,504	sq. Yd	$ -	$ -	31,504	sq. Yd	$ 41.67	$ 1,312,667
Toe Protection	Riprap	4,501	cu. Yd	$ 75.00	$ 337,575	1,350	sq. Yd	$ -	$ -	1,350	sq. Yd	$ 25.00	$ 33,750
Drop Structures	Concrete	29	EA	$ 11,160.00	$ 323,640	287	sq. Yd	$ -	$ -	287	sq. Yd	$ 41.67	$ 11,958
Drop Str. - LC Enhancement	Concrete	29	EA	$ 1,116.00	$ 32,364	29	sq. Yd	$ -	$ -	29	sq. Yd	$ 41.67	$ 1,196
Sedimentation Basins		3	EA	$ 20,328.00	$ 60,984	16,575	sq. Yd	$ -	$ -	16,575	sq. Yd	$ 8.33	$ 138,125
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,441,980	Base Maintenance Cost			$ 2,944,167
						LC Enhancement Cost			$ 388,845	LC Enhancement Cost			$ 1,673,904
						Total Landscape Cost			$ 1,830,825	Total Maintenance Cost			$ 4,618,071

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 27,752,334	$ 7,621,754	$ 35,374,088
Contingency Cost (25% of Construction Cost)	$ 6,938,084	$ 1,905,439	$ 8,843,522
Engineering Design Cost (5% of Construction Cost)	$ 1,387,617	$ 381,088	$ 1,768,704
Total Construction Cost	$ 36,078,034	$ 9,908,280	$ 45,986,314

Land Cost

Channel Length	8101	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	24.9	$100,000	$ 2,490,000
LC Enhancement Buffer	50	9.3	$100,000	$ 930,000
Channel	178	33.1	$100,000	$ 3,310,000
Channel LC Enhancement	48	8.9	$100,000	$ 890,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	410	76.2		$ 7,620,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	58	$100,000	$ 5,800,000
LC Enhancement Cost	acre	18.2	$100,000	$ 1,820,000
Total Land Cost	acre	76.2	$100,000	$ 7,620,000

Total Cost

Base Total Cost	$ 46,264,181
Total Landscape Enhancement Cost	$ 13,791,029
Total Cost Including LC Enh.	$ 60,055,210

Open Channel

Structure ID	N130

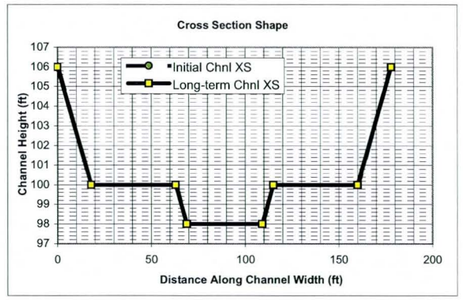
HEC1 ID	P1A-1B

Longitudinal Geometry

Length	10853.3	ft
U/S Elev	1276.4	ft
D/S Elev	1133.0	ft
Initial Channel Slope	0.0132	ft/ft
Long-term Channel Slope	0.0025	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	6



Initial Channel XS Geometry

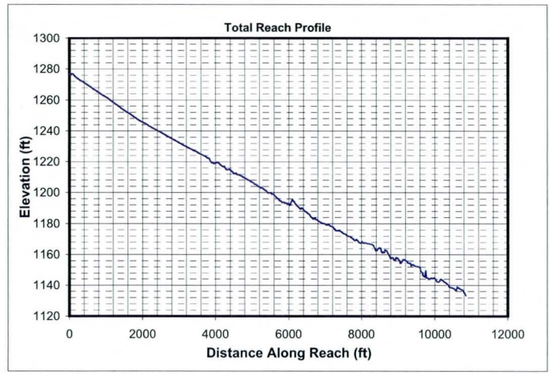
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	6	45	3	40	8	3	45	6	3

PT. ID	1	2	3	4	5	6	7	8
X	0	18	63	69	109	115	160	178
Y	106	100	100	98	98	100	100	106

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	6	45	3	40	8	3	45	6	3

PT. ID	1	2	3	4	5	6	7	8
X	0	18	63	69	109	115	160	178
Y	106	100	100	98	98	100	100	106



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	P1A-1B	P1B							TOTAL
HEC1 Peak-Flow	6396	852							7248
Weighting Factor	1.00	0.64							
Flow into Channel	6396	545							6941

Reach Sediment Inflow Characteristics

U/S Contributing ID	N1-P1A_N125	P1A-1B_RRP1A10							TOTAL
Flow Volume (ac. ft)	898.00	1026.00							1924
Sediment Conc. (ppm)	2371	2204							
Sediment Volume (ac. ft)	0.80	0.85							1.66
Weighting Factor	1	1							
Weighted Sed. Vol. (ac. ft)	0.80	0.85							1.66

Hydrology

Drainage Area	15.41	sq. miles

(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	6941	cfs	
Long-term Max. Chnl Capacity	12687	cfs	
Q2 Channel	694	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	178	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
694	146.0	169.0	1.2	98.0	100.5	4.1	2.5	145.2	1.2	0.40	0.67
2082	153.0	332.9	2.2	98.0	101.6	6.3	3.6	151.8	2.2	0.57	0.74
5206	163.5	592.4	3.6	98.0	103.3	8.8	5.3	161.8	3.7	0.83	0.81
6941	168.1	711.9	4.2	98.0	104.0	9.8	6.0	166.1	4.3	0.94	0.83

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
694	146.0	169.0	1.2	98.0	100.5	4.1	2.5	145.2	1.2	0.40	0.67
2082	153.0	332.9	2.2	98.0	101.6	6.3	3.6	151.8	2.2	0.57	0.74
5206	163.5	592.4	3.6	98.0	103.3	8.8	5.3	161.8	3.7	0.83	0.81
6941	168.1	711.9	4.2	98.0	104.0	9.8	6.0	166.1	4.3	0.94	0.83

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
	N1-P1A_N125	P1A-1B_RRP1A10								
694	2051	217								2268
2082	8327	803								9130
5206	27710	2408								30118
6941	40749	3416								44166

Allowable Velocity

Channel Lining: Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
694	1.74	1.4423	1.3701	Erosive	Erosive	Erosive	0.3	Erosive	4.8	Stable	Stable
2082	1.74	1.6375	1.5557	Erosive	Erosive	Erosive	0.4	Erosive	6.4	Stable	Stable
5206	1.74	1.7982	1.7083	Erosive	Erosive	Erosive	0.5	Erosive	8.5	Stable	Stable
6941	1.74	1.8590	1.7661	Erosive	Erosive	Erosive	0.5	Erosive	9.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	694	2082	5206	6941	694	2082	5206	6941	694	2082	5206	6941
Bray - Equation #1	75	133	216	252	2.4	3.4	4.6	5.1	3.9	4.6	5.2	5.5
Bray - Equation #2	98	175	285	331	2.6	3.7	5.0	5.5	2.7	3.2	3.6	3.7
Hey	24	43	72	84	7.7	11.8	16.7	18.6				
Ackers & Charlton/Lacey	56	89	131	148					2.4	2.9	3.3	3.5
Parker	181	313	496	572	2.1	3.3	4.8	5.4				
Chang	111	218	381	454	0.3	0.0	-0.5	-0.8				
Kellerhals	47	82	130	150	3.7	5.8	8.3	9.4	3.9	4.4	4.8	4.9
AMAFCA/Schumm	145	152	162	166								
Moody & Odem	34	34	34	34	1.4	1.4	1.4	1.4				
BUREC	26.0	39.2	55.2	61.5	7	10	15	16	6.1	8.0	10.0	10.8
Average	80	128	196	225	3.4	5.0	6.9	7.6	3.8	4.6	5.4	5.7
Values As Designed	145	152	162	166	2.5	3.6	5.3	6.0	4.1	6.3	8.8	9.8
Difference with Design	-65	-24	34	59	0.9	1.3	1.6	1.6	-0.3	-1.7	-3.4	-4.1

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
694	3080	4446	7750	32922	4716	3502	1796	2557	19612	3012	13672	8824
2082	16397	15541	22063	206465	7099	15871	5390	11287	59374	11134	59522	39104
5206	65077	42131	58740	937222	9993	72287	12915	36136	148849	13566	190566	144317
6941	99903	57264	82460	1499797	11155	113275	16918	51582	198559	14426	271846	219744

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
694	1646	2377	4143	17597	2521	1872	960	1367	10483	1610	7308	4717
2082	2921	2769	3931	36785	1265	2828	960	2011	10579	1984	10605	6967
5206	4638	3003	4186	66793	712	5152	920	2575	10608	967	13581	10285
6941	5340	3061	4408	80165	596	6055	904	2757	10613	771	14530	11745

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
694	3080	3492	3788	2708	1394	1464	1796	2557	1428	415	3009	2285
2082	16397	12701	11244	16984	2478	5757	5390	11287	4691	355	14910	9290
5206	65077	35144	27881	77095	3790	17974	12915	36136	12038	536	52846	31039
6941	99903	48001	37976	123372	4312	25730	16918	51582	16122	731	77739	45671

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
694	1646	1867	2025	1448	745	783	960	1367	763	222	1608	1221
2082	2921	2263	2003	3026	442	1026	960	2011	836	63	2656	1655
5206	4638	2505	1987	5494	270	1281	920	2575	858	38	3766	2212
6941	5340	2566	2030	6594	230	1375	904	2757	862	39	4155	2441

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
694	0.0005	0.0003	230	0.70	0.052	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0003	0.0039	0.0002	0.0006	0.0025	0.0017
2082	0.0002	0.0002	316	0.96	0.055	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0039	0.0001	0.0003	0.0025	0.0017
5206	0.0001	0.0001	407	1.24	0.058	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0039	0.0001	0.0001	0.0025	0.0016
6941	0.0001	0.0001	440	1.34	0.058	0.0001	33	0.036	0.0000	0.0159	0.0001	0.0001	0.0039	0.0001	0.0001	0.0025	0.0016

Drop Structures

Design Slope	0.0025	ft/ft
Total Drop Needed	116.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	39	
Distance between structs.	278	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.83	sq. mi
Total Sediment Yield Volume	3.47	ac ft

Sedimentation Basins

Length	278 ft	Depth	3 ft
Width	178 ft	Side slope	3 ft/ft
Total Volume per Basin		3.14	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		5	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
694	1.1	0.5	0.2	24.6	2.5	1.2	4.1	0.0025	0.5	0.0	1.0	2.7
2082	1.1	1.1	0.5	24.6	3.6	2.2	6.3	0.0025	0.7	0.0	1.0	4.1
5206	1.1	2.1	1.1	24.6	5.3	3.7	8.8	0.0025	1.1	0.0	1.0	6.2
6941	1.1	2.6	1.3	24.6	6.0	4.3	9.8	0.0025	1.3	0.0	1.0	7.2

Toe Protection Needed	8.0	ft

HEC1 Results For Open Channel

Peak Flow	6396	cfs
Stage at Peak Flow	102.1	ft
Volume at Peak Flow	1026.0	ac. ft

Freeboard

Max. Flow Depth	6.0	ft
Channel Depth as designed	8.0	ft
Available Freeboard	2.0	ft
Required Freeboard	1.9	ft

Sediment Volume

Inflowing Sediment Volume	5.12	ac. ft
Outflowing Sediment Volume	0.95	ac. ft
Deposited(+)/Eroded(-) Volume	4.18	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	10853	10853
Side Slope (?H:1V)	3	6
Channel Width (ft)	178	226
Channel XS Area (sq. ft)	1052	1244
Channel Perimeter (ft)	181	228

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	4584086	5783390
Excavated Area (sq. Yd)	214648	272531

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	10853	10853
Lining Width (ft)	38	73
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	45824	88030
Lining Volume (cu. Yd)	7637	14672

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	10853	ft
Thickness	1.5	ft
Protection Depth	8	ft
Tie-in Length/Depth	3.0	ft
Total Depth	11.0	ft
Area needed	1809	sq. Yd
Volume	6632	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	10853	10853
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	10853	10853
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	178	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	19.8	ft
Structure Height	22.8	ft
Number of Structures	39	
Volume per structure	75	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 11,625	
Area per structure	10	sq. Yd
Total Area	386	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	5	
Total Volume per Basin	5066	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 20,264	
Other Cost	$ -	
Total cost per basin	$ 20,264	
Area per basin	5,504	sq. Yd
Total Area	27,520	sq. Yd

Structure Type	Structure Cost											
	Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	4,584,086	cu. Yd	$ 10.00	$ 45,840,860	214,648	sq. Yd	$ 9.00	$ 1,931,832	214,648	sq. Yd	$ 8.33	$ 1,788,733
Exc. Chl - LC Enhancement	Excavated	1,199,304	cu. Yd	$ 10.00	$ 11,993,040	57,883	sq. Yd	$ 9.00	$ 520,947	57,883	sq. Yd	$ 8.33	$ 482,358
Channel Lining	Concrete	7,637	cu. Yd	$ 155.00	$ 1,183,735	45,824	sq. Yd	$ -	$ -	45,824	sq. Yd	$ 41.67	$ 1,909,333
Channel Lining - LC Enhancement	Concrete	7,035	cu. Yd	$ 155.00	$ 1,090,425	42,206	sq. Yd	$ -	$ -	42,206	sq. Yd	$ 41.67	$ 1,758,583
Toe Protection	Riprap	6,632	cu. Yd	$ 75.00	$ 497,400	1,809	sq. Yd	$ -	$ -	1,809	sq. Yd	$ 25.00	$ 45,225
Drop Structures	Concrete	39	EA	$ 11,625.00	$ 453,375	386	sq. Yd	$ -	$ -	386	sq. Yd	$ 41.67	$ 16,083
Drop Str. - LC Enhancement	Concrete	39	EA	$ 1,162.50	$ 45,338	39	sq. Yd	$ -	$ -	39	sq. Yd	$ 41.67	$ 1,608
Sedimentation Basins		5	EA	$ 20,264.00	$ 101,320	27,520	sq. Yd	$ -	$ -	27,520	sq. Yd	$ 8.33	$ 229,333
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,931,832	Base Maintenance Cost			$ 3,988,708
						LC Enhancement Cost			$ 520,947	LC Enhancement Cost			$ 2,242,550
						Total Landscape Cost			$ 2,452,779	Total Maintenance Cost			$ 6,231,258

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 48,076,690	$ 13,128,803	$ 61,205,493
Contingency Cost (25% of Construction Cost)	$ 12,019,173	$ 3,282,201	$ 15,301,373
Engineering Design Cost (5% of Construction Cost)	$ 2,403,835	$ 656,440	$ 3,060,275
Total Construction Cost	$ 62,499,697	$ 17,067,443	$ 79,567,140

Land Cost

Channel Length	10853	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	33.4	$100,000	$ 3,340,000
LC Enhancement Buffer	50	12.5	$100,000	$ 1,250,000
Channel	178	44.3	$100,000	$ 4,430,000
Channel LC Enhancement	48	12	$100,000	$ 1,200,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	410	102.2		$ 10,220,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	77.7	$100,000	$ 7,770,000
LC Enhancement Cost	acre	24.5	$100,000	$ 2,450,000
Total Land Cost	acre	102.2	$100,000	$ 10,220,000

Total Cost

Base Total Cost	$ 76,190,237
Total Landscape Enhancement Cost	$ 22,280,940
Total Cost Including LC Enh.	$ 98,471,178

Open Channel

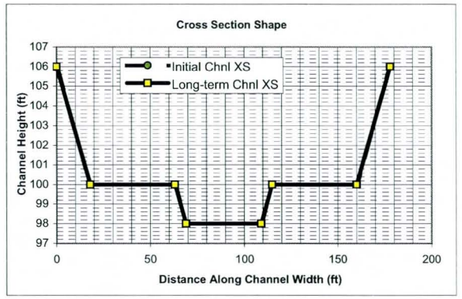
Structure ID	N140	HEC1 ID	P1A-1B

Longitudal Geometry

Length	5668.0	ft
U/S Elev	1133.0	ft
D/S Elev	1092.0	ft
Initial Channel Slope	0.0072	ft/ft
Long-term Channel Slope	0.0025	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	6



Initial Channel XS Geometry

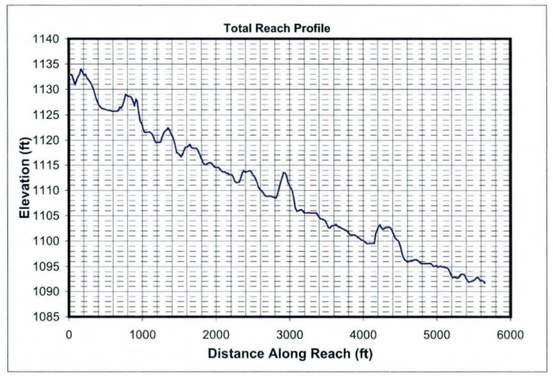
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	6	45	3	40	8	3	45	6	3

PT. ID	1	2	3	4	5	6	7	8
X	0	18	63	69	109	115	160	178
Y	106	100	100	98	98	100	100	106

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	6	45	3	40	8	3	45	6	3

PT. ID	1	2	3	4	5	6	7	8
X	0	18	63	69	109	115	160	178
Y	106	100	100	98	98	100	100	106



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	P									TOTAL
HEC1 Peak-Flow	7456									7456
Weighting Factor	1.00									
Flow into Channel	7456									7456

Reach Sediment Inflow Characteristics

U/S Contributing ID	P1A-1B_N130	Q1A-P_P1B10								TOTAL
Flow Volume (ac. ft)	1026.00	97.00								1123
Sediment Conc. (ppm)	2441	2227								
Sediment Volume (ac. ft)	0.95	0.08								1.03
Weighting Factor	1	1								
Weighted Sed. Vol. (ac. ft)	0.95	0.08								1.03

Hydrology

Drainage Area	15.41	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	7456	cfs	
Long-term Max. Chnl Capacity	12687	cfs	
Q2 Channel	746	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	178	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
746	146.4	176.6	1.2	98.0	100.6	4.2	2.6	145.5	1.2	0.40	0.68
2237	153.7	348.1	2.3	98.0	101.7	6.4	3.7	152.4	2.3	0.58	0.75
5592	164.6	620.0	3.8	98.0	103.5	9.0	5.5	162.8	3.8	0.85	0.81
7456	169.4	745.3	4.4	98.0	104.2	10.0	6.2	167.3	4.5	0.97	0.84

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
746	146.4	176.6	1.2	98.0	100.6	4.2	2.6	145.5	1.2	0.40	0.68
2237	153.7	348.1	2.3	98.0	101.7	6.4	3.7	152.4	2.3	0.58	0.75
5592	164.6	620.0	3.8	98.0	103.5	9.0	5.5	162.8	3.8	0.85	0.81
7456	169.4	745.3	4.4	98.0	104.2	10.0	6.2	167.3	4.5	0.97	0.84

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
	P1A-1B_N130	Q1A-P_P1B10								
746	2285	499								2784
2237	9290	1565								10855
5592	31039	4931								35970
7456	45671	7125								52796

Allowable Velocity

Channel Lining: Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
746	1.74	1.4551	1.3824	Erosive	Erosive	Erosive	0.3	Erosive	4.9	Stable	Stable
2237	1.74	1.6501	1.5676	Erosive	Erosive	Erosive	0.4	Erosive	6.6	Stable	Stable
5592	1.74	1.8134	1.7227	Erosive	Erosive	Erosive	0.5	Erosive	8.7	Stable	Stable
7456	1.74	1.8740	1.7803	Erosive	Erosive	Erosive	0.5	Erosive	9.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	746	2237	5592	7456	746	2237	5592	7456	746	2237	5592	7456
Bray - Equation #1	78	139	225	261	2.4	3.5	4.7	5.2	4.0	4.7	5.3	5.5
Bray - Equation #2	102	182	296	344	2.6	3.8	5.1	5.7	2.7	3.2	3.6	3.8
Hey	25	45	74	87	8.0	12.1	17.1	19.1				
Ackers & Charlton/Lacey	58	92	135	152					2.4	2.9	3.4	3.5
Parker	188	325	514	593	2.2	3.4	5.0	5.6				
Chang	116	228	398	474	0.3	0.0	-0.6	-0.9				
Kellerhals	49	85	135	155	3.8	5.9	8.6	9.6	4.0	4.4	4.8	5.0
AMAFCA/Schumm	146	153	163	168								
Moody & Odem	34	34	34	34	1.4	1.4	1.4	1.4				
BUREC	26.7	40.2	56.7	63.2	7	11	15	17	6.2	8.1	10.2	11.0
Average	82	132	203	233	3.5	5.1	7.1	7.8	3.9	4.7	5.5	5.8
Values As Designed	146	152	163	167	2.6	3.7	5.5	6.2	4.2	6.4	9.0	10.0
Difference with Design	-63	-20	40	66	0.9	1.4	1.6	1.6	-0.4	-1.8	-3.5	-4.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
746	3436	4449	6622	14995	3312	2691	1935	2829	8379	1722	9130	5409
2237	18268	15670	18393	93914	5160	11562	5775	12383	25624	2843	41401	22818
5592	72415	42659	48131	425615	7393	38852	13815	39495	64434	3573	136975	81214
7456	111105	58037	66528	680645	8287	63100	18090	56324	85998	3848	197356	122665

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
746	1710	2214	3295	7461	1648	1339	963	1407	4169	857	4543	2691
2237	3030	2599	3051	15577	856	1918	958	2054	4250	472	6867	3785
5592	4804	2830	3193	28237	490	2578	917	2620	4275	237	9088	5388
7456	5528	2888	3310	33868	412	3140	900	2803	4279	191	9820	6104

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
746	3436	3811	4105	3054	1452	1602	1935	2829	1549	410	3350	2503
2237	18268	13772	12020	19127	2565	6291	5775	12383	5054	352	16492	10191
5592	72415	37990	30103	86683	3914	19650	13815	39495	12947	578	58201	34163
7456	111105	51847	40894	138624	4452	28136	18090	56324	17334	790	85507	50282

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
746	1710	1896	2043	1520	723	797	963	1407	771	204	1667	1245
2237	3030	2284	1994	3172	425	1043	958	2054	838	58	2735	1690
5592	4804	2520	1997	5751	260	1304	917	2620	859	38	3861	2267
7456	5528	2580	2035	6898	222	1400	900	2803	863	39	4255	2502

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
746	0.0005	0.0003	174	0.53	0.049	0.0002	30	0.036	0.0002	0.0159	0.0002	0.0003	0.0038	0.0002	0.0006	0.0025	0.0017
2237	0.0002	0.0002	238	0.73	0.052	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0001	0.0038	0.0001	0.0003	0.0025	0.0016
5592	0.0001	0.0001	307	0.94	0.055	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0001	0.0038	0.0001	0.0001	0.0025	0.0016
7456	0.0001	0.0001	332	1.01	0.056	0.0001	32	0.036	0.0000	0.0159	0.0001	0.0001	0.0038	0.0001	0.0001	0.0025	0.0016

Drop Structures

Design Slope	0.0025	ft/ft
Total Drop Needed	26.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	630	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.70	sq. mi
Total Sediment Yield Volume	1.34	ac ft

Sedimentation Basins

Length	630 ft	Depth	3 ft
Width	178 ft	Side slope	3 ft/ft
Total Volume per Basin		7.23	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		1	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
746	1.1	0.5	0.2	24.6	2.6	1.2	4.2	0.0025	0.5	0.0	1.0	2.8
2237	1.1	1.2	0.6	24.6	3.7	2.3	6.4	0.0025	0.8	0.0	1.0	4.2
5592	1.1	2.2	1.1	24.6	5.5	3.8	9.0	0.0025	1.2	0.0	1.0	6.4
7456	1.1	2.7	1.4	24.6	6.2	4.5	10.0	0.0025	1.4	0.0	1.0	7.5

Toe Protection Needed	8.0	ft

HEC1 Results For Open Channel

Peak Flow	6396	cfs
Stage at Peak Flow	102.1	ft
Volume at Peak Flow	1026.0	ac. ft

Freeboard

Max. Flow Depth	6.2	ft
Channel Depth as designed	8.0	ft
Available Freeboard	1.8	ft
Required Freeboard	1.9	ft

Sediment Volume

Inflowing Sediment Volume	2.36	ac. ft
Outflowing Sediment Volume	0.97	ac. ft
Deposited(+)/Eroded(-) Volume	1.40	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	5668	5668
Side Slope (?H:1V)	3	6
Channel Width (ft)	178	226
Channel XS Area (sq. ft)	1052	1244
Channel Perimeter (ft)	181	228

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	720899	896051
Excavated Area (sq. Yd)	112100	142330

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	5668	5668
Lining Width (ft)	38	73
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	23932	45974
Lining Volume (cu. Yd)	3989	7662

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5668	ft
Thickness	1.5	ft
Protection Depth	8	ft
Tie-in Length/Depth	3.0	ft
Total Depth	11.0	ft
Area needed	945	sq. Yd
Volume	3464	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5668	5668
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	5668	5668
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	178	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	20.5	ft
Structure Height	23.5	ft
Number of Structures	9	
Volume per structure	78	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 12,090	
Area per structure	10	sq. Yd
Total Area	89	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	1	
Total Volume per Basin	11664	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 46,656	
Other Cost	$ -	
Total cost per basin	$ 46,656	
Area per basin	12,456	sq. Yd
Total Area	12,456	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction					Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	720,899	cu. Yd	$ 10.00	$ 7,208,990	112,100	sq. Yd	$ 9.00	$ 1,008,900	112,100	sq. Yd	$ 8.33	$ 934,167
Exc. Chl - LC Enhancement	Excavated	175,152	cu. Yd	$ 10.00	$ 1,751,520	30,230	sq. Yd	$ 9.00	$ 272,070	30,230	sq. Yd	$ 8.33	$ 251,917
Channel Lining	Concrete	3,989	cu. Yd	$ 155.00	$ 618,295	23,932	sq. Yd	$ -	$ -	23,932	sq. Yd	$ 41.67	$ 997,167
Channel Lining - LC Enhancement	Concrete	3,673	cu. Yd	$ 155.00	$ 569,315	22,042	sq. Yd	$ -	$ -	22,042	sq. Yd	$ 41.67	$ 918,417
Toe Protection	Riprap	3,464	cu. Yd	$ 75.00	$ 259,800	945	sq. Yd	$ -	$ -	945	sq. Yd	$ 25.00	$ 23,625
Drop Structures	Concrete	9	EA	$ 12,090.00	$ 108,810	89	sq. Yd	$ -	$ -	89	sq. Yd	$ 41.67	$ 3,708
Drop Str. - LC Enhancement	Concrete	9	EA	$ 1,209.00	$ 10,881	9	sq. Yd	$ -	$ -	9	sq. Yd	$ 41.67	$ 371
Sedimentation Basins		1	EA	$ 46,656.00	$ 46,656	12,456	sq. Yd	$ -	$ -	12,456	sq. Yd	$ 8.33	$ 103,800
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,008,900	Base Maintenance Cost			$ 2,062,467
						LC Enhancement Cost			$ 272,070	LC Enhancement Cost			$ 1,170,704
						Total Landscape Cost			$ 1,280,970	Total Maintenance Cost			$ 3,233,171

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 8,242,551	$ 2,331,716	$ 10,574,267
Contingency Cost (25% of Construction Cost)	$ 2,060,638	$ 582,929	$ 2,643,567
Engineering Design Cost (5% of Construction Cost)	$ 412,128	$ 116,586	$ 528,713
Total Construction Cost	$ 10,715,316	$ 3,031,231	$ 13,746,547

Land Cost

Channel Length	5668	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	17.4	$100,000	$ 1,740,000
LC Enhancement Buffer	50	6.5	$100,000	$ 650,000
Channel	178	23.2	$100,000	$ 2,320,000
Channel LC Enhancement	48	6.2	$100,000	$ 620,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	410	53.3		$ 5,330,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	40.6	$100,000	$ 4,060,000
LC Enhancement Cost	acre	12.7	$100,000	$ 1,270,000
Total Land Cost	acre	53.3	$100,000	$ 5,330,000

Total Cost

Base Total Cost	$ 17,846,683
Total Landscape Enhancement Cost	$ 5,744,005
Total Cost Including LC Enh.	$ 23,590,688

Open Channel

Structure ID	P1B10

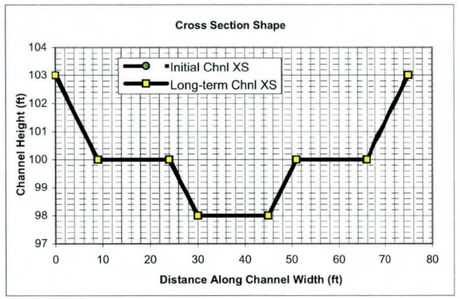
HEC1 ID	Q1A-P

Longitudal Geometry

Length	5122.9	ft
U/S Elev	1190.4	ft
D/S Elev	1133.0	ft
Initial Channel Slope	0.0112	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	2



Initial Channel XS Geometry

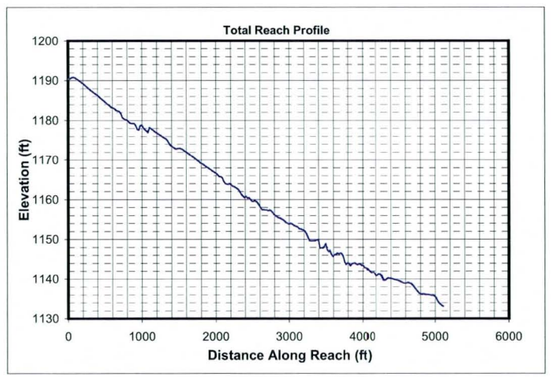
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	15	3	15	5	3	15	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	24	30	45	51	66	75
Y	103	100	100	98	98	100	100	103

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	15	3	15	5	3	15	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	24	30	45	51	66	75
Y	103	100	100	98	98	100	100	103



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	Q1A	P1B							TOTAL
HEC1 Peak-Flow	990	852							1842
Weighting Factor	1.00	0.23							
Flow into Channel	990	197							1187

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	16.71	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	1187	cfs	
Long-term Max. Chnl Capacity	2097	cfs	
Q2 Channel	119	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	75	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (ib/sq. ft)	Froude Number
119	23.8	26.9	1.1	98.0	99.4	4.4	1.4	23.4	1.1	0.26	0.73
356	61.3	75.8	1.2	98.0	100.6	4.7	2.6	60.4	1.3	0.48	0.74
890	67.3	136.3	2.0	98.0	101.5	6.5	3.5	66.2	2.1	0.66	0.80
1187	70.0	164.5	2.4	98.0	101.9	7.2	3.9	68.7	2.4	0.74	0.82

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
119	23.8	26.9	1.1	98.0	99.4	4.4	1.4	23.4	1.1	0.26	0.73
356	61.3	75.8	1.2	98.0	100.6	4.7	2.6	60.4	1.3	0.48	0.74
890	67.3	136.3	2.0	98.0	101.5	6.5	3.5	66.2	2.1	0.66	0.80
1187	70.0	164.5	2.4	98.0	101.9	7.2	3.9	68.7	2.4	0.74	0.82

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
119										0
356										0
890										0
1187										0

Allowable Velocity

Channel Lining	Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
119	1.74	1.4381	1.3662	Erosive	Erosive	Erosive	0.3	Erosive	3.9	Stable	Stable
356	1.74	1.4651	1.3918	Erosive	Erosive	Erosive	0.3	Erosive	5.4	Stable	Stable
890	1.74	1.6182	1.5373	Erosive	Erosive	Erosive	0.4	Erosive	6.9	Stable	Stable
1187	1.74	1.6647	1.5815	Erosive	Erosive	Erosive	0.4	Erosive	7.5	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	119	356	890	1187	119	356	890	1187	119	356	890	1187
Bray - Equation #1	29	53	85	99	1.3	1.9	2.6	2.8	3.1	3.6	4.1	4.3
Bray - Equation #2	39	69	112	130	1.4	2.1	2.8	3.1	2.1	2.5	2.8	2.9
Hey	9	16	27	32	4.0	6.0	8.5	9.5				
Ackers & Charlton/Lacey	27	42	62	70					1.8	2.1	2.5	2.6
Parker	75	130	205	237	1.0	1.6	2.3	2.6				
Chang	40	78	138	165	0.3	0.3	0.1	0.1				
Kellerhals	20	34	54	62	1.8	2.9	4.1	4.6	3.3	3.7	4.0	4.1
AMAFCA/Schumm	23	61	66	69								
Moody & Odem	35	35	35	35	1.4	1.4	1.4	1.4				
BUREC	12.9	19.5	27.5	30.7	3	5	7	8	4.2	5.5	6.9	7.4
Average	31	54	81	93	1.9	2.7	3.7	4.0	2.9	3.5	4.1	4.3
Values As Designed	23	60	66	69	1.4	2.6	3.5	3.9	4.4	4.7	6.5	7.2
Difference with Design	8	-7	15	24	0.5	0.1	0.1	0.1	-1.5	-1.2	-2.5	-2.9

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
119	684	909	1382	4697	681	651	375	540	2612	479	2193	1382
356	2248	2704	4108	15662	1858	2078	1138	1732	7854	1547	7029	4360
890	8777	7529	10004	69738	2723	6990	2793	5722	19792	3091	23472	14603
1187	13391	10295	13548	110773	3077	10206	3678	8213	26425	3363	33858	21530

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
119	2137	2841	4320	14682	2130	2036	1173	1689	8164	1496	6855	4320
356	2342	2818	4280	16317	1936	2165	1185	1805	8183	1612	7323	4542
890	3658	3138	4169	29062	1135	2913	1164	2384	8248	1288	9782	6086
1187	4185	3218	4235	34622	962	3190	1150	2567	8259	1051	10582	6729

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
119	684	755	818	651	262	327	375	540	333	79	667	499
356	2248	2261	2523	2169	729	1027	1138	1732	1014	199	2170	1565
890	8777	6434	5819	9659	1181	3163	2793	5722	2661	191	7844	4931
1187	13391	8842	7690	15343	1365	4496	3678	8213	3576	191	11587	7125

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
119	2137	2360	2556	2034	818	1022	1173	1689	1042	247	2084	1560
356	2342	2355	2628	2260	760	1070	1185	1805	1057	208	2261	1630
890	3658	2681	2425	4025	492	1318	1164	2384	1109	79	3269	2055
1187	4185	2764	2404	4795	427	1405	1150	2567	1118	60	3622	2227

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
119	0.0005	0.0003	209	0.64	0.051	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0003	0.0071	0.0004	0.0012	0.0029	0.0027
356	0.0005	0.0003	219	0.67	0.051	0.0002	31	0.036	0.0002	0.0159	0.0002	0.0003	0.0071	0.0003	0.0005	0.0029	0.0026
890	0.0002	0.0002	280	0.85	0.054	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0002	0.0071	0.0002	0.0003	0.0029	0.0026
1187	0.0002	0.0002	302	0.92	0.055	0.0001	32	0.036	0.0001	0.0159	0.0001	0.0001	0.0071	0.0002	0.0002	0.0029	0.0026

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	42.0	ft
Height of Drop Structure	3	ft
No . of Drop Structures	15	
Distance between structs.	342	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	1.74	sq. mi
Total Sediment Yield Volume	3.31	ac ft

Sedimentation Basins

Length	342 ft	Depth	3 ft	
Width	75 ft	Side slope	3 ft/ft	
Total Volume per Basin		1.51	ac. ft.	
Basin Trap Efficiency		0.6		
No. of Basins		8		

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
119	1.1	0.3	0.3	24.6	1.4	1.1	4.4	0.0030	0.3	0.0	1.0	2.2
356	1.1	0.6	0.3	24.6	2.6	1.3	4.7	0.0030	0.5	0.0	1.0	2.9
890	1.1	1.1	0.6	24.6	3.5	2.1	6.5	0.0030	0.7	0.0	1.0	4.1
1187	1.1	1.3	0.7	24.6	3.9	2.4	7.2	0.0030	0.8	0.0	1.0	4.6

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	961	cfs
Stage at Peak Flow	100.7	ft
Volume at Peak Flow	97.0	ac. ft

Freeboard

Max. Flow Depth	3.9	ft
Channel Depth as designed	5.0	ft
Available Freeboard	1.1	ft
Required Freeboard	1.2	ft

Sediment Volume

Inflowing Sediment Volume	3.31	ac. ft
Outflowing Sediment Volume	0.08	ac. ft
Deposited(+)/Eroded(-) Volume	3.23	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	5123	5123
Side Slope (?H:1V)	3	6
Channel Width (ft)	75	105
Channel XS Area (sq. ft)	240	315
Channel Perimeter (ft)	77	106

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	344682	478571
Excavated Area (sq. Yd)	42692	59768

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	5123	5123
Lining Width (ft)	19	36
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	10815	20492
Lining Volume (cu. Yd)	1803	3415

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	5123	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	854	sq. Yd
Volume	2277	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	5123	5123
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	5123	5123
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	75	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	12.0	ft
Structure Height	15.0	ft
Number of Structures	15	
Volume per structure	21	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 3,255	
Area per structure	4	sq. Yd
Total Area	63	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	8	
Total Volume per Basin	2436	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 9,744	
Other Cost	$ -	
Total cost per basin	$ 9,744	
Area per basin	2,846	sq. Yd
Total Area	22,768	sq. Yd

Structure Type	Structure Cost											
	Excavation/Construction					Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	344,682	cu. Yd	$ 10.00	$ 3,446,820	42,692	sq. Yd	$ 9.00	$ 384,228	42,692	sq. Yd	$ 8.33	$ 355,767
Exc. Chl - LC Enhancement	Excavated	133,889	cu. Yd	$ 10.00	$ 1,338,890	17,076	sq. Yd	$ 9.00	$ 153,684	17,076	sq. Yd	$ 8.33	$ 142,300
Channel Lining	Concrete	1,803	cu. Yd	$ 155.00	$ 279,465	10,815	sq. Yd	$ -	$ -	10,815	sq. Yd	$ 41.67	$ 450,625
Channel Lining - LC Enhancement	Concrete	1,612	cu. Yd	$ 155.00	$ 249,860	9,677	sq. Yd	$ -	$ -	9,677	sq. Yd	$ 41.67	$ 403,208
Toe Protection	Riprap	2,277	cu. Yd	$ 75.00	$ 170,775	854	sq. Yd	$ -	$ -	854	sq. Yd	$ 25.00	$ 21,350
Drop Structures	Concrete	15	EA	$ 3,255.00	$ 48,825	63	sq. Yd	$ -	$ -	63	sq. Yd	$ 41.67	$ 2,625
Drop Str. - LC Enhancement	Concrete	15	EA	$ 325.50	$ 4,883	6	sq. Yd	$ -	$ -	6	sq. Yd	$ 41.67	$ 263
Sedimentation Basins		8	EA	$ 9,744.00	$ 77,952	22,768	sq. Yd	$ -	$ -	22,768	sq. Yd	$ 8.33	$ 189,733
Other					$ -				$ -				$ -
Base Landscape Cost									$ 384,228	Base Maintenance Cost			$ 1,020,100
LC Enhancement Cost									$ 153,684	LC Enhancement Cost			$ 545,771
Total Landscape Cost									$ 537,912	Total Maintenance Cost			$ 1,565,871

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 4,023,837	$ 1,593,633	$ 5,617,470
Contingency Cost (25% of Construction Cost)	$ 1,005,959	$ 398,408	$ 1,404,367
Engineering Design Cost (5% of Construction Cost)	$ 201,192	$ 79,682	$ 280,873
Total Construction Cost	$ 5,230,988	$ 2,071,722	$ 7,302,710

Land Cost

Channel Length	5123 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	15.8	$100,000	$ 1,580,000
LC Enhancement Buffer	50	5.9	$100,000	$ 590,000
Channel	75	8.8	$100,000	$ 880,000
Channel LC Enhancement	30	3.5	$100,000	$ 350,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	289	34		$ 3,400,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	24.6	$100,000	$ 2,460,000
LC Enhancement Cost	acre	9.4	$100,000	$ 940,000
Total Land Cost	acre	34	$100,000	$ 3,400,000

Total Cost

Base Total Cost	$ 9,095,316
Total Landscape Enhancement Cost	$ 3,711,177
Total Cost Including LC Enh.	$ 12,806,493

Open Channel

Structure ID	L30

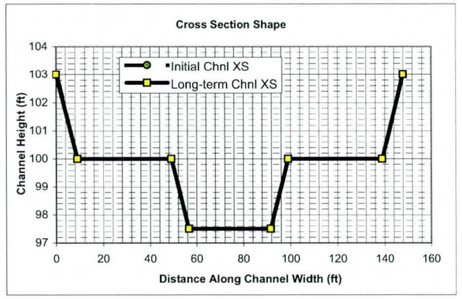
HEC1 ID	L30

Longitudinal Geometry

Length	6103.1	ft
U/S Elev	1119.1	ft
D/S Elev	1148.6	ft
Initial Channel Slope	0.0048	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	



Initial Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	40	3	35	5.5	3	40	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	49	56.5	91.5	99	139	148
Y	103	100	100	97.5	97.5	100	100	103

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	40	3	35	5.5	3	40	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	49	56.5	91.5	99	139	148
Y	103	100	100	97.5	97.5	100	100	103

Mannings n (includes effects of vegetation etc.)

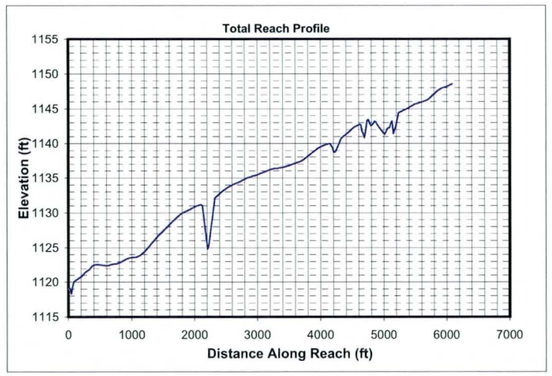
Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	L								TOTAL
HEC1 Peak-Flow	2162								2162
Weighting Factor	1.00								
Flow into Channel	2162								2162

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00



Hydrology

Drainage Area	12.5	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	2162	cfs	
Long-term Max. Chnl Capacity	4916	cfs	
Q2 Channel	216	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	148	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
216	42.9	48.7	1.1	97.5	98.8	4.4	1.3	42.5	1.1	0.24	0.73
649	50.0	100.1	2.0	97.5	99.9	6.5	2.4	49.3	2.0	0.44	0.80
1622	138.1	260.4	1.9	97.5	101.2	6.2	3.7	136.9	1.9	0.68	0.80
2162	140.5	311.5	2.2	97.5	101.5	6.9	4.0	139.2	2.2	0.75	0.82

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
216	42.9	48.7	1.1	97.5	98.8	4.4	1.3	42.5	1.1	0.24	0.73
649	50.0	100.1	2.0	97.5	99.9	6.5	2.4	49.3	2.0	0.44	0.80
1622	138.1	260.4	1.9	97.5	101.2	6.2	3.7	136.9	1.9	0.68	0.80
2162	140.5	311.5	2.2	97.5	101.5	6.9	4.0	139.2	2.2	0.75	0.82

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
216										0
649										0
1622										0
2162										0

Allowable Velocity

Channel Lining: Natural - Coarse Gravel (noncolloidal)

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
216	1.74	1.4372	1.3654	Erosive	Erosive	Erosive	0.3	Erosive	3.7	Stable	Stable
649	1.74	1.6141	1.5334	Erosive	Erosive	Erosive	0.4	Erosive	5.6	Stable	Stable
1622	1.74	1.5936	1.5139	Erosive	Erosive	Erosive	0.4	Erosive	6.9	Stable	Stable
2162	1.74	1.6440	1.5618	Erosive	Erosive	Erosive	0.4	Erosive	7.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	6

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	216	649	1622	2162	216	649	1622	2162	216	649	1622	2162
Bray - Equation #1	40	72	117	136	1.6	2.3	3.1	3.4	3.4	3.9	4.4	4.6
Bray - Equation #2	53	95	154	179	1.8	2.5	3.4	3.8	2.3	2.7	3.1	3.2
Hey	12	23	38	44	5.0	7.5	10.7	11.9				
Ackers & Charlton/Lacey	34	55	80	91					2.0	2.4	2.7	2.9
Parker	101	175	277	319	1.3	2.0	3.0	3.4				
Chang	58	114	199	237	0.3	0.2	0.0	-0.2				
Kellerhals	26	46	72	84	2.3	3.6	5.2	5.9	3.5	3.9	4.3	4.4
AMAFCA/Schumm	43	49	137	139								
Moody & Odem	32	32	32	32	1.4	1.4	1.4	1.4				
BUREC	16.2	24.5	34.5	38.4	4	7	9	10	4.8	6.4	8.0	8.6
Average	42	68	114	130	2.3	3.3	4.5	5.0	3.2	3.9	4.5	4.7
Values As Designed	43	49	137	139	1.3	2.4	3.7	4.0	4.4	6.5	6.2	6.9
Difference with Design	-1	19	-23	-9	1.0	0.9	0.8	0.9	-1.2	-2.6	-1.7	-2.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	1269	1504	1866	2436	700	754	694	999	1305	252	1952	1248
649	6342	5087	5145	14216	1210	2979	2042	4152	4040	307	8692	4928
1622	15144	12273	12986	33037	3220	7276	5174	10131	10077	841	21039	11927
2162	23402	16939	17226	53266	3638	10512	6823	14676	13506	876	31144	17455

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	2177	2581	3202	4181	1201	1294	1191	1715	2239	432	3349	2142
649	3628	2910	2943	8131	692	1704	1168	2375	2311	175	4972	2819
1622	3465	2808	2971	7559	737	1665	1184	2318	2306	193	4814	2729
2162	4016	2907	2956	9140	624	1804	1171	2518	2318	150	5344	2995

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	1269	1404	1506	1189	475	604	694	999	607	144	1233	920
649	6342	4798	4251	6936	870	2297	2042	4152	1937	142	5677	3586
1622	15144	11568	10760	16120	2303	5635	5174	10131	4822	403	13695	8705
2162	23402	16002	14159	25989	2636	8056	6823	14676	6493	393	20464	12645

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	2177	2409	2585	2040	815	1036	1191	1715	1042	248	2116	1579
649	3628	2744	2432	3967	498	1314	1168	2375	1108	81	3248	2051
1622	3465	2647	2462	3688	527	1289	1184	2318	1103	92	3133	1992
2162	4016	2746	2430	4460	452	1382	1171	2518	1114	67	3512	2170

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
216	0.0005	0.0003	138	0.42	0.047	0.0002	30	0.036	0.0002	0.0159	0.0002	0.0003	0.0058	0.0003	0.0013	0.0030	0.0024
649	0.0003	0.0002	183	0.56	0.050	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0002	0.0058	0.0002	0.0006	0.0029	0.0023
1622	0.0003	0.0002	178	0.54	0.049	0.0001	30	0.036	0.0001	0.0159	0.0001	0.0002	0.0058	0.0001	0.0003	0.0030	0.0023
2162	0.0002	0.0002	193	0.59	0.050	0.0001	31	0.036	0.0001	0.0159	0.0001	0.0001	0.0058	0.0001	0.0002	0.0030	0.0023

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	11.2	ft
Height of Drop Structure	3	ft
No . of Drop Structures	4	
Distance between structs.	1526	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	5.85	sq. mi
Total Sediment Yield Volume	11.12	ac ft

Sedimentation Basins

Length	1526 ft	Depth	3 ft	
Width	148 ft	Side slope	3 ft/ft	
Total Volume per Basin		14.52	ac. ft.	
Basin Trap Efficiency		0.6		
No. of Basins		3		

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
216	1.1	0.3	0.3	24.6	1.3	1.1	4.4	0.0030	0.2	0.0	2.5	4.1
649	1.1	0.7	0.6	24.6	2.4	2.0	6.5	0.0030	0.5	0.0	2.5	5.2
1622	1.1	1.1	0.5	24.6	3.7	1.9	6.2	0.0030	0.7	0.0	2.5	6.0
2162	1.1	1.4	0.7	24.6	4.0	2.2	6.9	0.0030	0.8	0.0	2.5	6.5

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	3301	cfs
Stage at Peak Flow	0.0	ft
Volume at Peak Flow	469.0	ac. ft

Freeboard

Max. Flow Depth	4.0	ft
Channel Depth as designed	5.5	ft
Available Freeboard	1.5	ft
Required Freeboard	1.2	ft

Sediment Volume

Inflowing Sediment Volume	11.12	ac. ft
Outflowing Sediment Volume	0.38	ac. ft
Deposited(+)/Eroded(-) Volume	10.73	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	6103	6103
Side Slope (?H:1V)	3	6
Channel Width (ft)	148	181
Channel XS Area (sq. ft)	523.2	613.95
Channel Perimeter (ft)	150	182

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	306145	368550
Excavated Area (sq. Yd)	100360	122738

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	6103	6103
Lining Width (ft)	19	36
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	12884	24412
Lining Volume (cu. Yd)	2147	4069

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	6103	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	1017	sq. Yd
Volume	3391	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	6103	6103
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	6103	6103
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures			
Structure Type	Concrete		
(Riprap, Gabions, Soil cement, Concrete,None)			
Structure Length	148	ft	
LC Enhancement Ratio	1.1		
Structure Thickness	0.5	ft	
Drop Height	3	ft	
Scour Depth	11.3	ft	
Structure Height	14.3	ft	
Number of Structures	4		
Volume per structure	39	cu. Yd	
Unit Cost	$ 155.00	cu. Yd	
Other Cost	$ -		
Cost per structure	$ 6,045		
Area per structure	8	sq. Yd	
Total Area	33	sq. Yd	

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	3	
Total Volume per Basin	23426	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 93,704	
Other Cost	$ -	
Total cost per basin	$ 93,704	
Area per basin	25,090	sq. Yd
Total Area	75,270	sq. Yd

Structure Type	Structure Cost												
	Excavation/Construction					Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	306,145	cu. Yd	$ 10.00	$ 3,061,450	100,360	sq. Yd	$ 9.00	$ 903,240	100,360	sq. Yd	$ 8.33	$ 836,333
Exc. Chl - LC Enhancement	Excavated	62,405	cu. Yd	$ 10.00	$ 624,050	22,378	sq. Yd	$ 9.00	$ 201,402	22,378	sq. Yd	$ 8.33	$ 186,483
Channel Lining	Concrete	2,147	cu. Yd	$ 155.00	$ 332,785	12,884	sq. Yd	$ -	$ -	12,884	sq. Yd	$ 41.67	$ 536,833
Channel Lining - LC Enhancement	Concrete	1,922	cu. Yd	$ 155.00	$ 297,910	11,528	sq. Yd	$ -	$ -	11,528	sq. Yd	$ 41.67	$ 480,333
Toe Protection	Riprap	3,391	cu. Yd	$ 75.00	$ 254,325	1,017	sq. Yd	$ -	$ -	1,017	sq. Yd	$ 25.00	$ 25,425
Drop Structures	Concrete	4	EA	$ 6,045.00	$ 24,180	33	sq. Yd	$ -	$ -	33	sq. Yd	$ 41.67	$ 1,375
Drop Str. - LC Enhancement	Concrete	4	EA	$ 604.50	$ 2,418	3	sq. Yd	$ -	$ -	3	sq. Yd	$ 41.67	$ 138
Sedimentation Basins		3	EA	$ 93,704.00	$ 281,112	75,270	sq. Yd	$ -	$ -	75,270	sq. Yd	$ 8.33	$ 627,250
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 903,240	Base Maintenance Cost			$ 2,027,217
						LC Enhancement Cost			$ 201,402	LC Enhancement Cost			$ 666,954
						Total Landscape Cost			$ 1,104,642	Total Maintenance Cost			$ 2,694,171

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 3,953,852	$ 924,378	$ 4,878,230
Contingency Cost (25% of Construction Cost)	$ 988,463	$ 231,095	$ 1,219,558
Engineering Design Cost (5% of Construction Cost)	$ 197,693	$ 46,219	$ 243,912
Total Construction Cost	$ 5,140,008	$ 1,201,691	$ 6,341,699

Land Cost

Channel Length	6103 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	14	2	$100,000	$ 200,000
LC Enhancement Buffer	50	7	$100,000	$ 700,000
Channel	148	20.7	$100,000	$ 2,070,000
Channel LC Enhancement	33	4.6	$100,000	$ 460,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	245	34.3		$ 3,430,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	22.7	$100,000	$ 2,270,000
LC Enhancement Cost	acre	11.6	$100,000	$ 1,160,000
Total Land Cost	acre	34.3	$100,000	$ 3,430,000

Total Cost

Base Total Cost	$ 10,340,464
Total Landscape Enhancement Cost	$ 3,230,048
Total Cost Including LC Enh.	$ 13,570,512

Open Channel

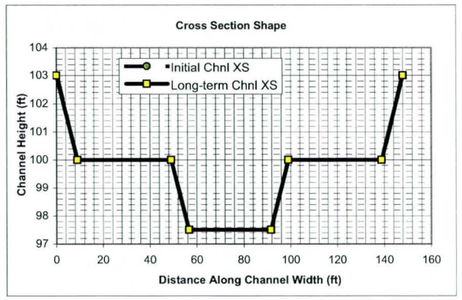
Structure ID	L40	HEC1 ID	L40

Longitudnal Geometry

Length	8055.0	ft
U/S Elev	1119.1	ft
D/S Elev	1087.1	ft
Initial Channel Slope	0.0040	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	



Initial Channel XS Geometry

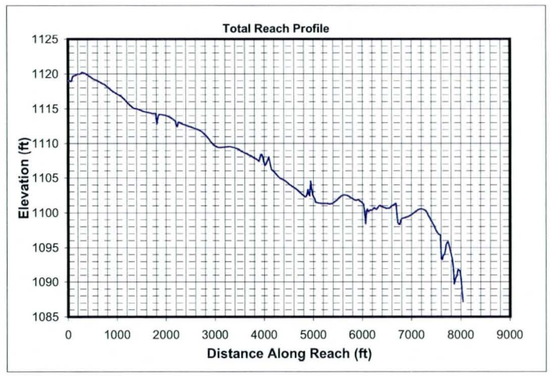
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	40	3	35	5.5	3	40	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	49	56.5	91.5	99	139	148
Y	103	100	100	97.5	97.5	100	100	103

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	3	40	3	35	5.5	3	40	3	3

PT. ID	1	2	3	4	5	6	7	8
X	0	9	49	56.5	91.5	99	139	148
Y	103	100	100	97.5	97.5	100	100	103



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	L								TOTAL
HEC1 Peak-Flow	2162								2162
Weighting Factor	1.00								
Flow into Channel	2162								2162

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	12.5	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	2162	cfs	
Long-term Max. Chnl Capacity	4916	cfs	
Q2 Channel	216	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	148	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5 mm
D90	5	mm	D84	3.5	mm		

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
216	42.9	48.7	1.1	97.5	98.8	4.4	1.3	42.5	1.1	0.24	0.73
649	50.0	100.1	2.0	97.5	99.9	6.5	2.4	49.3	2.0	0.44	0.80
1622	138.1	260.4	1.9	97.5	101.2	6.2	3.7	136.9	1.9	0.68	0.80
2162	140.5	311.5	2.2	97.5	101.5	6.9	4.0	139.2	2.2	0.75	0.82

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
216	42.9	48.7	1.1	97.5	98.8	4.4	1.3	42.5	1.1	0.24	0.73
649	50.0	100.1	2.0	97.5	99.9	6.5	2.4	49.3	2.0	0.44	0.80
1622	138.1	260.4	1.9	97.5	101.2	6.2	3.7	136.9	1.9	0.68	0.80
2162	140.5	311.5	2.2	97.5	101.5	6.9	4.0	139.2	2.2	0.75	0.82

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
216										0
649										0
1622										0
2162										0

Allowable Velocity

Channel Lining: Natural - Coarse Gravel (noncolloidal)

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
216	1.74	1.4372	1.3654	Erosive	Erosive	Erosive	0.3	Erosive	3.7	Stable	Stable
649	1.74	1.6141	1.5334	Erosive	Erosive	Erosive	0.4	Erosive	5.6	Stable	Stable
1622	1.74	1.5936	1.5139	Erosive	Erosive	Erosive	0.4	Erosive	6.9	Stable	Stable
2162	1.74	1.6440	1.5618	Erosive	Erosive	Erosive	0.4	Erosive	7.4	Stable	Stable

USCOE Allowable Velocity (ft/s)	6
FHWA Allowable Velocity (ft/s)	6

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	216	649	1622	2162	216	649	1622	2162	216	649	1622	2162
Bray - Equation #1	40	72	117	136	1.6	2.3	3.1	3.4	3.4	3.9	4.4	4.6
Bray - Equation #2	53	95	154	179	1.8	2.5	3.4	3.8	2.3	2.7	3.1	3.2
Hey	12	23	38	44	5.0	7.5	10.7	11.9				
Ackers & Charlton/Lacey	34	55	80	91					2.0	2.4	2.7	2.9
Parker	101	175	277	319	1.3	2.0	3.0	3.4				
Chang	58	114	199	237	0.3	0.2	0.0	-0.2				
Kellerhals	26	46	72	84	2.3	3.6	5.2	5.9	3.5	3.9	4.3	4.4
AMAFCA/Schumm	43	49	137	139								
Moody & Odem	32	32	32	32	1.4	1.4	1.4	1.4				
BUREC	16.2	24.5	34.5	38.4	4	7	9	10	4.8	6.4	8.0	8.6
Average	42	68	114	130	2.3	3.3	4.5	5.0	3.2	3.9	4.5	4.7
Values As Designed	43	49	137	139	1.3	2.4	3.7	4.0	4.4	6.5	6.2	6.9
Difference with Design	-1	19	-23	-9	1.0	0.9	0.8	0.9	-1.2	-2.6	-1.7	-2.2

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	1269	1462	1722	1811	601	685	694	999	955	187	1620	1091
649	6342	4967	4752	10567	1061	2665	2042	4152	2985	208	7317	4278
1622	15144	11979	12008	24558	2817	6522	5174	10131	7442	577	17685	10367
2162	23402	16548	15873	39594	3198	9382	6823	14676	9989	585	26280	15123

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	2177	2509	2954	3108	1031	1176	1191	1715	1638	322	2781	1873
649	3628	2841	2718	6044	607	1525	1168	2375	1708	119	4185	2447
1622	3465	2741	2747	5619	645	1492	1184	2318	1703	132	4046	2372
2162	4016	2840	2724	6794	549	1610	1171	2518	1714	100	4510	2595

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	1269	1404	1506	1189	475	604	694	999	607	144	1233	920
649	6342	4798	4251	6936	870	2297	2042	4152	1937	142	5677	3586
1622	15144	11568	10760	16120	2303	5635	5174	10131	4822	403	13695	8705
2162	23402	16002	14159	25989	2636	8056	6823	14676	6493	393	20464	12645

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
216	2177	2409	2585	2040	815	1036	1191	1715	1042	248	2116	1579
649	3628	2744	2432	3967	498	1314	1168	2375	1108	81	3248	2051
1622	3465	2647	2462	3688	527	1289	1184	2318	1103	92	3133	1992
2162	4016	2746	2430	4460	452	1382	1171	2518	1114	67	3512	2170

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
216	0.0005	0.0003	125	0.38	0.046	0.0002	29	0.035	0.0002	0.0159	0.0002	0.0003	0.0058	0.0003	0.0013	0.0030	0.0024
649	0.0003	0.0002	166	0.51	0.049	0.0001	30	0.036	0.0001	0.0159	0.0001	0.0002	0.0058	0.0002	0.0006	0.0029	0.0023
1622	0.0003	0.0002	161	0.49	0.049	0.0001	30	0.036	0.0001	0.0159	0.0001	0.0002	0.0058	0.0001	0.0003	0.0030	0.0023
2162	0.0002	0.0002	175	0.53	0.049	0.0001	30	0.036	0.0001	0.0159	0.0001	0.0001	0.0058	0.0001	0.0002	0.0030	0.0023

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	7.8	ft
Height of Drop Structure	3	ft
No . of Drop Structures	3	
Distance between structs.	2685	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	5.85	sq. mi
Total Sediment Yield Volume	11.12	ac ft

Sedimentation Basins

Length	2685 ft	Depth	3 ft
Width	148 ft	Side slope	3 ft/ft
Total Volume per Basin		25.62	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		2	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
216	1.1	0.3	0.3	24.6	1.3	1.1	4.4	0.0030	0.2	0.0	2.5	4.1
649	1.1	0.7	0.6	24.6	2.4	2.0	6.5	0.0030	0.5	0.0	2.5	5.2
1622	1.1	1.1	0.5	24.6	3.7	1.9	6.2	0.0030	0.7	0.0	2.5	6.0
2162	1.1	1.4	0.7	24.6	4.0	2.2	6.9	0.0030	0.8	0.0	2.5	6.5

Toe Protection Needed	7.0	ft

HEC1 Results For Open Channel

Peak Flow	3301	cfs
Stage at Peak Flow	0.0	ft
Volume at Peak Flow	469.0	ac. ft

Freeboard

Max. Flow Depth	4.0	ft
Channel Depth as designed	5.5	ft
Available Freeboard	1.5	ft
Required Freeboard	1.2	ft

Sediment Volume

Inflowing Sediment Volume	11.12	ac. ft
Outflowing Sediment Volume	0.38	ac. ft
Deposited(+)/Eroded(-) Volume	10.73	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	8055	8055
Side Slope (?H:1V)	3	6
Channel Width (ft)	148	181
Channel XS Area (sq. ft)	523.2	613.95
Channel Perimeter (ft)	150	182

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	328933	394547
Excavated Area (sq. Yd)	132460	161995

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	8055	8055
Lining Width (ft)	19	36
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	17005	32220
Lining Volume (cu. Yd)	2834	5370

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	8055	ft
Thickness	1.5	ft
Protection Depth	7	ft
Tie-in Length/Depth	3.0	ft
Total Depth	10.0	ft
Area needed	1343	sq. Yd
Volume	4475	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	8055	8055
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	8055	8055
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	148	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	11.3	ft
Structure Height	14.3	ft
Number of Structures	3	
Volume per structure	39	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 6,045	
Area per structure	8	sq. Yd
Total Area	25	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	2	
Total Volume per Basin	41334	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 165,336	
Other Cost	$ -	
Total cost per basin	$ 165,336	
Area per basin	44,153	sq. Yd
Total Area	88,306	sq. Yd

Structure Type	Structure Cost											
		Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	328,933	cu. Yd	$ 10.00	$ 3,289,330	132,460	sq. Yd	$ 9.00	$ 1,192,140	132,460	sq. Yd	$ 8.33	$ 1,103,833
Exc. Chl - LC Enhancement	Excavated	65,614	cu. Yd	$ 10.00	$ 656,140	29,535	sq. Yd	$ 9.00	$ 265,815	29,535	sq. Yd	$ 8.33	$ 246,125
Channel Lining	Concrete	2,834	cu. Yd	$ 155.00	$ 439,270	17,005	sq. Yd	$ -	$ -	17,005	sq. Yd	$ 41.67	$ 708,542
Channel Lining - LC Enhancement	Concrete	2,536	cu. Yd	$ 155.00	$ 393,080	15,215	sq. Yd	$ -	$ -	15,215	sq. Yd	$ 41.67	$ 633,958
Toe Protection	Riprap	4,475	cu. Yd	$ 75.00	$ 335,625	1,343	sq. Yd	$ -	$ -	1,343	sq. Yd	$ 25.00	$ 33,575
Drop Structures	Concrete	3	EA	$ 6,045.00	$ 18,135	25	sq. Yd	$ -	$ -	25	sq. Yd	$ 41.67	$ 1,042
Drop Str. - LC Enhancement	Concrete	3	EA	$ 604.50	$ 1,814	3	sq. Yd	$ -	$ -	3	sq. Yd	$ 41.67	$ 104
Sedimentation Basins		2	EA	$ 165,336.00	$ 330,672	88,306	sq. Yd	$ -	$ -	88,306	sq. Yd	$ 8.33	$ 735,883
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 1,192,140	Base Maintenance Cost			$ 2,582,875
						LC Enhancement Cost			$ 265,815	LC Enhancement Cost			$ 880,188
						Total Landscape Cost			$ 1,457,955	Total Maintenance Cost			$ 3,463,063

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 4,413,032	$ 1,051,034	$ 5,464,066
Contingency Cost (25% of Construction Cost)	$ 1,103,258	$ 262,758	$ 1,366,016
Engineering Design Cost (5% of Construction Cost)	$ 220,652	$ 52,552	$ 273,203
Total Construction Cost	$ 5,736,942	$ 1,366,344	$ 7,103,285

Land Cost

Channel Length	8055	ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	14	2.6	$100,000	$ 260,000
LC Enhancement Buffer	50	9.2	$100,000	$ 920,000
Channel	148	27.4	$100,000	$ 2,740,000
Channel LC Enhancement	33	6.1	$100,000	$ 610,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	245	45.3		$ 4,530,000

Right of Way

Preservation Corridor Width	0	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	30	$100,000	$ 3,000,000
LC Enhancement Cost	acre	15.3	$100,000	$ 1,530,000
Total Land Cost	acre	45.3	$100,000	$ 4,530,000

Total Cost

Base Total Cost	$ 12,511,957
Total Landscape Enhancement Cost	$ 4,042,346
Total Cost Including LC Enh.	$ 16,554,303

Open Channel

Structure ID	RRP1A10

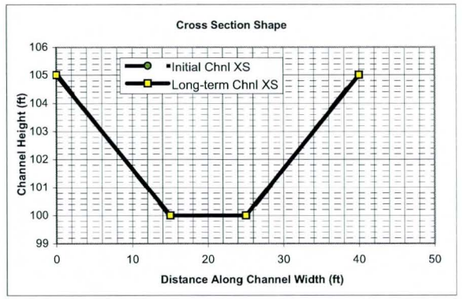
HEC1 ID	RRP1A10

Longitundal Geometry

Length	1465.1	ft
U/S Elev	1276.4	ft
D/S Elev	1305.2	ft
Initial Channel Slope	0.0196	ft/ft
Long-term Channel Slope	0.0030	ft/ft

Numerical Integration Time Steps (For Routing in HEC-1)

NSTPS	1



Initial Channel XS Geometry

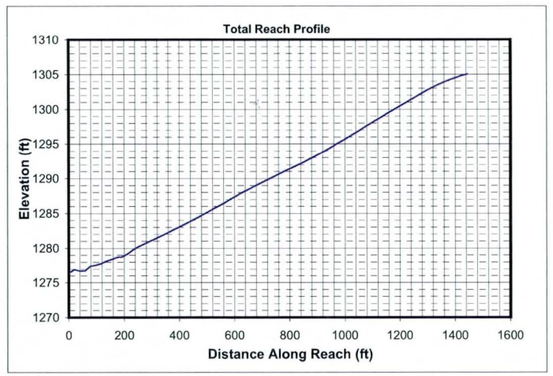
Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	10	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	25	25	25	40
Y	105	100	100	100	100	100	100	105

Long-term Channel XS Geometry

Left Side Slope 1	Left Bench Depth (ft)	Left Bench Length (ft)	Left Side Slope 2	Bottom Width	Channel Depth	Right Side Slope 2	Right Bench Length	Right Bench Depth	Right Side Slope 1
3	5	0	3	10	5	3	0	5	3

PT. ID	1	2	3	4	5	6	7	8
X	0	15	15	15	25	25	25	40
Y	105	100	100	100	100	100	100	105



Mannings n (includes effects of vegetation etc.)

Location	Initial Chl. Left	Initial Chl. Main	Initial Chl. Right	Long-term Chl. Left	Long-term Chl. Main	Long-term Chl. Right
Mannings n	0.02	0.02	0.02	0.02	0.02	0.02

HEC1 Results Used to Determine Design Peak Flows

Contributing HEC1 ID	P1A								TOTAL
HEC1 Peak-Flow	575								575
Weighting Factor	1.00								
Flow into Channel	575								575

Reach Sediment Inflow Characteristics

U/S Contributing ID									TOTAL
Flow Volume (ac. ft)									0
Sediment Conc. (ppm)									
Sediment Volume (ac. ft)									0.00
Weighting Factor									
Weighted Sed. Vol. (ac. ft)									0.00

Hydrology

Drainage Area	15.41	sq. miles	(Used in Moody & Odem Regime Eqs. & Sediment Yield Calcs.)

Design Peak Flow	575	cfs	
Long-term Max. Chnl Capacity	1062	cfs	
Q2 Channel	58	cfs	(Used in Equilibrium Slope Bray Eq.)
Bank Full Width	40	ft	(Used in Equilibrium Slope BUREC Eq.)

Sediment Data

D50	1	mm	D16	0.5	mm	D65	1.5	mm
D90	5	mm	D84	3.5	mm			

Initial Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
58	17.2	15.3	0.9	100.0	101.1	3.8	1.1	16.8	0.9	0.21	0.70
173	23.0	33.1	1.4	100.0	102.1	5.2	2.1	22.3	1.5	0.38	0.75
431	30.6	64.4	2.1	100.0	103.3	6.7	3.3	29.5	2.2	0.61	0.80
575	33.7	79.5	2.4	100.0	103.7	7.2	3.7	32.5	2.4	0.70	0.81

Long-term Channel Normal Depth Hydraulics

Discharge (cfs)	Wetted Perimeter (ft)	Wetted Area (sq. ft)	Hydraulic Radius (ft)	Min.Chnl Elev. (ft)	Water Surface Elevation	Velocity (ft/s)	Depth (ft)	Topwidth (ft)	Hydraulic Depth (ft)	Shear Stress (lb/sq. ft)	Froude Number
58	17.2	15.3	0.9	100.0	101.1	3.8	1.1	16.8	0.9	0.21	0.70
173	23.0	33.1	1.4	100.0	102.1	5.2	2.1	22.3	1.5	0.38	0.75
431	30.6	64.4	2.1	100.0	103.3	6.7	3.3	29.5	2.2	0.61	0.80
575	33.7	79.5	2.4	100.0	103.7	7.2	3.7	32.5	2.4	0.70	0.81

Inflowing Sediment Load from U/S Routing Reach

Discharge (cfs)	Sediment Inflow (tons/day) Contributions from Upstream (Identified using Contributing ID)									TOTAL
58										0
173										0
431										0
575										0

Allowable Velocity

Channel Lining: Concrete

Discharge (cfs)	Fortier & Scobey (as modified in Chow)				BUREC	Neill (gravel/cobble)				USACOE Allowable Velocity Table	FHWA Allowable Velocity Table
	Permissive Velocity (ft/s)					Non-cohesive		Cohesive			
	Initial Estimate	After Adjusting for D.	After Adjusting For Sinuousity	Erosive?	Erosive?	Erosive?	All'ble Vel (ft/s)	Erosive?	All'ble Vel (ft/s)		
58	1.74	1.3653	1.2970	Erosive	Erosive	Erosive	0.3	Erosive	3.4	Stable	Stable
173	1.74	1.5173	1.4415	Erosive	Erosive	Erosive	0.4	Erosive	5.0	Stable	Stable
431	1.74	1.6356	1.5538	Erosive	Erosive	Erosive	0.4	Erosive	6.7	Stable	Stable
575	1.74	1.6715	1.5880	Erosive	Erosive	Erosive	0.4	Erosive	7.3	Stable	Stable

USCOE Allowable Velocity (ft/s)	20
FHWA Allowable Velocity (ft/s)	50

Regime Width

	Channel Width (ft)				Flow Depth (ft)				Velocity (ft/s)			
Discharge (cfs)	58	173	431	575	58	173	431	575	58	173	431	575
Bray - Equation #1	20	36	58	68	1.0	1.5	2.0	2.2	2.8	3.2	3.7	3.8
Bray - Equation #2	26	47	76	89	1.1	1.6	2.2	2.4	1.9	2.2	2.5	2.6
Hey	6	11	18	21	3.0	4.6	6.5	7.2				
Ackers & Charlton/Lacey	20	31	46	52					1.6	1.9	2.2	2.3
Parker	52	90	143	165	0.7	1.2	1.7	1.9				
Chang	25	50	88	105	0.3	0.3	0.3	0.2				
Kellerhals	14	24	37	43	1.4	2.1	3.1	3.5	3.1	3.4	3.7	3.9
AMAFCA/Schumm	17	22	30	33								
Moody & Odem	34	34	34	34	1.4	1.4	1.4	1.4				
BUREC	9.9	14.9	21.0	23.4	3	4	6	6	3.5	4.6	5.8	6.2
Average	22	36	55	63	1.5	2.1	2.9	3.1	2.6	3.1	3.6	3.8
Values As Designed	17	22	30	32	1.1	2.1	3.3	3.7	3.8	5.2	6.7	7.2
Difference with Design	6	14	26	31	0.3	0.0	-0.4	-0.6	-1.2	-2.1	-3.1	-3.5

Initial Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
58	266	445	858	3995	596	383	178	220	2945	330	1410	1057
173	1229	1469	2407	21197	1045	1600	538	908	8891	1402	5604	4208
431	4305	3872	6128	82577	1707	6406	1314	2774	22281	4482	16868	13883
575	6362	5235	8218	126006	1997	9649	1733	3912	29722	5073	23688	20145

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
58	1713	2872	5534	25775	3843	2471	1150	1420	18999	2129	9097	6818
173	2643	3159	5177	45589	2249	3440	1158	1952	19122	3014	12052	9050
431	3703	3331	5272	71040	1468	5511	1130	2387	19168	3856	14512	11943
575	4105	3377	5302	81302	1288	6226	1118	2524	19177	3273	15284	12998

Long-term Channel Sediment Transport Capacity

	Sediment Load (tons/day)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
58	266	336	376	239	152	142	178	220	153	61	262	217
173	1229	1154	1168	1268	310	523	538	908	502	70	1169	803
431	4305	3108	2762	4939	549	1531	1314	2774	1293	84	3835	2408
575	6362	4225	3660	7536	655	2144	1733	3912	1734	90	5527	3416

	Sediment Concentrations (ppm by weight)											
Discharge (cfs)	Zeller Fullerton	Ackers White	Einstein	Engelund/Hansen	Kalinske	Laursen	MPM	Rottner	Schoklitsch	Toffaleti	Yang	Average
58	1713	2168	2423	1541	978	915	1150	1420	989	392	1693	1399
173	2643	2481	2512	2726	666	1125	1158	1952	1079	150	2514	1728
431	3703	2674	2376	4249	472	1317	1130	2387	1112	72	3299	2072
575	4105	2726	2361	4862	423	1383	1118	2524	1119	58	3566	2204

Equilibrium Slope Calculations

Discharge	Schoklitsch	MPM	Shields							Lane's Tractive Force		Average BUREC	Bray	Henderson	BUREC	Simplified AMAFCA	Average
Q (cfs)	SL (ft/ft)	SL (ft/ft)	R*o	U*	T*o	Slo (ft/ft)	R*f	T*f	Slf (ft/ft)	Tc (Fig. 4)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	SL (ft/ft)	Ss (ft/ft)	SL (ft/ft)
58	0.0007	0.0004	246	0.75	0.053	0.0003	31	0.036	0.0002	0.0159	0.0003	0.0004	0.0090	0.0006	0.0013	0.0029	0.0032
173	0.0004	0.0002	313	0.95	0.055	0.0002	32	0.036	0.0001	0.0159	0.0002	0.0002	0.0090	0.0004	0.0006	0.0029	0.0031
431	0.0002	0.0002	378	1.15	0.057	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0002	0.0090	0.0002	0.0003	0.0029	0.0031
575	0.0002	0.0001	401	1.22	0.058	0.0001	33	0.036	0.0001	0.0159	0.0001	0.0001	0.0090	0.0002	0.0002	0.0029	0.0031

Drop Structures

Design Slope	0.0030	ft/ft
Total Drop Needed	24.3	ft
Height of Drop Structure	3	ft
No . of Drop Structures	9	
Distance between structs.	163	ft

Sediment Yield from Adjacent Drainage Area

Annual Sediment Yield	0.3	ac ft/sq.mi./yr
3-yr Sediment Volume	0.9	ac ft/sq.mi.
100-yr Sediment Volume	1	ac ft/sq.mi.
Contributing Drainage Area	0.50	sq. mi
Total Sediment Yield Volume	0.95	ac ft

Sedimentation Basins

Length	163 ft	Depth	3 ft
Width	40 ft	Side slope	3 ft/ft
Total Volume per Basin		0.33	ac. ft.
Basin Trap Efficiency		0.6	
No. of Basins		10	

Scour and Toe Protection (Not applicable for concrete channel)

	Pima County General Scour Equations								Bend	LongTerm	Thalweg	
Discharge	COT/PC	General	Antidune	Bend	Max. Depth	Hyd. Depth	Avg Vel	Se	Scour	Scour	channel	Total
Q (cfs)	Sinuosity	Zgs (ft)	Za (ft)	Angle (deg)	Ymax (ft)	Yh (ft)	Vm (ft/s)		Zbs (ft)	Zls (ft)	Zlft (ft)	Zt (ft)
58	1.1	0.2	0.2	24.6	1.1	0.9	3.8	0.0030	0.2	0.0	1.0	2.0
173	1.1	0.5	0.4	24.6	2.1	1.5	5.2	0.0030	0.4	0.0	1.0	2.7
431	1.1	1.0	0.6	24.6	3.3	2.2	6.7	0.0030	0.7	0.0	1.0	3.9
575	1.1	1.2	0.7	24.6	3.7	2.4	7.2	0.0030	0.8	0.0	1.0	4.4

Toe Protection Needed	5.0	ft

HEC1 Results For Open Channel

Peak Flow	575	cfs
Stage at Peak Flow	0.0	ft
Volume at Peak Flow	44.0	ac. ft

Freeboard

Max. Flow Depth	3.7	ft
Channel Depth as designed	5.0	ft
Available Freeboard	1.3	ft
Required Freeboard	1.1	ft

Sediment Volume

Inflowing Sediment Volume	0.95	ac. ft
Outflowing Sediment Volume	0.04	ac. ft
Deposited(+)/Eroded(-) Volume	0.91	ac. ft

Cost Estimates

Channel Characteristics	Base	LC Enhanced
Type (Existing/Leveed/Excavated)	Excavated	Excavated
Channel Length (ft)	1465	1465
Side Slope (?H:1V)	3	6
Channel Width (ft)	40	70
Channel XS Area (sq. ft)	125	200
Channel Perimeter (ft)	42	71

Channel	Base	LC Enhanced
Excavation Volume (cu. Yd)	33200	57082
Excavated Area (sq. Yd)	6511	11394

Bank And Channel Lining	Base	LC Enhanced
Lining Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Bank Linings Only? (Yes/No)	Yes	Yes
Lining Length (ft)	1465	1465
Lining Width (ft)	32	61
Lining Thickness (ft)	0.5	0.5
Lining Area (sq. Yd)	5209	9929
Lining Volume (cu. Yd)	868	1655

Toe Protection		
Protection Type	Riprap	
(Riprap, Gabions, Soil cement, Concrete,None)		
Protection Length	1465	ft
Thickness	1.5	ft
Protection Depth	5	ft
Tie-in Length/Depth	3.0	ft
Total Depth	8.0	ft
Area needed	244	sq. Yd
Volume	651	cu. Yd

Levee	Base	LC Enhanced
Levee Type (Fill/Wall/None)	None	None
Left Levee Length (ft)	0	0
Left Levee Top Width (ft)	14	20
Left Levee Side Slope (ft/ft)	N/A	6
Left Levee Height (ft)	0	1
Left Levee Surface Area (sq. Yd)	0	0
Left Levee Volume (cu. Yd)	0	0
Right Levee Length (ft)	0	0
Right Levee Top Width (ft)	14	20
Right Levee Side Slope (ft/ft)	N/A	6
Right Levee Height (ft)	0	1
Right Levee Surface Area (sq. Yd)	0	0
Right Levee Volume (cu. Yd)	0	0
Total Levee Surface Area (sq. Yd)	0	0
Total Levee Volume (cu. Yd)	0	0

Levee Lining	Base	LC Enhanced
Lining Type	None	None
(Riprap, Gabions, Soil cement, Concrete,None)		
Left Levee Length (ft)	1465	1465
Left Levee Lining Width (ft)	0	0
Left Levee Lining Thickness (ft)	0	0
Left Levee Lining Area (sq. Yd)	0	0
Left Levee Lining Volume (cu. Yd)	0	0
Right Levee Length (ft)	1465	1465
Right Levee Lining Width (ft)	0	0
Right Levee Lining Thickness (ft)	0	0
Right Levee Lining Area (sq. Yd)	0	0
Right Levee Lining Volume (cu. Yd)	0	0
Total Lining Area (sq. Yd)	0	0
Total Lining Volume (cu. Yd)	0	0

Drop Structures		
Structure Type	Concrete	
(Riprap, Gabions, Soil cement, Concrete,None)		
Structure Length	40	ft
LC Enhancement Ratio	1.1	
Structure Thickness	0.5	ft
Drop Height	3	ft
Scour Depth	12.1	ft
Structure Height	15.1	ft
Number of Structures	9	
Volume per structure	11	cu. Yd
Unit Cost	$ 155.00	cu. Yd
Other Cost	$ -	
Cost per structure	$ 1,705	
Area per structure	2	sq. Yd
Total Area	20	sq. Yd

Sedimentation Basins		
Include Sed. Basins	Yes	
(Yes/No)		
Number of basins	10	
Total Volume per Basin	532	cu. Yd
Unit excavation cost	$ 4.00	cu. Yd
Excavation cost per basin	$ 2,128	
Other Cost	$ -	
Total cost per basin	$ 2,128	
Area per basin	724	sq. Yd
Total Area	7,240	sq. Yd

Structure Type	Structure Cost											
	Excavation/Construction				Landscape				Maintenance			
	Structure Type	Quantity	Units	Unit Cost	Cost Subtotal	Quantity	Units	Unit Cost	Landscape Cost	Quantity	Units	Unit Cost	Maintenance Cost
Levee	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee - LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Levee Lining -LC Enhancement	None	0	cu. Yd	$ -	$ -	0	sq. Yd	$ -	$ -	0	sq. Yd	$ -	$ -
Excavated Channel	Excavated	33,200	cu. Yd	$ 10.00	$ 332,000	6,511	sq. Yd	$ 9.00	$ 58,599	6,511	sq. Yd	$ 8.33	$ 54,258
Exc. Chl - LC Enhancement	Excavated	23,882	cu. Yd	$ 10.00	$ 238,820	4,883	sq. Yd	$ 9.00	$ 43,947	4,883	sq. Yd	$ 8.33	$ 40,692
Channel Lining	Concrete	868	cu. Yd	$ 155.00	$ 134,540	5,209	sq. Yd	$ -	$ -	5,209	sq. Yd	$ 41.67	$ 217,042
Channel Lining - LC Enhancement	Concrete	787	cu. Yd	$ 155.00	$ 121,985	4,720	sq. Yd	$ -	$ -	4,720	sq. Yd	$ 41.67	$ 196,667
Toe Protection	Riprap	651	cu. Yd	$ 75.00	$ 48,825	244	sq. Yd	$ -	$ -	244	sq. Yd	$ 25.00	$ 6,100
Drop Structures	Concrete	9	EA	$ 1,705.00	$ 15,345	20	sq. Yd	$ -	$ -	20	sq. Yd	$ 41.67	$ 833
Drop Str. - LC Enhancement	Concrete	9	EA	$ 170.50	$ 1,535	2	sq. Yd	$ -	$ -	2	sq. Yd	$ 41.67	$ 83
Sedimentation Basins		10	EA	$ 2,128.00	$ 21,280	7,240	sq. Yd	$ -	$ -	7,240	sq. Yd	$ 8.33	$ 60,333
Other					$ -				$ -				$ -
						Base Landscape Cost			$ 58,599	Base Maintenance Cost			$ 338,567
						LC Enhancement Cost			$ 43,947	LC Enhancement Cost			$ 237,442
						Total Landscape Cost			$ 102,546	Total Maintenance Cost			$ 576,008

Construction Cost Component	Base	LC Enhancement	Total
Construction Cost	$ 551,990	$ 362,340	$ 914,330
Contingency Cost (25% of Construction Cost)	$ 137,998	$ 90,585	$ 228,582
Engineering Design Cost (5% of Construction Cost)	$ 27,600	$ 18,117	$ 45,716
Total Construction Cost	$ 717,587	$ 471,041	$ 1,188,628

Land Cost

Channel Length	1465 ft

Land Cost Component	Width (ft)	Area (acre)	Unit Cost	Cost
Misc. Right of Way	134	4.5	$100,000	$ 450,000
LC Enhancement Buffer	50	1.7	$100,000	$ 170,000
Channel	40	1.3	$100,000	$ 130,000
Channel LC Enhancement	30	1	$100,000	$ 100,000
Levee	0	0	$100,000	$ -
Levee LC Enhancement	0	0	$100,000	$ -
Other	0	0	$100,000	$ -
Total	254	8.5		$ 850,000

Right of Way

Preservation Corridor Width	120	ft
Maintenance Access	14	ft
Landscape Enhancement Buffer	50	ft
Other	0	ft

Land Cost	Units	Quantity	Unit Cost	Cost Subtotal
Base Land Cost	acre	5.8	$100,000	$ 580,000
LC Enhancement Cost	acre	2.7	$100,000	$ 270,000
Total Land Cost	acre	8.5	$100,000	$ 850,000

Total Cost

Base Total Cost	$ 1,694,753
Total Landscape Enhancement Cost	$ 1,022,430
Total Cost Including LC Enh.	$ 2,717,183