WATSON DRAINAGE SYSTEM PRE-DESIGN

FCD 2012C003

DESIGN REPORT

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Flood Control District of Maricopa County

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WATSON DRAINAGE SYSTEM

FCD 2012C003

PRE-DESIGN REPORT

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EXECUTIVE SUMMARY

The purpose of the Watson Drainage System Pre-Design project is to improve upon the Buckeye ADMP Watson Drainage System by refining and firmly establishing the project alignment and features, determining design constraints, resolving unknowns, confirm feasibility, and clearly establishing the final design criteria for the Project. The Pre-Design involves collection of field data, identification of potential major utility conflicts, acquisition of information to support design, refinement of hydrologic and hydraulic models, development of preliminary plans that define the project in sufficient detail such that the size, alignment, and profile of major project features are determined that will be required for completion of the final design, definition of project rights-of-way requirements, and refinement of project costs.

This Pre-Design Report summarizes the process followed in accomplishing this purpose.

The ADMP recommendations for the Watson System (i.e. "Base Alternative") were used as a starting point for the pre-design process. Three additional alternatives (Alternatives A, B, and C) were developed that purported to add value to the Base Alternative by increasing performance or by reducing cost. These four alternatives were presented to the project team and were ranked according to several criteria, from which Alternative A emerged as the ***Preferred Alternative***.

The preliminary cost estimate for the Preferred Alternative was **$58,495,043**, not including contingencies, design, or other 'soft' costs.

A Value Analysis session was held over a two-day span, with attendees including some individuals that had not hitherto been involved in the project. The purpose of the VA session was to further vet the Preferred Alternative and determine if there were any refinements that could be made to the system to, once again, add value by increasing performance or reducing cost. Several VA proposals were developed, some of which were incorporated into the plan, along with certain direction from the Town of Buckeye. These refinements came together to form the ***Recommended Plan***.

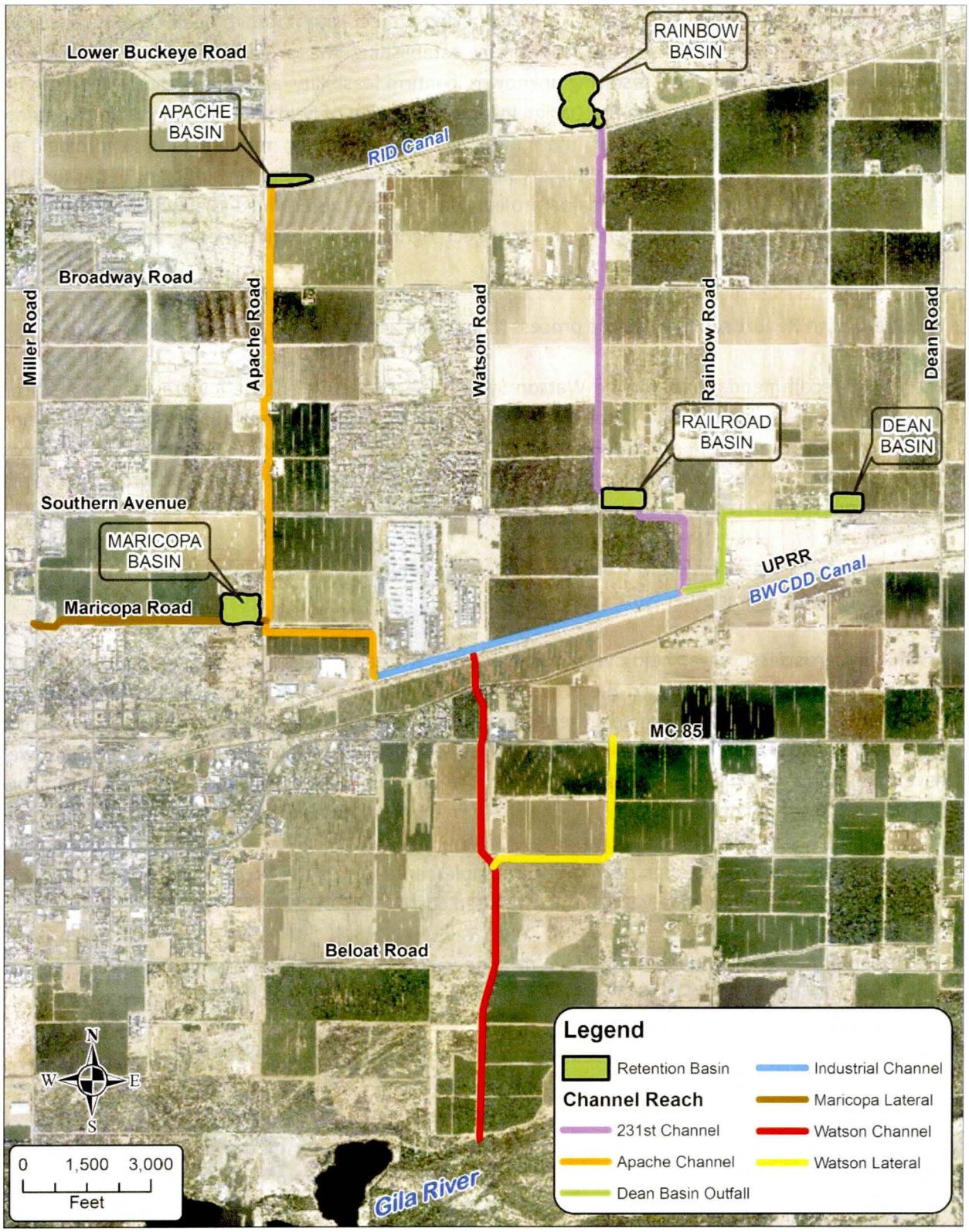
Estimated potential cost savings resulting from implementation of the VA directives and refinements was **$2,867,500** or approximately 5% of the estimated cost.

The design of Recommended Plan was then developed to a conceptual level, (which plans are provided separately bound), and used as the basis for a conceptual cost estimate for the Recommended Plan.

The estimated cost of the Recommended Plan from the conceptual design is **$69,584,285**.

The Recommended Plan will provide a benefit to the area by creating an outfall for the areas that are currently delineated with FEMA floodplains. While implementation of the recommended plan will provide the outfall system, the full benefit to the area will be dependent on area developers providing the necessary conveyance to deliver the floodwater from their respective parcels to the proposed Recommended Plan system channels.

FIGURE ES1 – RECOMMENDED PLAN SYSTEM LAYOUT



I. INTRODUCTION

This *Preliminary Design Report* is prepared for the Flood Control District of Maricopa County (FCDMC) and the Town of Buckeye (Buckeye) as part of the Watson Drainage System Pre-Design project. The FCDMC and Buckeye developed the *Buckeye Area Drainage Master Plan* (ADMP) in 2009. The ADMP identified a Recommended Plan for regional drainage improvements to alleviate existing flooding hazards, provide conveyance for runoff accumulation along irrigation canals, and provide drainage outfalls for local developments. The Watson Drainage System is one of five unique and separate north-to-south systems recommended by the ADMP.

A. Purpose

The purpose of the Pre-Design is to refine and firmly establish the project alignment and features, determine design constraints, resolve unknowns, confirm feasibility and clearly establish the final design criteria for the Project. The Pre-Design involves collection of field data, identification of potential major utility conflicts, acquisition of information to support design, refinement of hydrologic and hydraulic models, development of preliminary plans that define the project in sufficient detail such that the size, alignment, and profile of major project features are determined that will be required for completion of the final design, definition of project rights-of-way requirements, and refinement of project costs.

The Pre-Design also provides a basis for determining the scope of FCDMC and Buckeye shared implementation responsibilities, preparation of final design construction documents, subsequent required utility relocations, rights-of-way reservation and acquisition, and construction.

This *Preliminary Design Report* describes the development and recommendations for further implementation of the recommended plan for the Watson System. For the purposes of this report, the ***Pre-Design Recommended Plan*** is the result of refinement of the ***Preferred Alternative*** resulting from an analysis of various alternatives which were all based on the ADMP plan for the Watson System. The alternatives analysis is described in the *Preliminary Alternatives Memo* which is bound separately.

The Watson Drainage System, as recommended by the ADMP, included 2 separate locations where the UPRR tracks, the ANPP 96" waterline, the BWCDD canal and the Kinder-Morgan fuel pipeline were proposed to be crossed. Crossing each of these facilities represents a significant cost and requires time to obtain permits. Therefore, one of the main objectives of the Pre-Design was to evaluate the potential of consolidating the crossings into a single location.

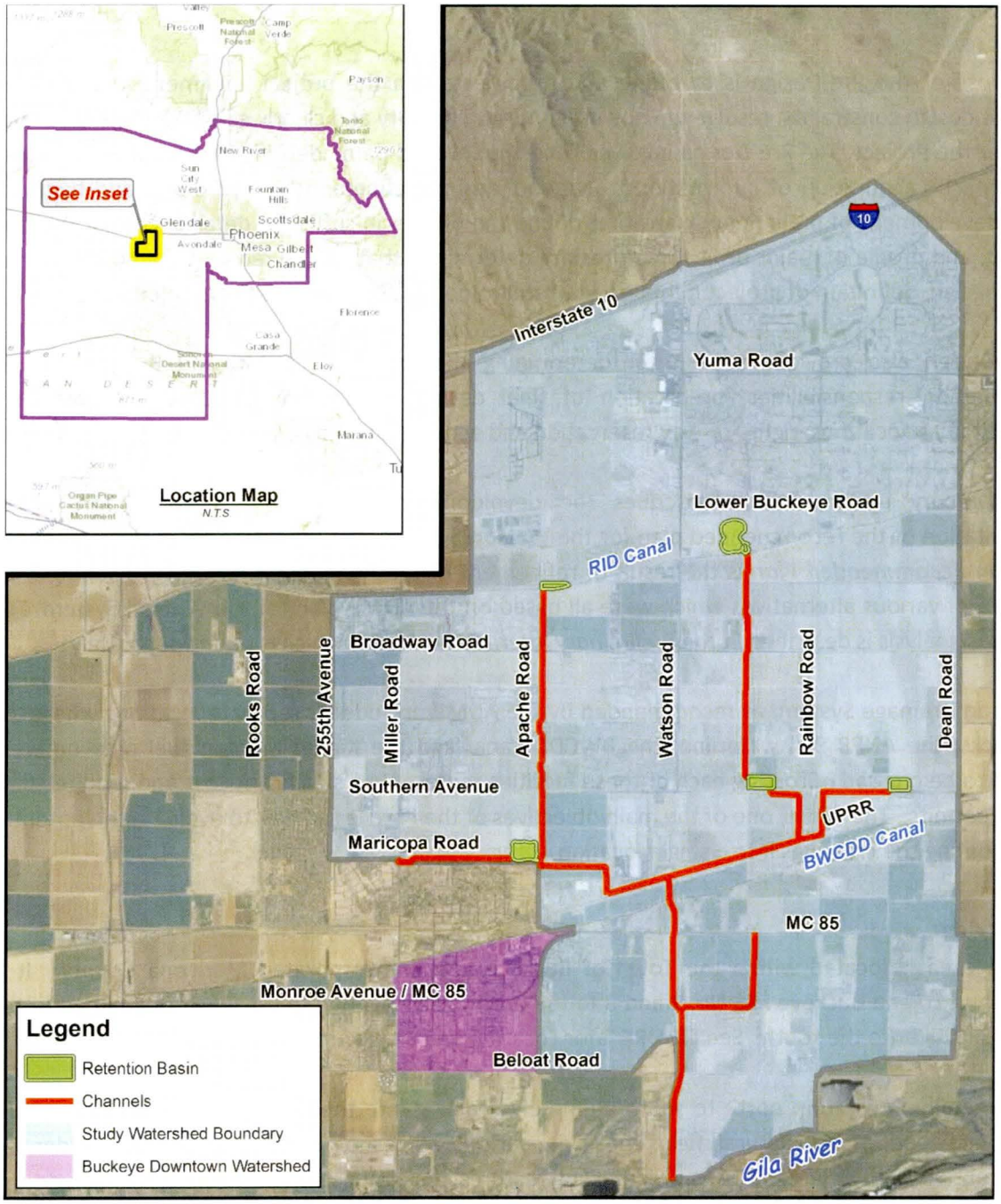
B. Study Area

The study area is located within the Town of Buckeye and unincorporated Maricopa County. It is bounded by I-10 and Buckeye FRS No. 2 and 3 to the north, 255th Avenue to the west, Dean Road to the east and Gila River to the south. See **FIGURE 2** for Location and Study Area.

Runoff generally flows from north to south ultimately draining into the Gila River. Most of the study area is developed as agricultural fields or is in various stages of redevelopment as residential, commercial, and industrial land uses. Significant features that impact drainage patterns include the

Roosevelt Irrigation District (RID) Canal and the Buckeye Water Conservation and Drainage District (BWCDD) canal which both flow from east to west and intercept runoff from the north. The two canals split the area approximately into thirds in the north-south direction. The BWCDD canal is within a corridor that includes the Union Pacific Railroad (UPRR) and the Arizona Nuclear Power Project (ANPP) reclaimed water line that transports treated effluent to the Palo Verde Nuclear Generating Station to the west. There are other significant utilities within this corridor as well which will be described later in this report.

FIGURE 2 – LOCATION AND STUDY AREA



C. Environmental Assessment

Prior to the alternatives analysis and during the data collection activities, a cursory inventory of environmental conditions including but not limited to the Clean Water Act Section 404 jurisdictional areas, hazardous material sites, cultural resource sites and the biological and ecological surveys was conducted by FCDMC to identify potential adverse environmental impacts within the preferred project alignment and boundaries. This process included a review of prior reports, such as area drainage master plans, and other environmental work completed for the project site. Additional inventory work was conducted for project areas not covered under any prior assessments. The information was compiled and utilized in the ranking of each of the alternatives.

D. Selection of Preferred Alternative

At the time the ADMP was completed, development was occurring at a rapid pace. Subsequent to the completion of the ADMP, and as a result of the national economic downturn, development activity effectively stopped. During development of this Pre-Design study, development plans within the study area have begun to start up again. The renewed development activity has resulted in changed plans which have an impact on the selected alignments and basin locations from the ADMP recommended plan. This necessitated that the ADMP alignments be re-evaluated and variations be considered to adapt to the changed conditions.

The following changed conditions that have occurred since the completion of the ADMP were reviewed and incorporated into the refinement of the previously recommended plan:

- Newer rainfall data with the release of NOAA 14 which for the Buckeye area result in reductions in design rainfall values.
- Elimination of the White Tanks #4 outfall channel from the project due to regional planning changes which will reduce design discharges in portions of the project.
- Updates to the Town of Buckeye General Plan which impact planned land use and attendant runoff characteristics.

The ADMP proposed plan was included in the new alternatives analysis as the base alternative for comparison with new alternatives identified for consideration. It was determined that a meaningful improvement to the ADMP proposed plan would be necessary in order to justify any revisions to the ADMP plan. In addition to the Base alternative, three new alternatives were identified which were modifications to the Base that would potentially add value to the project and/or reduce cost or other conflicts. A significant objective for the new alternatives was to combine outfalls so that only one crossing would be required across the UPRR, BWCDD Canal, and ANPP pipeline.

Due to the reduction in peak discharge and runoff volume resulting from the revised rainfall design values, there was an opportunity to significantly reduce the detention basin sizes or channel sizes from the ADMP plan. Based on these opportunities, 3 alternatives were developed for further evaluation. The first, Alternative A, was developed to take full advantage of storage volumes from the ADMP and reduce the downstream conveyance requirements as much as practical. The opposite approach was taken for Alternative B, which was to reduce the detention basin volumes and associated footprint as much as practical and take full advantage of downstream conveyance corridors. A third approach (Alternative C) was developed based on the strategy of developing a system upstream of the UPRR that

would allow the 100-year discharge to pass through the existing railroad culverts or, alternatively, with minimal cost additions of culvert barrels.

The ADMP was developed using a value-based approach to planning within the Buckeye ADMP area. This approach was based on clearly identifying the project objectives as expressed by "end-users", which in this case are the local community stakeholders. The project objectives were supplemented by opportunities to add value to the project as identified during the ADMP data collection process. The project objectives were restated as performance criteria, which were then used as a guide in developing stormwater management alternatives and as a means to measure the performance, or value, of the various alternatives.

The project objectives expressed by the stakeholders fall into the general categories of flood protection, community enhancement, synergy, and implementation.

The project goals and objectives stated by the stakeholders were synthesized into a set of performance criteria to be used in an evaluation matrix to measure the alternatives according to how well they meet the criteria and thereby add value for the community. As part of the ADMP, the criteria were each assigned a weighting factor from one to five based on how important the criteria should be considered against the others. It was determined by the design team to keep the weighting factors from the ADMP intact for consistency across planning and design platforms/efforts. The Performance Criteria with the ADMP assigned weighting factors are:

- Constructability (3)
- Implementation (1)
- Life Cycle Costs (2)
- Landscape Aesthetics and Land Use Compatibility (4)
- Natural & Cultural Resources (4)
- Public and Political Acceptance (2)
- Safety / Flood Hazard Reduction (5)
- Synergy and Multi-Use (4)

The base plan plus the three alternatives were documented in the Draft Preliminary Alternatives Memo and distributed to the evaluation committee prior to an Alternative Selection Meeting. The alternatives were presented and discussed at the meeting and an evaluation matrix was used to assign scores to each of the alternatives to identify which alternatives provided the greatest value. The alternative cost and assigned value score were used to identify the preferred alternative to be carried forward in the project. Alternative A was selected as the preferred alternative and, with minor modification, was presented for review in a Value Analysis process. The Preferred Alternative presented to the VA team is shown on **FIGURE 3**

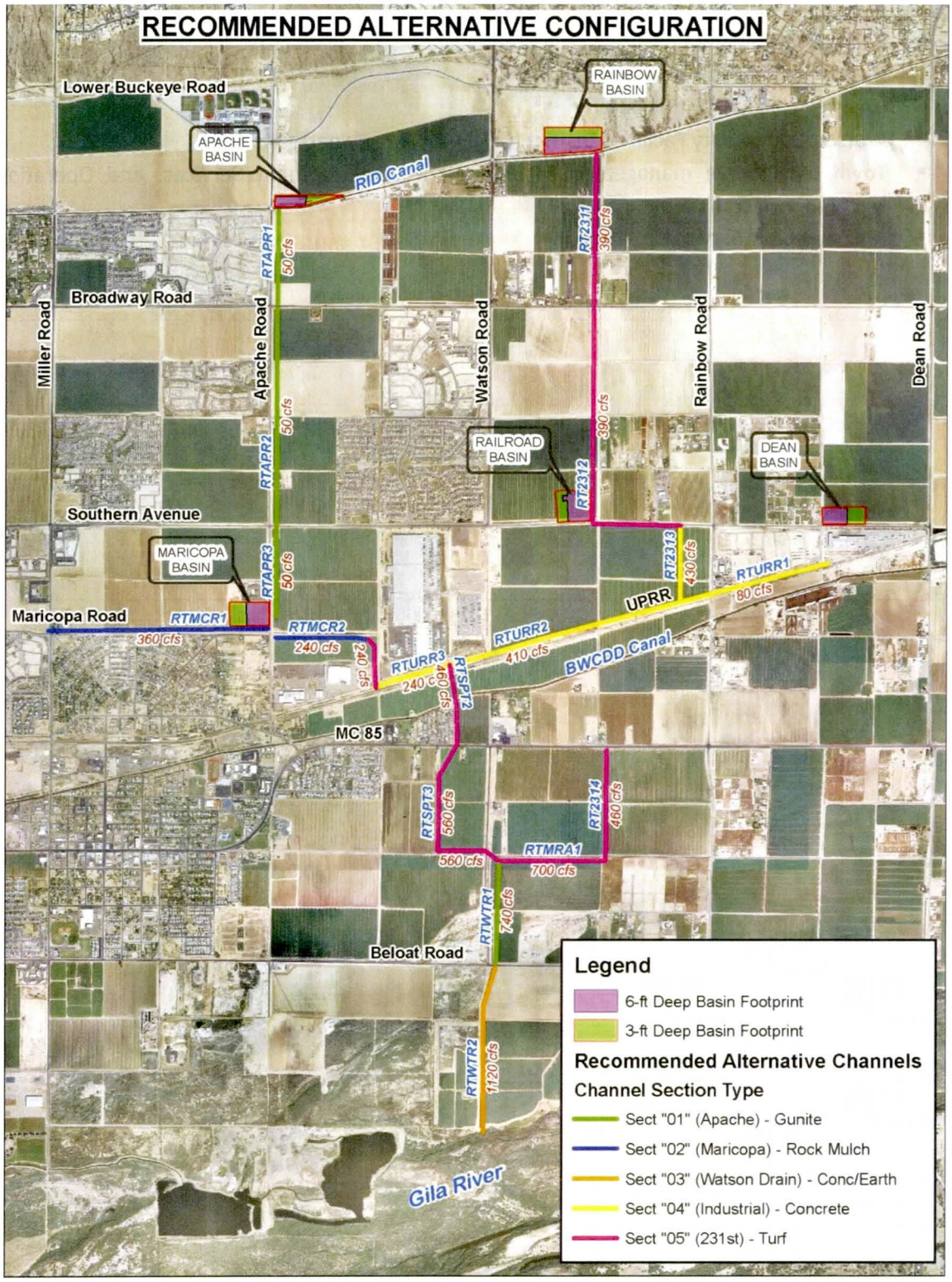
E. Public and Stakeholder Input

As noted in the previous section, an emphasis was placed on identifying and addressing the goals and objectives of the project stakeholders. Input was solicited from the general public via two public meetings, a Project Aesthetics Advisory Committee (PAAC) was formed to provide input on the multi-use and aesthetic aspects of the project elements, and meetings were conducted with a number of

direct stakeholders who would need to participate in the project or would be directly impacted by the project. Meetings were held with the following stakeholders:

- Buckeye Water and Conservation and Drainage District (BWCDD)
- Roosevelt Irrigation District (RID)
- Union Pacific Railroad (UPRR)
- Watson Community Facilities District (CFD) property owners
- Town of Buckeye management, Public Works, Development Services, and Operation and Maintenance staff.
- Arizona Public Service Co. (APS)

FIGURE 3 - PREFERRED ALTERNATIVE PRESENTED TO VA TEAM



F. Value Analysis

The Preferred Alternative that emerged from the Alternatives Analysis (Alternative A) was presented to an independent Value Analysis (VA) team for review. The VA Team met on June 17-18, 2013 to review the plan thoroughly with the goal of identifying ways to improve or enhance the value of the final project. Enhancement of value can be achieved by improving performance, reducing costs, or various combinations of the two. The plan modifications resulting from the Value Analysis are presented in this section. The summary report from the VA session is included in **Appendix A**.

The estimated cost of the Preferred Alternative as identified by the Alternatives Analysis was **$58,495,953**, which included the estimated cost of property acquisition.

1. VA Workshop

The VA Team included members of the consultant team, staff from FCDMC and the Town of Buckeye that had been involved in the development of the project, and staff from FCDMC that had not previously been involved in the project. This makeup provided adequate project history and knowledge, as well as a fresh unbiased perspective on the proposed system.

At the beginning of the first day of the workshop, the project team provided background information regarding project goals, constraints, and alternatives development. The VA team then broke into 3 groups to focus on 3 different areas of the proposed system, with the purpose of adding value by improving performance or reducing costs.

On the afternoon of the last day of the workshop, the VA Team presented ideas for adding value to the proposed system to FCDMC senior management.

2. VA Proposals

The VA Team identified several proposals for adding value to the proposed system, ranging from delaying the implementation of turf lining and the associated irrigation system, to utilizing steeper side slopes on some of the channel reaches, to revising the downstream terminus of the project to avoid impacting the existing sand and gravel operation. The VA proposals are discussed in more detail in the Value Analysis Report in **Appendix A**.

3. VA Directives

Subsequent to the VA session and FCDMC internal discussion, the consultant team was directed to incorporate the following revisions into Alternative A from the Alternatives Analysis:

- Utilize 2:1 (h:v) side slopes for the concrete industrial channel reaches of the system. A fence or rail will need to be included at the top of banks.

- Design the channel reaches that are planned to ultimately be turf for the interim condition. That is, no turf or irrigation system will be included. The channel will be lined with non-irrigated hydroseeding and soil stabilizers for erosion control, collection swales where appropriate, and

grade control structures composed of dumped riprap to protect the interim channel from degrading beyond the ultimate channel slope.

- Include first flush water quality microswales and mini-basins into the overbank areas for channel sections adjacent to existing or future roadways.

- The channel outfall option proposed in the VA for Alternative A will require agreements to implement and will be pursued by the project partners with BWCDD and property owners. An exhibit of this alternative is included following the VA Report in Appendix A.

- During initial project discussion, the City of Buckeye requested that the Watson system incorporate a planned discharge from the downtown area since they did not have adequate storm water infrastructure of 100-year, 2-hour retention available. Alternative A will include the potential to accommodate discharge from the Downtown area along Monroe Avenue and Beloat Road. The input hydrographs were prepared by the City's consultant and were incorporated into Alternative A. A memo summarizing the inflow locations and flows has been included in **Appendix A**.

The full VA report is included in **Appendix A**.

The combined potential savings that could be realized through implementation of these directives was estimated to be **$2,867,500** or approximately 5% of the estimated cost.

The estimated cost of the Recommended Plan from the conceptual design is **$69,584,285**, including estimated costs of property acquisition.

II. HYDROLOGY

A. Introduction

The Buckeye ADMP developed a hydrology model for the study area using the DDMSW software program based upon NOAA Atlas 2 rainfall data. The Watson system is one of four distinct and independent drainage systems proposed for implementation in the ADMP. The Watson system, as proposed in the ADMP, included a significant offsite flow contribution from the White Tanks Flood Retarding Structure (FRS) #4 Outfall Channel.

Since the completion of the ADMP, policy changes and physical changes within the watershed have occurred which warranted certain revisions to the hydrology model.

B. Hydrology Model Modifications

For the purposes of the Pre-Design project, the portion of the hydrology model specific to Watson watershed was extracted as a stand-alone model.

Subsequent to the completion of the Buckeye ADMP, FCDMC adopted NOAA Atlas 14 as the standard for rainfall data for hydrology modeling in Maricopa County. In addition to this significant policy change, the Town of Buckeye updated its General Plan, which modified certain land uses in the study area. Furthermore, the White Tanks FRS #4 Outfall Channel was redirected to a different outfall.

A summary of the modifications made to the ADMP hydrology model follows:

- Watson watershed model was isolated and extracted as a stand-alone model
- Rainfall data was updated based on NOAA 14 values
- Land use values were updated based on latest Town General Plan, including 100-year, 2-hour retention volume for all areas planned for future development
- The offsite flow contribution from the White Tanks FRS #4 Outfall Channel was removed from the model

These changes to the hydrology model created the Watson Pre-Design Base model.

A more detailed explanation of the hydrology model modifications made for the Watson Pre-Design Project is provided in the Watson Drainage System Pre-Design: Hydrology Memorandum which has been prepared under separate cover as Volume I of the Design Report.

Once the Pre-Design base model was established, alternative-specific models were developed for each of the alternatives evaluated in the Alternatives Analysis. Alternative A emerged as the Preferred Alternative, and thus the hydrology developed to represent Alternative A is the Recommended Plan model.

The proposed channel sections developed for the project were utilized in the Recommended Plan hydrology models for the hydrograph routing steps. Estimated composite roughness coefficients were developed for each of the channel sections.

Preliminary detention basin stage-storage-discharge relationships were developed for each of the 5 proposed basins, which were utilized in the Recommended Plan model for the storage routing routines. Comparisons were made between in-line and off-line storage basins. It was determined that off-line basins provide the most discharge reduction per unit area. Each proposed basin was optimized for efficiency, and it was determined that allowing a by-pass flow of 50 cfs prior to intercepting flow in the basin yields the most benefit for a given basin footprint. A series of diversion statements was incorporated into the Recommended Plan hydrology model in the logic tree upstream from the offline basins which allows the first 50 cfs to pass by the basin in the channel. Once the flow exceeds 50 cfs in the adjacent channel, flow is diverted into, and routed through the basin.

III. CONCEPTUAL DESIGN

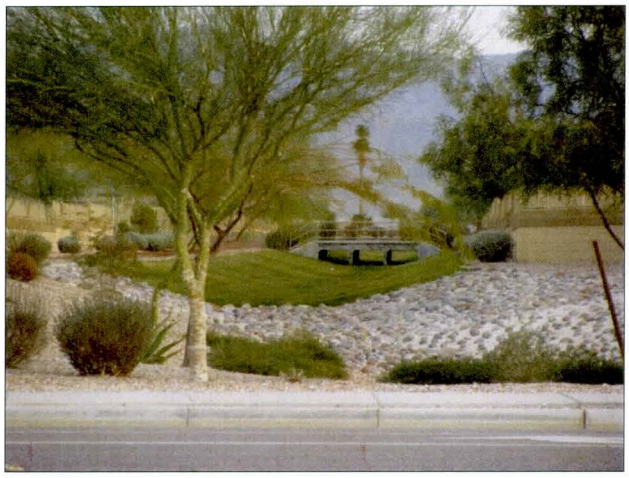
A. Introduction

The Recommended Plan includes 5 detention basins to attenuate flows north of the UPRR tracks, all of which are designed as off-line basins. A single crossing of the UPRR tracks, the 96" ANPP Waterline and BWCDD canal is included in the Recommended Plan, with combination of the east and west legs of the system occurring just north of the UPRR tracks. The Recommended Plan makes use of the existing Watson Drain as its outfall to the Gila River. Once the elements of the Recommended Plan were established, conceptual plan development commenced.

B. Landscape and Multi-Use

The landscape and multi-use concepts for the Recommended Alternative reflect refinements to the design guidelines from the Buckeye Area Drainage Master Plan, with two important considerations driving the results.

FIGURE 4 – EXISTING DEVELOPMENT CHANNEL



The first of these considerations came from the Town of Buckeye's strong preference for alternatives that are responsive to their adjacent settings rather than having a "one-size-fits-all" approach to channel and basin design. This resulted in the development of the suite of channel concepts depicted in the recommended plan that reflect both constraints as well as opportunities afforded by the planned developments along the conveyance routes.

The second consideration that shaped the Recommended Alternative landscape design is the phasing of the system between facilities to be constructed by the District in the near term from approximately the UPRR tracks to the Gila River and facilities that will be the Town's responsibility to implement in the future. The Town-implemented facilities will be further refined and implemented through partnerships with the adjacent developers to include the installation and maintenance of the landscape and multi-use needs. Where the District's phase will be constructed in advance of incoming development, interim landscape treatments have been included in the Watson Drainage System Recommended Plan. Final landscape treatments for the District's phase of the system, including turf and irrigated landscape material, will be implemented post-construction through partnerships between the Town of Buckeye and the adjacent developers. The Town envisions providing incentives to the developers to facilitate these partnerships including offering open space credits, density credits, or allowing potential co-location of stormwater storage. Both interim and final landscape treatments should be carried forward through final design.

1. *Landscape*

Landscape design requirements related to each channel and basin concept are described in more detail in *Section III-C Design Criteria* including configuration criteria and landscape and lining materials with their associated n-values.

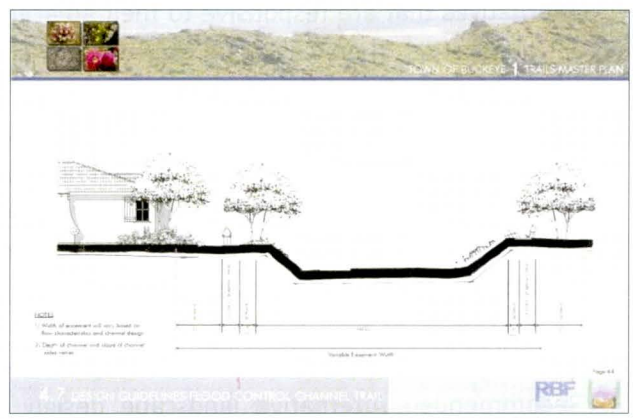
2. *Multi-Use*

Three primary multi-use opportunities have been incorporated into the Watson Drainage System Recommended Plan:

- Co-locating a proposed Town of Buckeye park with the Rainbow Basin near the existing Sundance Park site.
- Providing opportunity to implement the Town of Buckeye's Trails Master Plan through dual use of the O&M roads as multi-use paths or trails and providing public access onto the O&M roads rather than restricting access and fencing off the projects.
- Preserving passive open space within the multiple basin sites and allowing for other multi-use opportunities in the future.

Implementation of the Town of Buckeye's Trails Master Plan (2009) will be accomplished largely by designating project O&M roads as multi-use trails. Further refinement and coordination with the Town regarding this opportunity will be required at final design to resolve how best to route the trail at the UPRR and BWCDD crossings. The future design and construction of the Watson Road Parkway may serve as an opportunity to resolve this obstacle to having a continuous pedestrian corridor from the Gila River to the Sundance Park complex on the north side of the Roosevelt Irrigation District Canal.

FIGURE 5 – EXAMPLE FROM TOWN TRAILS MASTER PLAN



Implementation of the basin multi-use objectives will be accomplished by the Town of Buckeye as part of the completion of their phase of the Watson System. Where no project partner is present, basin design is intended to preserve open space areas through the restoration of the basin site using native landscape materials as described in *Section III.D.3- Detention Basins*. Where partnering with an adjacent landowner is possible, the multi-use concept for the basin will be developed and implemented through the agreements of that partnership and may include active recreation to provide open space credits to the development as well as other incentives, as determined by the Town of Buckeye.

C. *Environmental Considerations*

1. *Section 404 of the Clean Water Act*

The regulatory program administers and enforces Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act. Under Section 10, a United States Army Corps of Engineers (USACE) permit is required for work or structures in, over or under navigable waters of the United States. Under

Section 404, a USACE permit is required for the discharge of dredged or fill material into waters of the United States.

A preliminary determination was conducted to determine the limits of the USACE's jurisdiction within the project area under Section 404 of the Clean Water Act. The preliminary JD finds that there "may be" waters of the United States on the subject project site, and identifies all aquatic features on the site that could be affected by the proposed activity.

For a larger riverine system such as the Gila River, the USACE typically defers to the 100 year floodway for their Jurisdictional Delineation (JD). Results of a field survey and aerial map review indicated that a FEMA 100 year flood plain exists along the banks of the Gila River around the Arlingon Canal. Based on a meeting and several discussions with Ric Barnas, with the Gila River Sand and Gravel company, a JD (File no. 2005-01600 RWF) was conducted by the AGFD within the Gila River and encompassed 160 acres along the Gila River, which included the current gravel pit and a portion of the Arlington Canal immediately downstream of our proposed outlet. Results of the survey indicated that the approved JD limits of the Gila River were determined to be farther south of the canal, toward the south bank of the river. Consequently, it is likely that no Section 404 permit would be required for impacts within the proposed outlet of the drain. However, further analysis and JD determination may be required during final design.

2. *Hazardous Material Surveys*

The emphasis of this review is to obtain regional data in evaluating the project area for the presence of recognized environmental conditions (REC's) resulting from past or present uses, as defined by ASTM Standard Practice for ESA's (E1527-05) which could potentially adversely impact each of the alternative alignments. A cursory environmental analysis was conducted as part of the Buckeye Area Drainage Master Plan (ADMP) and was used to determine potential areas of environmental concerns within the proposed alignment of the drain.

Based on this cursory review of the site, areas of concern would include the alignment through the industrial sites in addition to the crossings along the Kinder Morgan pipeline which will require testing and analysis of the soil prior to construction of the drain. A more definitive analysis of the project area including a Phase I Environmental Site Assessment will be conducted once a preferred alignment has been approved and rights of entry have been obtained.

3. *Cultural Surveys*

The FCDMC completed an archeological inventory of the Watson Drainage System base alternative corridor in compliance with among others a) the National Historic Preservation Act of 1966, b) the Arizona Antiquities Act of 1960 (Arizona Revised Statute [A.R.S.] Section [§] 41-841 et seq.), and c) the State Historic Preservation Act of 1982 (A.R.S. § 41-861 et seq.). The principal concern of all three laws is the realistic protection of all important cultural properties that might otherwise be impacted or destroyed during various undertakings such as geotechnical work and project construction.

The survey corridor was based on the conceptual design plans for the Watson drainage system as proposed in the Buckeye Area Drainage Master Plan (ADMP). The proposed alignment was surveyed by Scientific Archeological Services (SAS) on behalf of the District. The results of the survey indicated that seven previously recorded cultural resource sites occurred within the Area of Potential Effects (APE) for the project. One of the sites, AZ T:10:43 was officially relocated by ASM approximately 500 meters to the west of the proposed outlet of the drain, and is no longer within the APE of the project. Two other sites, including the historic GLO roads, have been destroyed by cultivation and are no longer in jeopardy of being impacted by the proposed drainage system. The remaining four sites, the Buckeye Canal (AZ T:10:82[ASM]), the Roosevelt Canal (AZ T:10:83[ASM]), the Southern Pacific Railroad (AZ T:10:84[ASM]) and the old US 80 (AZ FF:9:17[ASM]), have been recommended for or formally determined to be eligible for nomination with the National Register of Historic Places and will be impacted by the alignment of the drainage system.

Based on SAS's recommendations, mitigation of the sites would not be necessary if it could be demonstrated that the National Register characteristic of the four structures would not be altered as a result of the impacts. Given that the proposed impacts from the drainage system will be limited to box culverts or similar architectural features constructed below and over the structures, the potential for alteration is minimal. Consequently, no further work would most likely be needed prior to implementing the recommended plan. Final approval of the survey report by the State Historic Preservation Office (SHPO) is pending and contingent upon determination of a final alignment and potential processing under the Section 106 of the NHPA through the Section 404 permit.

4. Biological

A list of Federally listed Threatened and Endangered Species for Maricopa and Pinal County is obtained from the United States Fish and Wildlife Services (USFWS), to determine the presence of any of these species within the study area. Based on meetings and discussions with the Arizona Game and Fish Department (AGFD), there is the potential presence of Threatened & Endangered species within the Gila River at the proposed location of the drain outlet upstream of the Arlington Canal. Based on conversation with Dana Warneke, with the AGFD, the known locations of some of the species is "spotty" and may not be prolific enough to warrant changes in the proposed location of the outlet. Additional surveys will be conducted as needed prior to construction in the event that T&E species are identified in the proposed outlet area.

FIGURE 6 - BURROWING OWL NEAR 231st AVE

Other concerns include burrowing owls which could be present within the bermed areas of the agricultural channels. Measures will be implemented to either avoid or relocate these owls prior to the construction of the project.

5. *Ecological*

Vegetation is scarce along the major reaches of the drain and includes primarily agricultural crops including alfalfa and several varieties of shrubs and weeds. Stands of native mesquites (*prosopis veluntina*) and palo verde species (*Parkinsonia sp.*) have established in the areas upstream of the RID Canal where two proposed basin sites are located. Native plant inventory and salvage following the Town of Buckeye's *Protection of Native Plant Species Within Pristine or Environmentally Sensitive Areas* ordinance is recommended to protect or reestablish these resources during project design. Water impounding upstream of the UPRR has led to the establishment of volunteer desert broom, saltbush, and other scrub materials with few trees. Areas within the outlet area at the Gila River are significantly more dense in vegetation consisting primarily of tamarisk or salt cedar, mesquite and palo verde trees and riparian shrubs. Occasional cottonwoods can be found near the outfall as observed from the river embankment.

FIGURE 7 – VEGETATION AT GILA RIVER AND WATSON DRAIN

D. *Design Criteria*

Drainage design for hydraulic structures in Maricopa County is governed by criteria presented in Drainage Design Manual for Maricopa County, Arizona, Volume II, Hydraulics, August, 2013 (Hydraulics Manual). In addition to the criteria from the Hydraulics Manual, additional criteria are adopted for conceptual design. The Town of Buckeye Storm Water Drainage System Design Manual (DM-500) has also been referenced for this project. The criteria listed below are used as a guideline during design development and are intended to be used for final design.

1. *Open Channels*

Channel Section – The maximum side slope is 2H:1V for concrete channels, 4H:1V for earth channels, and 5H:1V for turf channels for maintenance. It is intended that the side slope for earth channels is an average of 6H:1V and is expected to vary from 4H:1V to 8H:1V to create side slope warping and channel meander where sufficient right-of-way is available. A minimum bottom width of 8-ft is required. The design channel lining depth is the normal flow depth plus freeboard. Required freeboard is 0.25 times the sum of depth plus velocity head with a minimum of 1-ft for sub-critical flow and 2-ft for super-critical flow conditions.

Right-of-Way – Channel right-of-way is to conform to the specific channel type described in *Section III-E,* and include space for landscape buffers and O&M roads. Where channels are adjacent to roadways,

road rights-of-way have been integrated into the proposed channel setbacks to provide dual-use as part of the landscape buffer, and assist in reducing the overall project cost.

Roughness Coefficient –The Manning's roughness coefficients (n-values) used in development of the channel design sections are shown in **TABLE 1**. The n-values selected for this project were derived from the FCDMC Hydraulics Manual (January, 1996) and through discussions with FCDMC staff.

TABLE 1 – MANNING'S ROUGHNESS COEFFICIENTS

Description	Roughness Coefficient
Concrete Channel Lining	0.016
Gunite Channel Lining	0.022
Rock Mulch Channel Lining	0.033
Unlined Earthen Channel	0.032
Turf Channel Lining	0.035

Froude Number – Froude numbers for channel design are to be less than or equal to 0.86 for sub-critical flow. In most cases, channels are designed for sub-critical flow. Drop structures are provided, if necessary, to flatten the grade to achieve sub-critical flow conditions. Although no super-critical reaches are anticipated, super-critical flow may be allowed in special circumstances, such as where right-of-way is limited. Super-critical flow channels, if used, are to have Froude numbers greater than 1.13 and less than 2.0.

Longitudinal Slope – Extremely flat slopes are avoided for constructability reasons. However, where necessary, a minimum longitudinal slope of 0.0008-ft/ft is used. Generally, slopes are set to approximate the existing ground slope within the limitations of the channel material maximum allowable velocity and the limitation on Froude number. Final designers should note that minimum and maximum permissible velocities have been established for the channel reaches in this project based on site specific soil information. A memo prepared by FCDMC pertaining to allowable project velocities is included in **Appendix A**.

Vertical Drop Structures and Channel Profile – When the natural ground slope is steeper than the maximum allowable longitudinal channel slope, vertical drop structures are provided. The size and spacing of drop structures are established based on a net drop height of 1.5-ft. These structures have been sized based on the criteria established in Chapter 7 of the Hydraulics Manual (January, 1996) for vertical riprap basins, with a drop height of 2.5-ft and an end sill height of 1-ft. The top of channels should project no more than 2-ft above adjacent existing ground (fill situations) and the top of channels should be incised no more than 2-ft below adjacent existing ground (cut situations).

Channel Alignment – Horizontal curves are designed with a minimum radius greater than 3 times the flow top width. Channel confluences which occur at channel curves maintain tangency at the outer bank toe rather than at the channel centerline. Horizontal angle points without a transition radius only occur within culverts or storm drain segments, and are limited to a maximum deflection angle of 45 degrees. The final design will incorporate channel meander through the variation in side slope from 4:1

to 6:1. These design criteria do not apply to minor curves to provide subtle channel meander less than 1/3 the width of the channel.

River Outfall – The Watson Drainage System will outfall into the Gila River. At this location, the backwater from the river could spill into the Watson Drain channel. However, since it is unlikely that the peak flow in the Gila River would occur at the same time as the peak from the Watson drainage area, a reasonable assumption is for the Watson Drainage System 100-year event to occur during the Gila River 10-year event. The Gila River 10-year WSEL is much lower than the 100-year WSEL, and no backwater effect from the Gila River on the Watson Drainage System is anticipated. A more detailed explanation of the Backwater Analysis prepared to document this finding is included in **Appendix A**.

Side Drainage – Surface runoff entering the channel from the side should be directed through microswales, mini-basins and/or bioswales to enter the channel at planned locations. This will prevent rill erosion for earth channels and undermining at the concrete-soil interface for concrete channels.

Auxiliary Drainage Facilities – A parallel v-shaped swale will be used to convey runoff to planned channel inflow points. These swales will be constructed within the channel buffer areas, above the channel top of bank and within the proposed channel right-of-way.

Maintenance Access Road – The channel cross-section includes a 14-ft wide maintenance road on at least one side of the channel. In locations where the maintenance road is adjacent to a future public street, the channel maintenance road will take the place of the sidewalk on that side of the road, with the maintenance road meandering within both the roadway and channel rights-of-way. New maintenance roads should have a 2% cross slope, away from the main channel. At specified locations, the maintenance road should be dipped to allow side drainage to enter the main channel via a down drain. The maintenance roads will be surfaced with asphalt concrete pavement or as coordinated with the partnering developer. Where two O&M roads are included adjacent to a channel, a soft surfacing should be considered in place of asphalt for one of the two roads. Soft surfacing should incorporate ¼" minus decomposed granite or aggregate base course (ABC) as an alternative and applied as noted on the plan sheets.

Fencing – Due to the multiple-use objective in the channel design, new fencing is only provided along the industrial channel reaches due to the steeper side slopes of this channel section. Existing private fences along the alignment are suggested to be protected in place during construction or replaced in kind.

Concrete Lining – Preliminary concrete channel lining was designed using the methodology outlined in the US Army Corp of Engineers' Engineering Manual 1110-2-2007. Based on the design procedures for Continuously Reinforced Concrete Pavement outlined in this manual, the concrete channel lining includes a 6-inch thick concrete lining with reinforcing steel using #4 bars at 6-inch center spacing longitudinally and 12-inch center spacing transversely. The final concrete channel section design should be based on recommendations from a future geotechnical investigation.

Landscape – For channels designed with partnering developers and final conditions, tree and shrub densities for the landscape areas shall conform with the Town of Buckeye's Development Code Section 7-5-6. Specific plant species will be selected by the developer to complement the development landscape design, and should be compliant with the ADWR Low-Water Plant List for the Phoenix AMA. Controlled water-harvest swales and micro-basins should be included within the road PUE and setback design to provide water-quality benefits, landscape establishment, and erosion reduction.

Interim Channel Landscape – Where construction occurs in advance of adjacent development, channel landscape materials shall be selected, based on those materials that can survive without supplemental irrigation and do not prohibit future channel improvement and development landscape. Tall pot trees consisting of blue palo verde (*Parkinsonia florida)*, foothills palo verde (*Parkinsonia microphylla),* native mesquite (*Prosopis velutina)*, ironwood (*Olneya tesota)*, and desert willow (*Chilopsis linearis)* should be planted in the landscape buffers only and at a density of approximately nine (9) trees per acre to allow for future installation of additional trees from the development plant palette. Hydroseed in the overbank areas should include flowering shrubs and native grasses such as indicated below in **TABLE 2**. Hydroseed in the channel side-slopes and bottoms should consist of grasses and herbaceous species so as to provide erosion protection in the interim condition while requiring minimal clearing and grubbing at the time the channel is fully developed. Plant species should be similar to that shown in **Table-2** below. Seed availability at the time of final design and construction may necessitate modifications to the recommended hydroseed mixes.

TABLE 2 - GENERAL HYDROSEED MIX

Botanical Name	Common Name	PLS Rate (Pounds Per Acre)
Ambrosia deltoidea	**Triangle-leaf Bursage**	**1.0**
Ambrosia dumosa	**White Bursage**	**1.0**
Aristida purpurea	**Purple Three-Awn**	**1.0**
Atriplex polycarpa	**Desert Saltbush**	**2.0**
Baileya multiradiata	**Desert Marigold**	**0.50**
Bouteloua aristidoides	**Needle Grama**	**1.0**
Castilleja exerta ssp. exerta	**Purple Owl's Clover**	**0.10**
Encelia farinosa	**Brittlebush**	**2.0**
Eschscholtzia mexicana	**Mexican Poppy**	**1.0**
Lesquerella gordonii	**Gordon's Bladderpod**	**0.50**
Lupinus sparsiflorus	**Desert Lupine**	**0.50**
Phacelia crenulata	**Arizona Desert Bluebells**	**2.0**
Plantago ovata	**Desert Indian Wheat**	**2.0**
Salvia columbariae	**Desert Chia**	**0.50**
Senna covesii	**Desert Senna**	**0.50**
Sphaeralcea ambigua	**Desert Globemallow**	**0.50**
	Total PLS	**16.1**

TABLE 3 - EROSION CONTROL (NO WOODY MATERIAL) HYDROSEED MIX

Botanical Name	Common Name	PLS Rate (Pounds Per Acre)
Aristida purpurea	**Purple Three-Awn**	**1.5**
Baileya multiradiata	**Desert Marigold**	**1.5**
Bouteloua aristidoides	**Needle Grama**	**1.0**
Encelia farinosa	**Brittlebush**	**2.0**
Eschscholtzia mexicana	**Mexican Poppy**	**1.5**
Plantago ovata	**Desert Indian Wheat**	**3.0**
Sporobolus airoides	**Alkali Sacaton**	**1.0**
Sporobolus cryptandrus	**Sand Dropseed**	**1.0**
	Total PLS	**12.5**

2. Culverts and Storm Drain Pipe

Design Flow – Culverts constructed with channels are designed for the same 100-year design discharge as used for the channel.

Height and Cover Requirements – A minimum culvert height of 4-ft is provided for maintenance purposes. A minimum of 1-ft of cover is provided to allow for a full roadway structural section.

Conflicting Utility Clearance – Minimum recommended clearances between utilities and proposed culverts and storm drain pipes is 6-ft horizontal and 1-ft vertical. Special considerations will be needed during final design where these minimum clearances are not feasible.

Roughness Coefficient – The Manning's roughness coefficients used in development of the culvert and storm drain design are shown in **TABLE 4**.

TABLE 4 – MANNING'S ROUGHNESS COEFFICIENTS FOR CULVERTS AND STORM DRAIN

Description	Roughness Coefficient
Concrete Box Culverts	0.013
Storm Drain Pipe	0.013

Longitudinal Slope – Extremely flat slopes are avoided for constructability reasons. However, where necessary, a minimum longitudinal slope of 0.0008-ft/ft is used. Additionally, steep slopes are avoided for water velocity and flow regime reasons.

FIGURE 8 –PREFERRED DROP STRUCTURE EXAMPLE

Structural Aesthetics - The Town of Buckeye prefers the structures within the system be designed to complement the adjacent development rather than have a single aesthetic theme through-out. Structural aesthetics within the Town's phase of the system will be designed by the development. Within the phase to

be implemented by the District, permanent drop structures and culvert aesthetics should be concrete, include simple texturing, and be painted or stained a natural color to blend into the channel as described in the PAAC Meeting #2 minutes and depicted in **FIGURE 8**.

3. Detention Basins

Side Slopes – Side slopes of 6H:1V are normally used for the basin side slopes. Maximum side slopes of 4H:1V can be used when required to achieve the required volume within the available site. However, this should not be used throughout the basin site. Fill embankments are avoided for detention basins.

Basin Longitudinal Slope – Minimum slopes of 0.5% are used for grass or earth low-flow channels or swales within the basin. A minimum slope of 0.2% and a maximum slope of 0.5% are used for concrete low-flow channels within the basin. For grass or earth low flow channels in detention basins, scour or sediment deposition should be analyzed during final design. Maintenance may be necessary to maintain these channels within the basin. Final basin design should include control of sedimentation unless the sediment yield analysis shows there is no concern for sedimentation.

Basin Cross Slope – A 0.5% minimum cross slope is used for sheet flow runoff surfaces. Surfaces are graded to drain toward the low-flow channel or outlet pipe.

Basin Multi-Use – Basin sites are intended to have a passive open space multi-use component unless an adjacent development partners with the Town to include an active recreation multi-use. The Town of Buckeye intends to include an active recreation component with the design of the Rainbow Basin.

Maintenance Road – A 14-ft wide maintenance access road is provided around the top of the basin. To minimize rill erosion, maintenance roads should have a 2% cross slope away from the top of basin. At specified locations, the maintenance road should be dipped, or other provision made, for side drainage to enter the basin via down drains. The maintenance road will be surfaced with ABC except for the Maricopa and Rainbow Basins which will use AC asphalt. The basin floor will be accessible for maintenance by one or more access ramps.

Structural Method – Passive open space basins are to be designed with a semi-soft structural method. This includes forming the basin to have a naturalized shape including varied side-slopes, meandered edges, the inclusion of islands and low-flow in the basin bottom, and the use of berms in the over-bank area to transition the basin form into the adjacent topography. Active recreation basins should be configured to be conducive to the active recreation programmed for the site.

Required Right-of-Way – Unless otherwise indicated in *Section V*, the basin site shall be of sufficient size to accommodate the engineering requirements of the basin, an additional 30-foot buffer for the O&M road and landscape, and an additional 30% of the minimum engineering requirement to allow for basin shaping to achieve the semi-soft structural method and context sensitivity within the setting that is placed.

Landscape – Where no project partner is participating on the project, the basin is to be earthen and landscaped with native, non-irrigated landscape materials. Tall pots should be installed at an approximate density of twenty (20) trees per acre, with a concentration of trees along the linear low-flow element in the basin bottom from the inlet to the outlet. Hydroseed mixes for passive open space basins should include a general hydroseed mix with flowering shrubs and native grasses similar to that indicated in **TABLE 2** above. The low-flow area of the basin should have a special riparian hydroseed mix with species that reflect those found within naturally occurring drainages and washes. **TABLE 5** includes recommendations for this mix.

TABLE 5 - RIPARIAN HYDROSEED MIX

Botanical Name	Common Name	PLS Rate (Pounds Per Acre)
Acacia greggii	Catclaw Acacia	1.5
Ambrosia deltoidea	Triangle-leaf Bursage	1.0
Aristida purpurea	Purple Three-Awn	1.0
Atriplex polycarpa	Desert Saltbush	0.5
Baileya multiradiata	Desert Marigold	1.0
Bouteloua rothrockii	Rothrock's Grama	0.25
Encelia farinosa	Brittlebush	1.5
Eschscholtzia mexicana	Mexican Poppy	2.0
Lupinus succulentus	Arroyo Lupine	1.0
Parkinsonia florida	Blue Palo Verde	0.5
Phacelia crenulata	Arizona Desert Bluebells	2.0
Salvia columbariae	Chia Sage	1.0
Sphaeralcea ambigua	Desert Globemallow	1.0
Sporobolus airoides	Alkali Sacaton	0.5
Sporobolus cryptandrus	Sand Dropseed	0.25
	Total PLS	**15.0**

Principal Outlet Pipe – Principal outlet pipes consist of a concrete storm drain pipe, designed to operate under inlet control. The minimum allowable outlet pipe size is 24 inches. Final design should incorporate a secondary drain or redundant outlet in case the principal outlet becomes clogged.

Emergency Spillway – The basins are proposed to be constructed in excavation conditions only, however, final design of the basin should incorporate an emergency overflow location to the natural flow path and a design that does not increase the flood hazard to downstream properties.

Freeboard – Freeboard is not required where basins are constructed entirely in cut. However, additional capacity is recommended to be provided during final design to account for volume lost to sedimentation, landscaping, or some other purpose, based on the specific site conditions at the time of final design.

Safety Features – All inflow and outflow pipes will be equipped with access barrier grates. The grates should have adequate open area to limit design flow velocities through the grate to 3-ft per second (ft/s) or less with a plugging factor of 50% applied to the clear opening area. A maximum clear opening of

4 inches is allowed between grate bars and the grates should be slanted to accommodate trash and debris.

Off Line Storage basins – Off line detention basin concepts are utilized in this plan. A detailed analysis will be required for the final design to ensure proper functioning of side weirs.

Water Quality – Water quality and retention of the first flush runoff should be considered during final design. Surface runoff directly discharging into a basin or channel should have first flush retention provided. This can be accomplished by diverting the first flush volume from channels adjacent to off-line basins into the basin with a low flow pipe and providing a zone within the basin for first flush storage. The water quality storage area of the basin should have planned uses and landscaping that is compatible with frequent short-term ponding from the first flush runoff. The FCDMC Drainage Manual provides additional guidance for water quality and first flush retention.

E. Design Calculations

New open channels, box culverts, and detention basins are sized based on projected peak runoff rates under future development conditions. The future conditions hydrology model is updated to reflect the design channel cross sections and slopes and the detention basin stage-storage-discharge relationships.

1. Open Channels

Open channels are sized using Manning's equation calculations in Bentley's FlowMaster computer program. A report including all input variables, along with the resulting water surface normal depth, is included in **Appendix D.**

Required channel freeboard was calculated independently of FlowMaster; a printout of the freeboard calculations is also included in **Appendix D.**

2. Sloping Drop Structures

There are two locations, immediately upstream of the channel crossing Watson Road at approximately Station 67+50, and immediately upstream of the realigned BWCDD Canal crossing at approximately Station 107+50, where substantial channel invert grade changes are necessary. These grade changes have been designed as sloping drop structures, using a drop slope of 6H:1V.

3. Culverts and Storm Drain Pipe

Culverts and storm drain pipe are modeled using the FHWA's HY-8 computer program. The roadway deck was set to an elevation that prevented any overtopping flows at the design flow rate. The calculated normal depth in the downstream channel, as reported by FlowMaster, was input as a constant tailwater elevation constraint, in order to capture any irregular cross sections or flow changes and provide consistency in the water surface calculations. A summary table for the Watson Pre-Design culverts is included as **TABLE 6**.

No adjustment to the culvert models was made to account for bends in the culvert or storm drain runs; however, most of the storm drain runs are operating under inlet control, with additional head loss attributed to these bends likely to be negligible. The modeling method used to determine the hydraulic grade line during final design should account for all junction and bend losses associated with the underground elements of the project. Final design of the culverts shown in TABLE 6 should attempt to mitigate potential velocities over 15 ft/sec., in accordance with FCDMC standards.

TABLE 6 – CULVERT SUMMARY TABLE

ID	Culvert Outlet Station	Size	Q (cfs)	V (ft/s
1	10+25	2-8x5 & 2-8x7	1170	6.13
2	27+30	2-8x5 & 2-8x7	1170	3.16
3	40+71	4-8x5	730	4.56
4	66+62	3-6x6	540	9.15
5	94+64	1-6x6	230	10.74
6	114+60	1-8x4	230	9.75
7	226+26	3-8x4	230	2.4
8	253+78	2-6x4	460	15.64
9	379+07	1-48"	60	7.88
10	392+48	2-6x6	540	19.73
11	439+60	2-8x6	390	14.7
12	466+51	2-8x4	390	16.49
13	466+75	1-36"	60	11.27
14	507+30	1-48"	50	7.39
15	624+49	1-8x4	240	9.89
16	634+76	1-48"	100	8.08
17	666+35	2-8x4	340	6.92
18	686+28	1-8x6	340	14.63
19	695+63	1-8x6	340	17.74
20	710+32	1-8x6	280	17.5
21	740+65	1-8x6	230	18.5
22	755+75	2-24"	50	7.96
23	812+79	4-8x4	360	2.81
24	851+11	2-8x4	360	6.43

4. Detention Basins

The hydraulic structures at the detention basins include the outlet pipes and side weirs for the off line detention basins. Basin outlet pipes were modeled as culverts, and were sized with a target depth of 6-ft to correspond to the target basin volume used in the hydrology model, while matching the outflow peak discharge.

Detention basin volumes were calculated using the contour average area method, with the calculations included in **Appendix F.**

Several of the basins are intended to operate as "Off-line basins" to allow for a more effective use of the available basin volume by passing low flows by the basin without occupying any storage volume. This preserves more available storage volume for attenuating the flow peaks when they arrive at the basin. Storage volume can be preserved for peak flows in flow-through basins by providing a low flow channel and by depressing the outlet. A depressed outlet allows a hydraulic head to build up on the outlet before a significant area within the basin is inundated. The low flow channel conveys low flows to the depressed outlet without ponding in the basin bottom.

Emergency spillways are sized using the broad crested weir equation using the average flow depth over the spillway.

F. Typical Channel Sections

The Town of Buckeye indicated that the Watson System Recommended Plan channel configurations and treatments should be responsive to the adjacent land-use rather than having a single channel type defined for the entire system. The design and stakeholder teams used this information to identify five character areas based roughly on the future land-use, probable implementation method, slope and assumed erosion potential, and relationship to existing or planned development in the Town. The five character areas identified based on this information are:

- 231st Avenue/Residential Channel
- Apache Channel
- Maricopa Channel
- Watson Channel
- Industrial Conveyance

Typical channel cross-sections were developed for each character area through close collaboration between the design team and the Town of Buckeye during the Design Charrette Meeting. Minor modifications were made to the industrial channel cross-section during the value-analysis meeting in order to reduce the cost of the concrete channel section. Channel configuration recommendations include: channel lining type and associated roughness, side slopes, buffer widths, relationship to existing irrigation district facilities, trail and other multi-use considerations, and relationships to Town easements. The typical requirements for these channel types are summarized in **TABLE 7**.

TABLE 7 - CHANNEL CONFIGURATION SUMMARY

Character Area	Lining	Street Side			Bottom Width	Inside		
		Buffer	O&M Road	Avg. Side Slope		Buffer	O&M Road	Avg. Side Slope
231st Ave	Turf	40'	14'	6:1	As needed	40'	14'	6:1
Apache Road	Gunite with aesthetic treatment	40' (+ 20' for R/W setback, etc.)	14'	4:1 / 6:1	As needed	10'-15'	n/a	4:1 / 6:1
Maricopa Road	Earthen with rock mulch or turf	40'	14'	6:1	As needed	10' (+ 24' if irrig. reloc.	14'	6:1
Watson Drain	Earthen with mowable hydroseed	40'	14'	6:1	30' (10' Concrete low-flow + 10' min each side for equipment)	40'	14'	6:1
Industrial Area	Concrete	20'	14' + 5' Buffer	2:1	As needed	10'	n/a	2:1

As noted in the design concepts above, District implemented channels that are intended to ultimately have a turf lining will require interim design measures to account for the higher velocities and soil conditions until turf is planted as part of future land development activities. These measures are depicted in the plans and include: riprap filled trenches to act as temporary grade controls that will not conflict with future turf installation, erosion control wattles and hydroseeded side slopes, and erosion control micro-swales above the channel overbank areas that also serve as water quality basins while harvesting stormwater for landscape establishment purposes.

1. 231st Avenue/Residential Channel

The 231st Avenue Channel is intended for suburban land-use areas adjacent to residential developments, with a turf lining selected by the Town of Buckeye based on anticipated flow velocities and soil conditions. Where possible, turfed channels should be designed contiguous to active recreation areas within the development to maximize the open space and recreation value of the space. Where this occurs, buffer reductions are permissible. The east 14' O&M road should serve as a soft surface equestrian trail, with both multi-use trails setback from the channel top-of-bank a min. of 5'. The turf channel should be designed with both alignment meander as well as side slope warping. 5:1 maximum

side slopes are permitted for turf maintenance, with a 6:1 average side slope preferred. See **FIGURE 10** at the end of this section of an illustration of the conceptual channel configuration.

Design guidelines for the 231st Avenue Channel include:

a. Landscape Guidance

- Landscape Design Theme: Sonoran Desert Park
- Channel Lining: Earthen with turf

b. Buffer

- 40 foot both sides of the channel, from top-of-bank to right-of-way to allow for landscape buffer, channel meander and side slope warping where possible.
- 14-foot O&M road, meandered within the buffer to serve as a multi-use path. East O&M road to be a soft-surface trail, preferably ¼" minus decomposed granite for equestrian use. Rock surfacing sized ½" or larger is not suitable for equestrian trail use.
- Incorporate berms and micro-swales for water harvesting, to control side slope erosion and to minimize costs associated with haul of excavated materials.
- Trees and shrubs: Per the most current version of the Town of Buckeye Development Standards based on adjacent land-use. Species to be selected from the ADWR Low-Water Plant List for the Phoenix AMA.

c. Channel

- 6:1 side slope average, 5:1 maximum for turf maintenance.
- Provide both side-slope warping (varying the side slope from 5:1 to 7:1) as well as channel alignment meander to create visual interest.

d. Multi-Use

- O&M roads for the channel should serve as multi-use trails, with the east road serving as an equestrian trail.
- The crossing of the RID canal provides opportunity to connect the trails along this channel with the Sundance Park as well as the planned Maricopa Regional Trail segment planned along the RID canal.
- Additional Town of Buckeye Trails have been identified along Broadway Road, Southern Avenue, MC-85, and the BWCDD which present potential connection and trailhead opportunities when implemented.
- Turf should be configured to provide active recreation benefits to the adjacent development and internal recreation area should be located adjacent to the channel to maximize the recreation benefits.

2. Apache Channel

The Apache Channel is intended for suburban land-use areas adjacent to residential developments. The gunite lining selected by the Town of Buckeye has been used successfully at the Festival Ranch development in north Buckeye and accommodates anticipated flow velocities and soil conditions. To be compatible with the suburban setting, the gunite lining must include aesthetic treatments such as integral color to match the color of the adjacent mulch and texturing. The gunite lining is intended to

extend to the channel design flow depth and have a maximum 4:1 side slope. The channel freeboard may be left earthen with a maximum slope of 6:1. Off-site flows should be controlled through the creation of water collection and harvesting swales and berms that can direct flows into the channel in designated locations to help reduce channel maintenance requirements while maximizing water-harvesting opportunities. **FIGURE 11** at the end of this section depicts the conceptual channel configuration.

Design Guidelines for the Apache Road Channel include:

a. Landscape Guidance

- Landscape Design Theme: Enhanced Desert
- Channel Lining: Gunite

b. Buffer

- 40 foot plus the road right-of-way to accommodate both the O&M road as a trail and sidewalk as well as the relocation of irrigation distribution laterals under the trail. Total width for the buffer and the right-of-way is 60-feet. Buffer width between the development the top of channel should be 10 to 15-feet in width without an O&M road or trail.
- 14-foot O&M road, meandered within the buffer to serve as a multi-use path in lieu of the street sidewalk.
- Incorporate berms and micro-swales for water harvesting, to control side slope erosion and to minimize costs associated with haul of excavated materials. Locate other areas in document with same statement and revise as noted.
- Trees and shrubs: Per the most current version of the Town of Buckeye Development Standards based on adjacent land-use. Species to be selected from the ADWR Low-Water Plant List for the Phoenix AMA.

c. Channel

- 4:1 side-slope for gunite, 6:1 side slope for earthen channel in the freeboard.
- Channel meander is a low priority for this channel type. Emphasis should instead be placed on creating visually interesting berms and swales in the buffer and meandering the O&M road.

d. Multi-Use

- O&M roads for the channel should serve as multi-use trails in lieu of street sidewalks.
- The crossing of the RID canal provides opportunity to connect the channel trail with the Maricopa Regional Trail segment planned along the RID canal and should be addressed as such during the final design.
- Additional Town of Buckeye Trails have been identified along Broadway Road, Southern Avenue, the Maricopa Road Channel, MC-85, and the BWCDD which present potential connection opportunities as well as trailhead opportunities when implemented.

3. Maricopa Channel

The Maricopa Channel is intended for suburban land-use areas and will serve as a pedestrian connection between the Downtown Core and the Watson Drainage System. The rock mulch was selected by the Town of Buckeye based on anticipated flow velocities and soil conditions and needs to be engineered to

stand up to flows within channel without decomposing. Rock should be selected that is also aesthetic, approved by the Town, and the selected rock should complement the overall landscape and aesthetic design of the development. The 14' O&M road will serve dual use as a multi-use trail, replacing the need for sidewalk in the right-of-way. The 8' PUE should be modified from the Town of Buckeye standard roadway design for Maricopa Road, and be located adjacent to the edge of right-of-way due to the replacement of the sidewalk with the multi-use trail, and to allow for some landscape buffer between the trail and channel top of bank. The Maricopa Channel design should include meander of the channel bottom through side-slope warping (4:1 to 8:1). See **FIGURE 12** at the end of this section for a graphic depiction of the conceptual channel configuration.

Design Guidelines for the Maricopa Road Channel include:

a. Landscape Guidance

- Landscape Design Theme: Enhanced Desert
- Channel Lining: Rock Mulch
- Earthen with hydroseed and soil stabilizers

b. Buffer

- 40 foot from back of curb to top-of-bank on the road side of the channel. Buffer width between the development and the top of channel should be 10-feet without an O&M road or trail.
- 14-foot O&M road to serve as a multi-use path in lieu of the street sidewalk.
- Trees and shrubs: Per the most current version of the Town of Buckeye Development Standards based on adjacent land-use. Species to be selected from the ADWR Low-Water Plant List for the Phoenix AMA.

c. Channel

- 6:1 side-slope average, varied from 4:1 to 8:1 to create movement using side-slope warping.
- The rock mulch lining may accommodate vegetation within the channel freeboard areas.

d. Multi-Use

- O&M road for the channel should serve as multi-use trails in lieu of the street sidewalk.
- The Maricopa Road alignment was identified by the Town of Buckeye as a potentially valuable multi-modal entrance into the downtown.

4. Watson Channel

The Watson Drain Channel is intended for the area south of Beloat Road where no currently planned developments have been identified, but options for future development should not be precluded by the current channel configuration. The Town of Buckeye desires the channel landscape to be simple, and not create a future regulatory restriction on reconfiguring the channel if future development so wishes. The earthen channel with hydroseed lining was selected by the Town of Buckeye in order to keep maintenance requirements low, with gentle side slopes of 6:1 maximum allowed in order to keep slope at a mowable grade. Sufficient space in the channel bottom is required for mowers and maintenance equipment to operate. Berms and swales should be included in the overbank area to control off-site flows and reduce erosion and be coordinated with meandered O&M roads on either side of the channel

that will serve dual use multi-use paths. The conceptual channel configuration is depicted at the end of this section in **FIGURE 13**.

Design guidelines for the Watson Drain Channel include:

a. Landscape Guidance

- Landscape Design Theme: Natural Lower Sonoran Desert
- Channel Lining: Earthen with hydroseed and soil stabilizers

b. Buffer

- 40 foot both sides of the channel, from top-of-bank to right-of-way.
- 14-foot O&M road, meandered within the buffer to serve as a multi-use path
- Incorporate berms and micro-swales for water harvesting and to control side slope erosion
- Tall Pot Trees: Approximately 1 tree per side per 30-foot of channel length, placed in irregular massings along the overbank of the channel. Maintain a min. of 10 feet of clearance from the O&M road to tree trunk to allow for tree growth and vertical clearance.
- Hydroseed with a mix of flowering shrubs and native grasses, similar to the General Hydroseed Mix provided in **TABLE 2**.

c. Channel

- 6:1 side slopes to allow periodic mowing of the native plant material in the event growth begins to impede channel function.
- Provide a 10-wide concrete low-flow to carry the perennial dewatering flows from the Watson Drain with 10 additional feet to either side of the low-flow for equipment access in the channel bottom.
- Plant material to consist of hydroseed only for the majority of the Watson Drain Channel. Tall pots and pole planting trees may be used in the Gila River outlet to create a desirable plant community to compete with potential invasive species present in the river and maintain habitat in the river bottom.

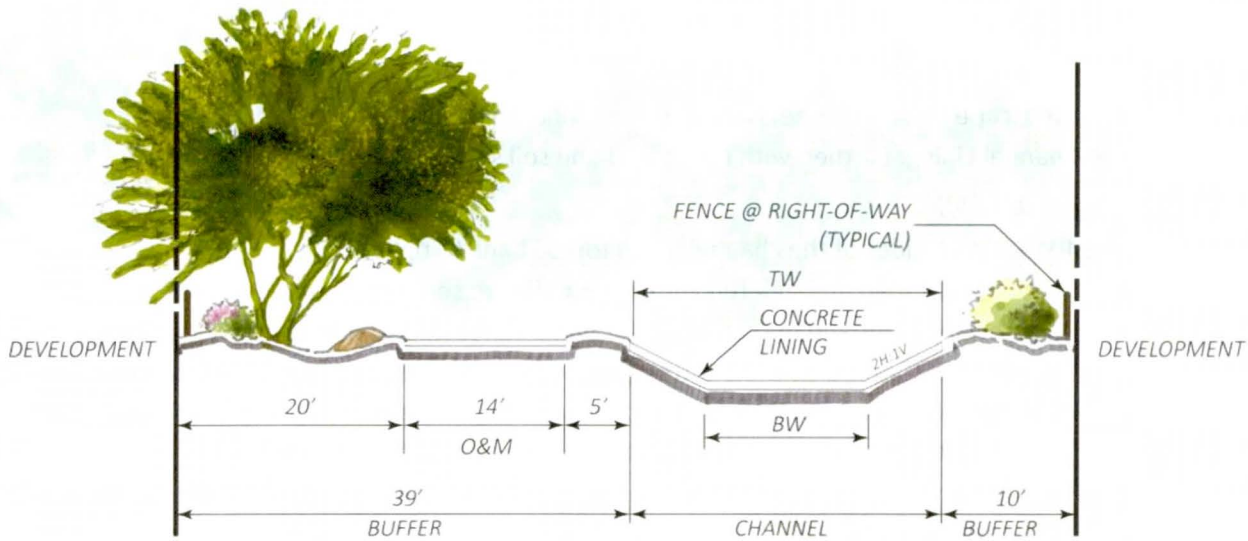
d. Multi-Use

- O&M roads for the channel should serve as multi-use trails and connect the future El Rio Levee trail along the Gila River with the northern channel reaches. O&M roads will be ABC on one side and AC for multi-use on the side adjacent to arterial streets.

5. Industrial Conveyance

The concrete channel is intended to include minimal landscape and aesthetic treatments and was selected by the Town of Buckeye based on the planned industrial land-use for the area. The concrete channel is considered compatible with the industrial valley plain landscape character unit associated with this planned land-use area. For the industrial conveyance areas, the multi-use path will be aligned separately from the channel corridor between MC-85 and Southern Avenue, and possibly up to Watson Parkway. Maintenance roads will be required within these corridors using ABC surfacing. Fencing or safety railing will also be required due to the steeper channel side slopes. The conceptual channel configuration is depicted below in **FIGURE 9**.

FIGURE 9 – INDUSTRIAL CONVEYANCE TYPICAL CROSS SECTION



Design guidelines for the concrete Industrial Channel include:

a. Landscape Guidance

- Landscape Design Theme: Semi-Natural Lower Sonoran Desert Wash
- Channel Lining: Concrete

b. Buffer

- 20 foot buffer for the side of the channel to include an O&M road. This reflects the minimum buffer required by the Town of Buckeye's Trails Master Plan for a Canal Trail.
- 10-foot buffer for the opposite side of the channel for safety railing or fencing and space between the channel and adjacent walls to accommodate worker needs.
- 14-foot O&M road, located 5-feet from the channel top of bank.
- Incorporate berms and micro-swales for water harvesting and to control side slope erosion in the 20' buffer.
- Trees and shrubs: One (1) tall pot tree per 30-foot of channel and hydroseed per the General Hydroseed Mix in Table III-1.

c. Channel

- 2:1 side slope with safety railing or fencing
- Concrete channel may receive low-cost aesthetic treatments such as a simulated desert varnish.

d. Multi-Use

- The trail system will not be co-located with the channel through the industrial reaches. The Town will evaluate alternate trail alignments to maintain trail system connectivity.

FIGURE 10 – 231ST AVENUE CHANNEL TYPICAL CROSS SECTION

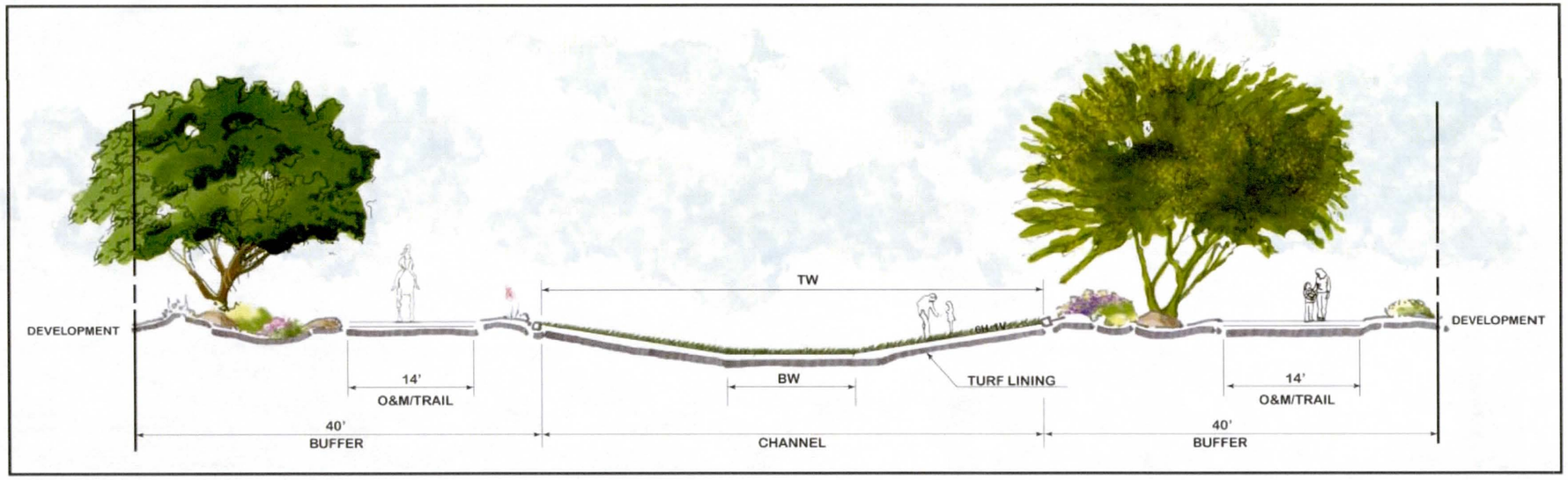


FIGURE 11 – APACHE ROAD CHANNEL TYPICAL CROSS SECTION

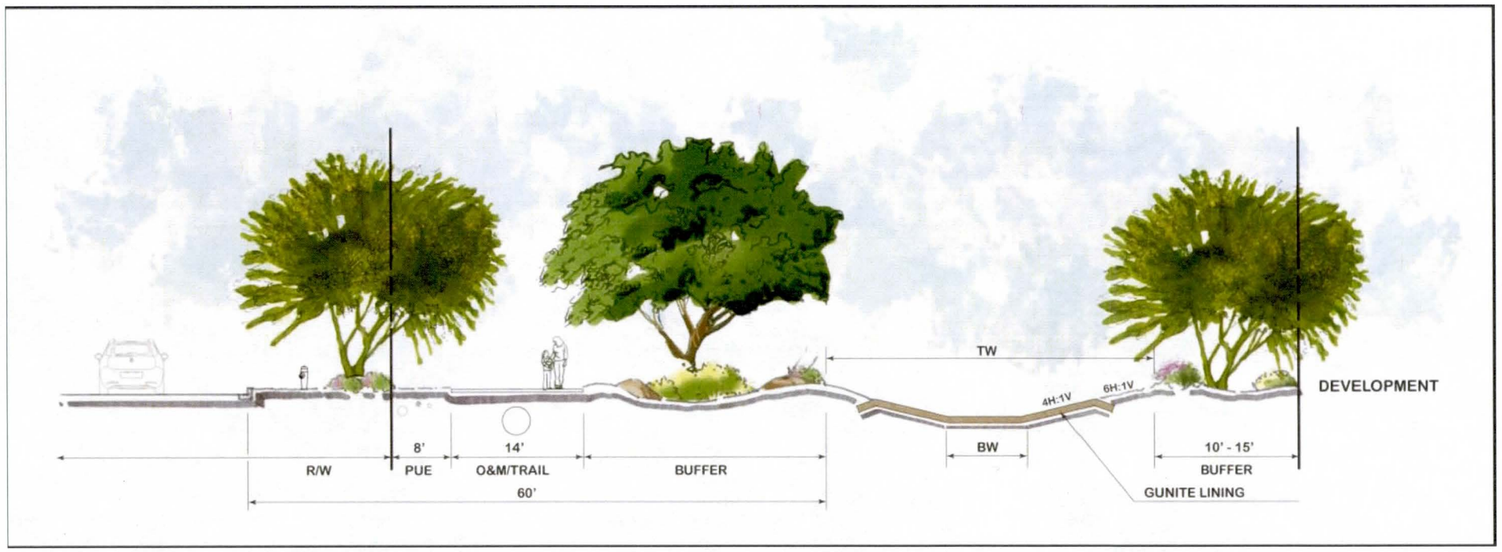


FIGURE 12 – MARICOPA ROAD CHANNEL TYPICAL CROSS SECTION

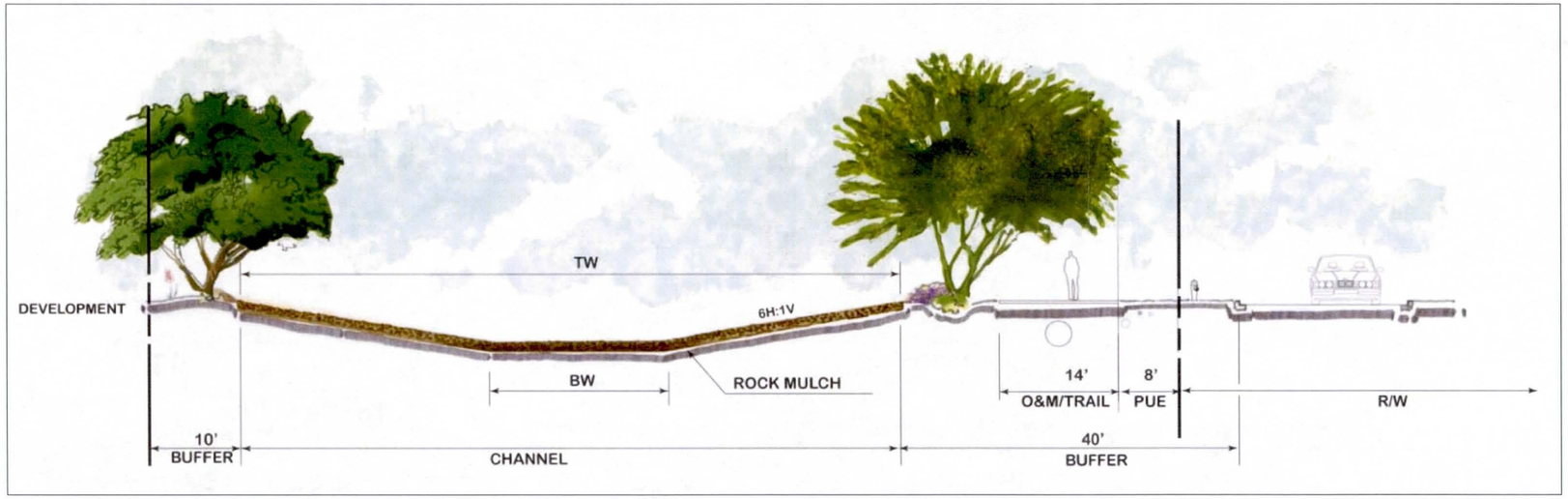
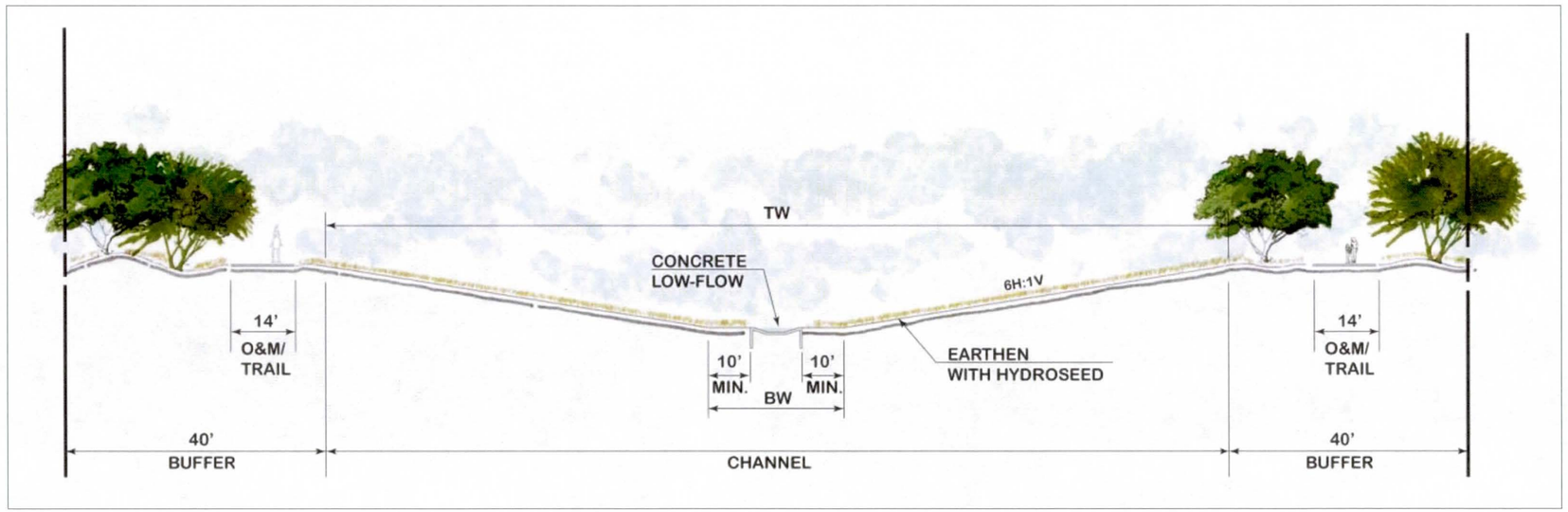


FIGURE 13 – WATSON DRAIN CHANNEL TYPICAL CROSS SECTION



IV. EXISTING FACILTIES AND PLANNING CONSTRAINTS

A. Introduction

The project watershed does not currently have significant regional drainage infrastructure in place. The Recommended Plan is proposed as a retrofit in this area that has been slowly converting from an agricultural use to mixed residential and industrial uses for many years. The historic and emerging uses of this area have included the installation of local and regional utility infrastructure and facilities, some of which represent design constraints to the Watson Drainage System, as it is not feasible to relocate them.

B. Existing Facilities

1. Roosevelt Irrigation District (RID)

The RID main canal runs through the project area near the north end. There are 2 crossings of the RID main canal in the Recommended Plan, both of which are intended to convey flow from detention basins planned north of the facility to the planned drainage channels south. These crossings are planned to be a single 36" pipe for the western crossing and 2-24" pipes for the eastern crossing.

In addition to the main canal, an intricate system of delivery and tailwater ditches exists to serve the area agricultural fields. The functionality of this system must be maintained. The conceptual design of the Recommended Plan includes facilities and features to maintain this functionality.

The RID has expressed concerns regarding using siphons to accomplish utility crossings of the new facilities. However, the project partners prefer to utilize siphons at select locations and this approach has been used herein.

2. Union Pacific Railroad (UPRR)

The UPRR bisects the project near the north-south mid-point of the proposed system. Although UPRR currently only has a single track in this area, their property is 200' wide, and is occupied by several critical utility facilities, including 5 fiber optic communication lines and a 20" petroleum gas line owned by Kinder-Morgan. Efforts to determine the elevations of these utility lines through potholing are on-going. These utility lines are currently assumed to be in conflict with the Recommended Plan. Although the cost is anticipated to be high, these utilities are planned to be relocated.

The UPRR track facility does represent a constraint to the system, as the track alignment and elevation cannot be changed. The Recommended Plan must cross under the UPRR tracks. The UPRR has indicated that they will not approve a facility that requires any amount of routine maintenance to occur on their property. For this reason, the crossing of the entire UPRR property is proposed to occur underground via a box culvert. The section of this box culvert that crosses the UPRR tracks will need to be pre-cast to facilitate quick placement and installation, and restoration of the tracks for UPRR operations. The box culverts in UPRR ROW are anticipated to require design for railroad loading.

3. *Arizona Nuclear Power Project (ANPP)*

The ANPP 96" reclaimed waterline is located just north of and parallel to the BWCDD main canal. This critical line delivers the coolant water supply to the Palo Verde Nuclear Generating Station. This waterline must not only be protected in place, but reinforced prior to construction activities. The conceptual design for the Recommended Plan crosses over the top of the ANPP line with 2 feet of clearance, and then immediately drops down under the adjacent Buckeye Water Conservation and Drainage District (BWCDD) main canal through a box culvert.

4. *Buckeye Water Conservation and Drainage District (BWCDD)*

The BWCDD main canal flows through the project area from east to west south of and generally parallel to the UPRR tracks. A single point of crossing of the BWCDD main canal is proposed in the Recommended Plan. The crossing of the BWCDD needs to convey more flow than the proposed crossings of the RID canal, and thus is planned to consist of a double barrel 8'x4' reinforced concrete box culvert. In order to facilitate the construction of this crossing while maintaining functionality of BWCDD operations, a permanent relocation of the main canal is proposed at this location. The box culvert may be constructed south of the existing canal, after which the relocated canal alignment can be excavated. Once the canal flow is diverted to the new alignment, then construction of the system drop and stilling basin can occur.

In addition to the main canal, an intricate system of delivery and tailwater ditches exists to serve the area agricultural fields. The functionality of this system must be maintained. The conceptual design of the Recommended Plan includes facilities and features to maintain this functionality.

Similar to the RID, the BWCDD has also expressed concerns regarding using siphons to accomplish utility crossings of the new facilities. However, the project partners prefer to utilize siphons at select locations and this approach has been used herein.

5. *Town of Buckeye Water and Sewer*

The Town of Buckeye has several water and sewer lines in the project area, most of which are not in conflict with the Recommended Plan. There are a couple of notable exceptions.

There is a 30-foot wide public utility easement immediately adjacent to the UPRR property on the north side. This easement is occupied by two separate 18" sewers and a 16" waterline. Because this corridor is so crowded, the Recommended Plan channel that parallels the UPRR is planned to be located north of the public utility easement, on what is currently private property.

The Apache Road corridor is also congested with underground utilities, including two Town of Buckeye sewer lines and a waterline near Maricopa Road, where the Watson Drainage System is planned to cross Apache Road via a 48" pipe. The western most sewer is fairly shallow and presents a challenge for the proposed road crossing of the Recommended Plan.

6. *Arizona Public Service (APS)*

In addition to several overhead and underground distribution power lines and services owned by APS, the APS Valencia substation is located just north of the Maricopa Road alignment and just east of Miller Road. The Recommended Plan includes the Maricopa Channel, which is proposed to be located on the north side of Maricopa Road, and extend westerly to Miller Road. The Valencia substation is in direct conflict with the extension of this proposed channel, and thus, the Maricopa Channel is planned to go underground into a box culvert and around the south side of the Valencia substation.

C. *Planned Future Projects*

There are several planned future projects in the project area which will need to be coordinated with the final design of the Watson Drainage System. At this concept design level, efforts have been undertaken to acquire as much information about these projects as possible, and to make accommodations, if necessary and appropriate, in the Recommended Plan conceptual design.

1. *Watson Road*

Watson Road currently does not exist between Southern Avenue and MC-85. Additionally, Watson Road does not extend south of Beloat Road. The Town of Buckeye Plans to extend Watson Road from Southern Avenue to MC-85, and to improve the roadway section to be 4 lanes plus a center median. In order to make the connection from Southern Avenue to MC-85, Watson Road is planned to cross the UPRR tracks and the BWCDD canal via an elevated grade separated crossing. The Town provided preliminary design line work depicting the future toe of embankment slopes for this future structure.

2. *Industrial Park*

The Town of Buckeye has held preliminary discussions with potential developers of the property immediately east of the Walmart Distribution Center, between the UPRR and Southern Avenue, extending to a point west of Rainbow Road. This land is proposed to be developed as an industrial park.

3. *Watson Community Facilities District*

In late 2005, the Watson CFD was formed, comprised of several land parcels bounded by Yuma Road on the north, Beloat Road on the south, Apache Road on the west and Rainbow Road on the east. These properties were planned for mostly residential developments. Many of these planned developments advanced their designs to the platting stage and have development agreements in place with the Town. In addition, the CFD invested in underground sewer infrastructure to serve the future developments, and are now encumbered by annual assessments for that infrastructure.

4. *El Rio Levee*

The El Rio Levee project has been planned for many years, and proposes to construct a levee along the north side of the Gila River throughout the Watson Project area and beyond. This levee is proposed to contain Gila River flows and prevent the flooding and inundation of adjacent land.

V. RECOMMENDED PLAN

A. Introduction

The Recommended Plan is shown on **FIGURE 14**. Each of the plan elements is shown in plan and profile on the Conceptual Design Plans (separately bound). The following sections are intended to be used with the Conceptual Design Plans to describe the proposed improvements and are organized according to the project reaches as shown on **FIGURE 14**. A summary of the reach design flows and along with an exhibit showing the reach locations has been included in **Appendix D**. Each section discusses issues to be considered during final design. The project elements are described as well as floodplain impacts, utility conflicts, environmental and permit issues, landscape and multi-use concepts, and any special considerations associated with the project.

B. Conceptual Design Costs

The estimated cost of the Recommended Plan is **$69,584,285** including estimated costs of property acquisition. The cost estimate prepared in conjunction with the conceptual plans is included in **Appendix H**.

C. Floodplain Impacts

The Recommended Plan will provide a benefit to the area by creating an outfall for the areas that are currently delineated with FEMA floodplains. While implementation of the recommended plan will provide the outfall system, the full benefit to the area will be dependent on area developers providing the necessary conveyance to deliver the floodwater from their respective parcels to the proposed Recommended Plan system channels.

There are currently FEMA delineated floodplains on the north side of the RID Canal, the north side of the UPRR tracks, the north side of the BWCDD Canal, and within the Gila River. At full implementation of the Recommended Plan and adjacent development, the 100-year floodplain will be mostly contained within the limits of the proposed system. Based on the effective floodplain study, the backwater from the Gila River 100-year flow encroaches into the 'Buckeye Slough' and unless levees or other mitigating features are incorporated into the design, the proposed Watson System will not fully contain the backwater from the Gila River during events exceeding the 25-year flooding event in the Gila, according to the 1999 Michael Baker, Jr. delineation (see FCDMC memo 2/7/2014 in Appendix A).

The elevation of the Gila River floodplain elevation, as shown on the current FEMA floodplain map, is represented on the project conceptual plans, and extends from the Gila River to just north of the Monroe Avenue Alignment. This means that during times of 100-year flow rates in the Gila River, the Watson Recommended Plan system will be filled with backwater from the Gila River to that point in the system. This Gila River backwater inundation will vary in depth from approximately 7 feet right at the Gila River to zero depth just north of Monroe Avenue.

There is an ongoing update of the Gila River floodplain in the vicinity of the Watson Outfall location. Reach 3 of this study is from SR-85 to Cotton Lane and was not available for review at the time of this pre-design report. Discussions with FCDMC staff have revealed that the project is planned for an initial

submittal to FEMA in October of 2014. The final designers should reference this project (FCD2012C017) for updated floodplain information.

D. Watson Channel and Lateral

1. Description

(See Pre-Design Plans, Sheets 6-21)

The Watson Channel serves as the outfall for the entire Watson system. It extends from the Gila River to the Industrial Channel north of the UPRR and includes the Watson Lateral channel, which extends along Monroe and 231st Avenues to the north side of MC 85. Portions of the channel will be co-located with the existing BWCDD Watson Drain and will require a ROW corridor ranging between 300 and 350 feet in width at its widest sections. Key features of the channel include the Gila River outfall, combined low flow and tailwater channel, seven (7) box culvert crossings including a quarter mile long box culvert section between MC 85 and the BWCDD canal, and a spillway between the BWCDD Canal and the ANPP water pipeline. Grade control structures are included in portions of the reach to stabilize the channel invert in the interim period between initial construction and installation of the ultimate turf erosion protection by future development. Further design details of the Watson Channel Reach are contained in the Pre-Design Plans on sheets 6-21.

Design flows and proposed channel section types for the Watson Channel are listed in **TABLE 8**.

TABLE 8 – WATSON CHANNEL FLOWS AND SECTIONS

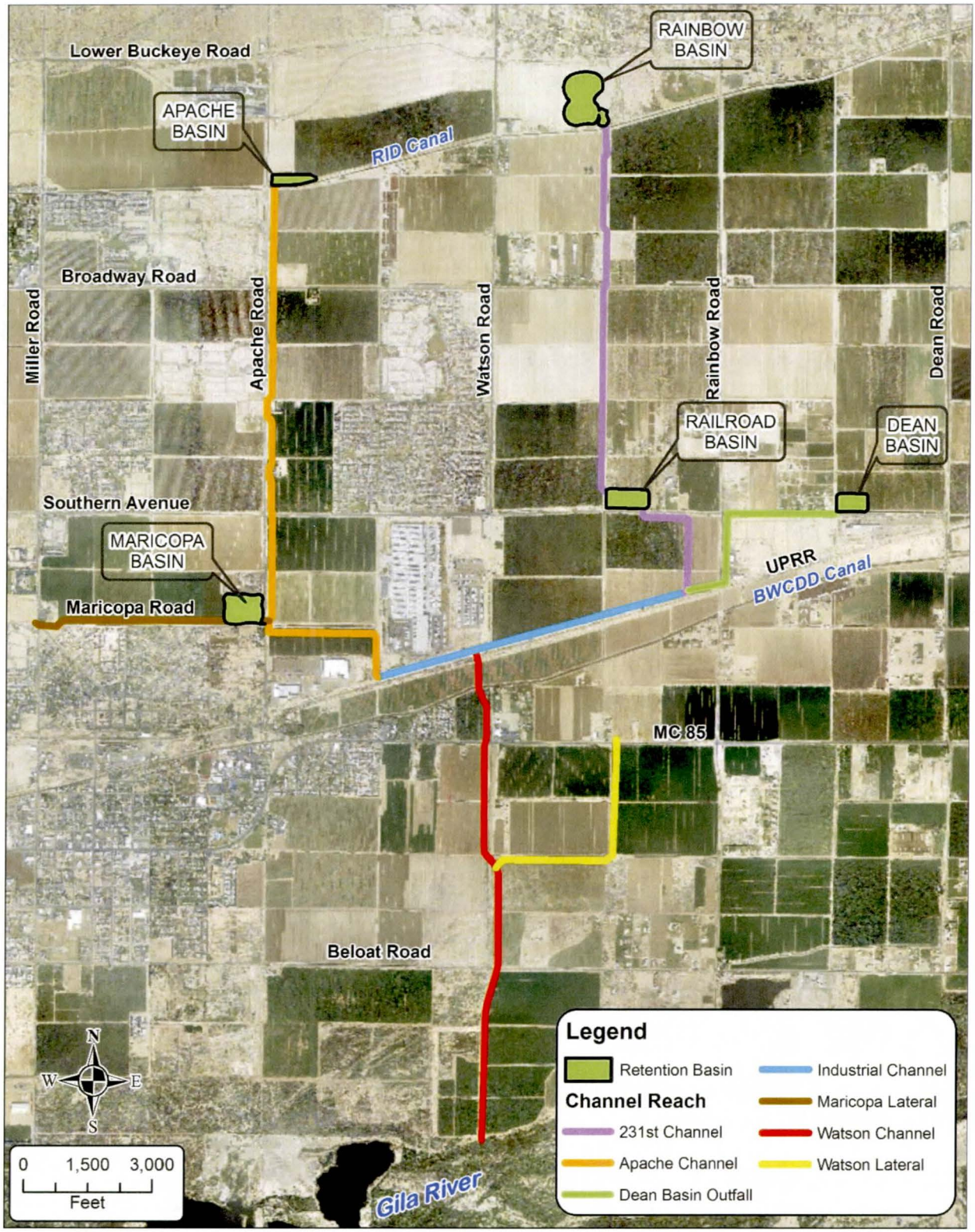
Station Limits	Design Flow	Channel Section
Sta 00+00 to Sta 41+50	1,120 CFS	Watson (Earth with Concrete Low Flow
Sta 41+50 to Sta 69+00	740 CFS	Apache (Gunite)
Sta 69+00 to Sta 94+64	560 CFS	231st/Residential (Turf)
Sta 94+64 to Sta 117+57	460 CFS	231st/Residential (Turf)

Design flows and proposed channel section types for the Watson Lateral are listed in **TABLE 9**.

TABLE 9 – WATSON LATERAL FLOWS AND SECTIONS

Station Limits	Design Flow	Channel Section
Sta 200+00 to Sta 226+26	700 CFS	231st/Residential
Sta 226+26 to Sta 255+18	460 CFS	231st/Residential

FIGURE 14 – RECOMMENDED PLAN



2. *Utility Conflicts*

Sta 11+00 (Sheet 7): An existing BWCDD irrigation ditch crosses the Watson Drain at this location. The Watson Drain crosses under the delivery ditch in pipe culvert. This location also provide vehicular access across the Watson Drain. The Pre-Design Plans includes relocating this ditch underground in a 24" pipe. The final solution to this conflict must be coordinated with BWCDD. The existing pipe culvert is proposed to be upsized at this location to handle the design flow for this reach.

Sta 18+80 (Sheet 7): An 18" irrigation drain is located along the east side of the existing Watson Drain. The need for a re-connection to the new Watson Drain will be required as a part of the Final Design Plans.

Sta 41+21 (Sheet 9): A 12" waterline is located along the south side of Beloat Road. The Pre-Design Plans include a box culvert crossing of Beloat Road. The waterline is proposed to be realigned vertically, if necessary, above the box culvert.

Sta 42+00 (Sheet 9): A 24" irrigation drain is located on the east side of the existing Watson Drain. The need for a re-connection to the new Watson Drain will be required as a part of the Final Design Plans.

Sta 54+60 (Sheet 10): A 24" irrigation drain is located east of the existing Watson Drain. The need for a re-connection to the new Watson Drain will be required as a part of the Final Design Plans.

Sta 66+72 (Sheet 11): A 24" irrigation lateral is located along the east side of the existing Watson Drain. This lateral provide the ability to transfer irrigation water from the northern portion of the existing Watson Drain to the agricultural fields to the southeast. An assessment of the need to re-establish this functionality will be required as a part of the Final Design Plans.

Sta 68+00 (Sheet 11): A 24" irrigation lateral is located adjacent to the existing Watson Drain. No re-connection to the new Watson Drain is anticipated.

Sta 68+65 (Sheet 11): A 24" irrigation drain is located adjacent to the existing Watson Drain. The need for a re-connection to the new Watson Drain will be required as a part of the Final Design Plans.

Sta 69+17 (Sheet 11): A 24" irrigation drain is located adjacent to the existing Watson Drain. The need for a re-connection to the new Watson Drain will be required as a part of the Final Design Plans.

Sta 81+60 (Sheet 12): A dead-end irrigation delivery ditch is located adjacent to the existing Watson Drain. No re-connection to the new Watson Drain is anticipated.

Sta 95+00 (Sheet 14): An irrigation lateral ditch is located adjacent to the existing Watson Drain. The need for a re-connection of this ditch will be required as a part of the Final Design Plans.

Sta 95+27 (Sheet 14): A 4" natural gas line is located along the south side of MC85, which will need to be relocated.

Sta 108+40 (Sheet 15): A RID irrigation ditch is located south of the existing BWCDD Canal. The need for a re-connection of this ditch will be required as a part of the Final Design Plans.

Sta 109+00 (Sheet 15): The BWCDD Canal will need to be relocated to the south for a short reach in order to facilitate construction phasing. The final design of the canal relocation must be coordinated with BWCDD.

Sta 109+31 (Sheet 15): The ANPP 96" water line is located approximately 50 feet north of the existing BWCDD Canal. This waterline is critical to the operation of the Palo Verde Nuclear Generating Station, and must be protected in place and reinforced at the proposed crossing location.

Sta 109+59 (Sheet 15): A RID irrigation ditch is located north of the existing BWCDD Canal. 24" storm drain pipes have been provided to drain this ditch into the new Watson Drain. An assessment of the need for a re-connection of this ditch will be required as a part of the Final Design Plans.

Sta 114+55 (Sheet 15): A dead-end irrigation delivery ditch is located adjacent to the new Watson Drain. No re-connection to the new Watson Drain is anticipated.

Sta 114+73 (Sheet 15): An irrigation delivery ditch is located adjacent to the new Watson Drain. A 30" irrigation siphon has been provided to re-connect this ditch.

Sta 115+00 (Sheet 15): Kinder-Morgan owns a 20" petroleum gas line located along the south side of the UPRR property. This gas line will need to be relocated.

Sta 115+19 (Sheet 15): A fiber optic telecommunication line is located with the UPRR property at this location. This fiber optic line will need to be relocated.

Sta 115+32 (Sheet 15): A fiber optic telecommunication line is located with the UPRR property at this location. This fiber optic line will need to be relocated.

Sta 116+70 (Sheet 15): A fiber optic telecommunication line is located with the UPRR property at this location. This fiber optic line will need to be relocated.

Sta 116+75 (Sheet 15): A fiber optic telecommunication line is located with the UPRR property at this location. This fiber optic line will need to be relocated.

Sta 116+99 (Sheet 15): A 16" waterline is located within a public utility easement at this location. This waterline will need to be relocated.

Sta 240+54 (Sheet 20): There is an existing BWCDD irrigation delivery ditch crossing the proposed Watson Lateral at this location. The functionality of the irrigation system must remain intact. The crossing is proposed to be accomplished via a siphon structure at this location. The final solution to this conflict must be coordinated with BWCDD.

Sta 254+12 (Sheet 21): A BWCDD irrigation delivery ditch is located along the south side of MC85. The Watson Lateral will cross MC85 is a box culvert, which will allow the irrigation ditch to be relocated underground in a pipe. The final design of this relocation must be coordinated with BWCDD.

Sta 254+25 (Sheet 21): A 4" natural gas line is located along the south side of MC85 at this location. The gas line may need to be relocated.

3. Environmental and Permit Issues

Environmental considerations for the Watson Drainage System are derived from the previous work done on the Buckeye ADMP with additional cultural resource inventory work and evaluation completed by the District through an on-call contract with an archeology consultant. Specific considerations for the Watson Drainage Channel include:

- Nationwide Permit will likely be necessary for impacts at the Gila River. It is anticipated that the channel outfall will fall under Nationwide Permit #7 *Outfall Structures and Maintenance* or #43 *Stormwater Management Facilities*.
- Threatened and Endangered Species impacts must be taken into consideration as part of the outfall design.
- Phase I Environmental Site Assessments (ESA) for land acquisitions will be required.
- Archeology inventory of the Watson Drain Channel alignment has been completed by the District through an on-call as part of the pre-design. Adjustments to the proposed channel alignment at final design may require additional evaluation.
- A Town of Buckeye Native Plant Inventory should be included for the channel as part of the final design, and will be most beneficial if completed at the commencement of the 30% design. Native tree salvage and replanting may be feasible within this reach given there is perennial flows from the Watson Drain into the Gila River that could irrigate the trees provided salvaged trees are replanted as part of the Gila Outlet or with supplemental irrigation for establishment.

4. Landscape and Multi-Use

The outlet of the Watson System at the Gila River is intended to serve as a transition element between the planned suburban development of the upper reaches and the natural riparian areas of the Gila River. AGFD hopes to see the future condition of the site serve as habitat area following restoration of the planned sand and gravel extraction operations. Design considerations for the outlet related to landscape and aesthetics are intended to assist in achieving AGFD's goals at the outfall and include:

- The creation of a low-flow within the buried riprap area to make use of the perennial flows from the Watson Drain to create the appearance of a natural running stream. This includes depressing the low-flow area, leaving the riprap in the low-flow exposed rather than burying it as well as including boulders along the low-flow embankment to create the impression of a stream's characteristic "riffle-pool-run" similar to example in **FIGURE 15**.

FIGURE 15 – CONSTRUCTED RIVER EXAMPLE

- Hydroseeding the buried riprap areas depicted on the plan and profile sheets with a native riparian mix along with the use of pole plantings to create a desirable plant community at the confluence of the Watson System with the river. The purpose of establishing a desirable plant community at the confluence is to resist the encroachment of salt cedar and other invasive species upstream into the system.
- The cut-off wall and grade-control structure should be integrated into a natural theme for the river and include rock-type formliners as well as natural desert varnish staining for those portions of the structure not expected to be frequently in contact with water from the Watson Drain.

Segments of the Watson Channel and Lateral that are designated as the Watson Drain Channel type should follow the design guidelines outlined in *Section III.F.4*.

Segments of the Watson Channel that are designated as the Apache Road Channel type should be designed and constructed following the design guidelines outlined in *Section III.F.2* with the following modifications for an interim condition:

- Where irrigation and final landscape materials will not be installed until future development participation is feasible, tall pot trees and hydroseed should be included in the landscape portions of the channel consistent with the **Interim Channel Landscape** recommendations in *Section III.D.*
- Shotcrete channel lining should include integral color and seeded aggregate for texture as required for the permanent condition. Shotcrete color should be selected to match rock mulch to be placed in the channel overbank areas and be natural in color.

FIGURE 16 – CONSTRUCTED GUNITE CHANNEL EXAMPLE WITH INTERIM LANDSCAPE ONLY.

Segments of the Watson Channel that are designated as the 231st Avenue Road Channel type should be designed and constructed following the design guidelines outlined in *Section III.F.1,* with special consideration for interim conditions as described in *Section III.D,* and in the special considerations below.

Town of Buckeye trail alignments require additional coordination with the Town for sections of the Watson Channel and Lateral that are intended to be undergrounded in a pipe. Appropriate connections, alternative alignments, or the inclusion of the O&M road along the pipe route should be considered.

Structural aesthetics for the Watson Channel and Lateral should either be natural in texture and color, simple in form, and blend into the setting or be based on an agricultural theme.

AGFD, the Town of Buckeye, a Maricopa County Regional Trail representative, and a representative from the planned El Rio project managed by the City of Avondale should be invited to participate in the Final Design project PAAC meetings based on the landscape, multi-use, and aesthetic needs of this reach.

5. Special Considerations

Portions of the Watson Lateral to be constructed by the District will require interim landscape treatments to mitigate the water velocities prior to the installation of the final turf lining. Objectives for the interim condition include:

Objective 1: Accomplish the stormwater mitigation requirements of the Watson System Pre-Design Project.
Objective 2: Accommodate both an interim earthen channel with hydroseed lining condition and a final build-out condition with a turf lining.
Objective 3: Not preclude the opportunity for open space credits to adjacent developer by imposing limiting conditions in the interim design.

Design guidelines associated with the interim conditions channels are described in *Section III.D.1.a.*

Mining Activities- Multiple sand and gravel operations are either currently present at the Watson Channel outfall or are planned in the case of the Gila River LLC's planned purchase of the AGFD land. CEMEX currently owns the land on either side of the Watson Drain which will be bisected by the channel construction. They have raised concerns regarding access to their land, impacts to their operations, and access to the minerals within the channel alignment that must be considered during final channel design.

Watson Road- The Town of Buckeye plans to extend Watson Road from Southern Avenue to MC 85, including a grade separated crossing over the UPRR and the BWCDD Canal. The structure required for the elevated crossing of these facilities will create fill embankments extending beyond the normal right-of-way requirements for a typical arterial roadway. The alignment of the Watson Channel has been set

to abut the western toe of the planned embankment, based on planning documents provided by the Town.

Watson Drain- The existing Watson Drain collects and conveys irrigation tailwater and pumped groundwater from the agricultural fields to the Gila River. Portions of the Watson Channel and the Watson Lateral are planned to be collocated with the Watson Drain, and to accommodate the tailwater and ground water flows.

Gila River Backwater- It is recognized that the 100-year water surface elevation in the Gila River will project upstream in the Watson Channel and the Watson Lateral to a point just north of the Monroe Avenue alignment. Due to the magnitude of the design flow in the Watson Channel, alternatives utilizing any type of control to prevent Gila River flows from entering the system (e.g. flap gates) were eliminated. Consideration should be given to Watson Channel interface with the planned El Rio Levee, and to prevent Gila River flows from breaking out and circumventing the Watson Channel, which may cause erosion in the overbank areas. Resolving 25- to 100-year flooding from the Gila River is beyond the scope of this project. The Watson Channel south of Monroe Avenue alignment will not confine concurrent floodwaters during high flood stage in the Gila River exceeding a 25-year event (based on the 1999 Baker delineation), therefore building pad elevations in this area should be set accordingly. If the El Rio levee is implemented, detention basins or other drainage systems at the Watson Channel outlet to the Gila River should be considered to contain Watson system flows during high flood stage in the Gila.

BWCDD Canal Crossing- The Watson Channel is proposed to cross under the BWCDD canal. Consideration has been given to construction phasing of this crossing, and a permanent relocation of the BWCDD canal has been proposed to facilitate this work. Design of the canal relocation must be coordinated with BWCDD.

ANPP 96" Waterline Crossing- The Watson Channel system is proposed to cross over the ANPP waterline. There is shallow cover over the ANPP line. The proposed configuration of the crossing leaves 1.8 feet of vertical clearance between the bottom of the Watson Channel and the top of the ANPP line. It is proposed that the ANPP line concrete reinforcement occupy the entire space to form the invert of the proposed channel. Final design of this crossing must be coordinated with APS.

UPRR Crossing- The Watson Channel is proposed to cross the full width of the UPRR property underground in a box culvert. This will help minimize any required maintenance activities related to the Watson system within the UPRR corridor. That portion of the proposed box culvert crossing under the actual tracks should be accomplished utilizing a prefabricated box culvert designed for railroad loading in order to facilitate as short a disruption in track operation as possible. The box culverts in UPRR ROW are anticipated to require design for railroad loading. Construction disruption of the tracks should last less than a day. If the tracks are proposed to be disrupted for longer than a day, then UPRR may require the design and construction of a temporary shoe-fly.

E. Industrial Channel

1. Description

(See Pre-Design Plans, Sheets 22-28 and 44-46)

The Industrial Channel collects and combines flow from both legs of the proposed upstream system upstream of the UPRR tracks. The channel will require a ROW corridor ranging between 80 and 100 feet in width. Key features of the channel include six (6) irrigation siphon crossings, and the entrance to the UPRR crossing box culvert. Further design details of the Watson Channel Reach are contained in the Pre-Design Plans on sheets 22-28 and sheets 44-46.

Design flows and proposed channel section types for the Industrial Channel are listed in **TABLE 10**.

TABLE 10 – INDUSTRIAL CHANNEL FLOWS AND SECTIONS

Station Limits	Design Flow	Channel Section
Sta 300+79 to Sta 351+33	110 CFS	Industrial (Concrete)
Sta 351+33 to Sta 379+07	60 CFS	Industrial (Concrete)
Sta 394+80 to Sta 439+60	540 CFS	Industrial (Concrete)
Sta 439+60 to Sta 472+00	390 CFS	Industrial (Concrete)

2. Utility Conflicts

Sta 304+74 (Sheet 22): There is an existing RID irrigation tailwater ditch crossing the proposed Industrial Channel at this location. The functionality of the irrigation system must remain intact. The crossing is proposed to be accomplished via a siphon structure at this location. The final solution to this conflict must be coordinated with RID.

Sta 304+76 (Sheet 22): There is an existing 24" sanitary sewer crossing the Industrial Channel at this location. While the sewer is sufficiently deep to cross under the proposed Industrial Channel, there is a manhole located with the channel footprint. The Recommended Plan includes 2 new manholes beyond the limits of the channel with a new pipe connecting the manholes to accomplish the crossing.

Sta 319+32 (Sheet 23): Tailwater from the adjacent agricultural field has historically drained overland near this location to a culvert crossing the UPRR tracks. The RID recaptures and reuses this tailwater in their system. The proposed Industrial Channel will cutoff the overland flow route for this tailwater. A siphon structure is proposed at this location to allow the tailwater to cross the Industrial Channel and continue along its historic path. The final design of this structure must be coordinated with RID.

Sta 332+09 (Sheet 25): There is an existing RID irrigation delivery and tailwater ditch crossing the proposed Industrial Channel at this location. The functionality of the irrigation system must remain intact. The crossing is proposed to be accomplished via a siphon structure at this location. The final solution to this conflict must be coordinated with RID.

Sta 337+31 (Sheet 25): Tailwater from the adjacent agricultural field has historically drained overland near this location to a culvert crossing the UPRR tracks. The RID recaptures and reuses this tailwater in

their system. The proposed Industrial Channel will cutoff the overland flow route for this tailwater. A siphon structure is proposed at this location to allow the tailwater to cross the Industrial Channel and continue along its historic path. The final design of this structure must be coordinated with RID.

Sta 356+67 (Sheet 27): An existing RID irrigation delivery ditch crosses the proposed Industrial Channel at this location. The functionality of this irrigation system must remain intact. The crossing is proposed to be accomplished via a siphon structure at this location. The final solution to this conflict must be coordinated with RID.

Sta 623+55 (Sheet 46): An existing 16" waterline crosses the proposed Industrial Channel at this location. This waterline will need to be realigned to cross below the proposed channel.

Sta 624+64 (Sheet 46): An existing RID irrigation tailwater and delivery ditch runs parallel to and within the footprint of the proposed Industrial Channel at this location. The functionality of this irrigation system must remain intact. The irrigation ditch is proposed to be relocated underground in a pipe along the east side of the proposed channel, and to cross the proposed drainage system above the proposed box culvert at this location. The final solution to this conflict must be coordinated with RID.

3. Environmental and Permit Issues

Environmental requirements for this reach are limited and expected to be coordinated by the FCDMC Environmental Program Manager during final design.

4. Landscape and Multi-Use

The Industrial Channel shall be constructed in accordance with the recommendations of *Section III.F.5*. Vertical drop structures within the system should be designed with minimal aesthetics to match the aesthetic design of the channel itself. The industrial site developer should be invited to participate in the PAAC meetings for the final design.

As mentioned earlier in the report, trail connectivity between this reach and the Watson Channel reach will require additional coordination with the Town of Buckeye to determine the best means of crossing the BWCDD channel and the UPRR.

5. Special Considerations

Longitudinal slope- The Industrial Channel runs parallel to the topographic contours in this area. As a result, minimum longitudinal slope is available for this channel. Most of the Industrial Channel is designed at a longitudinal slope of 0.0010 ft/ft. Concrete lining will aid in the effectiveness of the channel to convey the flows. Consideration should be given to minimize channel roughness for this reach.

Irrigation Tailwater- Because the topography falls from north to south, this generally east-west channel alignment would naturally intercept tailwater from the agricultural fields, if allowed to do so. The RID has the water rights to this tailwater, and therefore the tailwater must be returned to the irrigation system downstream of the Industrial Channel. A series of irrigation crossing structures is proposed in

the Pre-Design Plans to maintain segregation of stormwater flows and irrigation tailwater flows along this reach.

Sediment Deposition- Potential sediment deposition should be considered during final design since the slope of this channel is relatively flat and upstream interim channels may be unlined.

F. 231st Channel

1. Description

(See Pre-Design Plans, Sheets 29-38)

The 231ST Channel serves as the outfall for the proposed Rainbow Basin and Railroad Basin. The proposed channel alignment extends from Southern Avenue near Rainbow Road to the RID Canal along the west side of the 231st Avenue alignment. As an alternative, the alignment of the 231st Channel could straddle the mid-section line. The Town should be consulted during final design to determine the preferred alignment for this reach. The channel will require a ROW corridor ranging between 115 and 185 feet in width. Key features of the channel include the connection to the proposed Railroad Basin, the outfall connection from the proposed Dean Basin, three (3) box culvert crossings including a 1,500-foot long box culvert section north of Broadway Road in order to fit between the existing cemetery and a property containing structures of historic interest, connection to the Rainbow Basin outfall, three (3) irrigation siphons, eight (8) vertical drop structures, and the crossing of the RID Canal. Further design details of the Watson Channel Reach are contained in the Pre-Design Plans on sheets 29-38.

Design flows and proposed channel section types for the 231st Channel are listed in **TABLE 11**.

TABLE 11 – 231ST CHANNEL FLOWS AND SECTIONS

Station Limits	Design Flow	Channel Section
Sta 352+00 to Sta 369+00	430 CFS	Industrial (Concrete)
Sta 369+00 to Sta 378+71	430 CFS	231st/Residential (Turf)
Sta 378+71 to Sta 472+00	390 CFS	231st/Residential (Turf)

2. Utility Conflicts

Sta 379+88 (Sheet 29): An existing RID irrigation delivery ditch crosses the proposed channel at this location. The functionality of this irrigation system must remain intact. The crossing is proposed to be accomplished via a pipe crossing above the proposed box culvert crossing of Southern Avenue. The final design of this crossing must be coordinated with RID.

Sta 392+61 (Sheet 31): An existing RID irrigation delivery ditch crosses the proposed system at this location. The functionality of this irrigation system must remain intact. The crossing is proposed to be accomplished via a pipe crossing above the proposed box culvert inlet to the Railroad Basin. The final design of this crossing must be coordinated with RID.

Sta 401+14 (Sheet 31): An existing RID irrigation delivery ditch crosses the proposed channel at this location. The functionality of this irrigation system must remain intact. The crossing is proposed to be accomplished via a siphon structure at this location. The final solution to this conflict must be coordinated with RID.

Sta 413+64 (Sheet 32): An existing RID irrigation delivery ditch crosses the proposed channel at this location. The functionality of this irrigation system must remain intact. The crossing is proposed to be accomplished via a siphon structure at this location. The final solution to this conflict must be coordinated with RID.

Sta 426+96 (Sheet 34): An existing RID irrigation delivery ditch crosses the proposed channel at this location. The functionality of this irrigation system must remain intact. The crossing is proposed to be accomplished via a siphon structure at this location. The final solution to this conflict must be coordinated with RID.

Sta 440+70 (Sheet 35): An existing RID irrigation delivery ditch crosses the proposed system at this location. The functionality of this irrigation system must remain intact. The crossing is proposed to be accomplished via a pipe crossing above the proposed box culvert. The final solution to this conflict must be coordinated with RID.

Sta 453+33 (Sheet 36): An existing RID irrigation delivery ditch crosses the proposed system at this location. The functionality of this irrigation system must remain intact. The crossing is proposed to be accomplished via a pipe crossing above the proposed box culvert. The final solution to this conflict must be coordinated with RID.

Sta 466+80 (Sheet 37): An existing RID irrigation delivery ditch crosses the proposed system at this location. The functionality of this irrigation system must remain intact. The crossing is proposed to be accomplished via a pipe crossing above the proposed box culvert. The final solution to this conflict must be coordinated with RID.

3. Environmental and Permit Issues

Specific environmental and permit considerations for the 231st Channel include:

- Phase I Environmental Site Assessments (ESA) for land acquisitions will be required.
- Archeology inventory of the 231st Channel alignment indicate that the Buckeye Canal, the Roosevelt Canal, and the old US 80 have been recommended for or formally determined to be eligible for nomination with the National Register of Historic Places and will be impacted by the alignment. The on-call's recommendations indicate mitigation of the sites will not be necessary provided it can be demonstrated that the National Registry characteristic of the structures would not be altered as a result of the project.
- A Town of Buckeye Native Plant Inventory should be included for the channel as part of the final design, and will be most beneficial if completed at the commencement of the 30% design as a tool for identifying existing trees that may be left in place. Given the majority of the alignment is currently developed as agriculture the number of existing trees within the alignment is limited.

Native tree salvage should be included where supplemental irrigation will allow for the reestablishment of the trees back into project. Where supplemental irrigation is not feasible, tree salvage and replanting is no likely to be successful.

4. *Landscape and Multi-Use*

The 231st Channel shall be constructed in accordance with the recommendations of *Section III.F.1*. or the appropriate channel type if otherwise designated.

One of the O&M roads along the east side of the channel should be designated as the soft-surface trail for this reach with dual roads. Opportunities to connect equestrian users to the future Skyline Regional Park along the powerline trail north of the RID, along the Maricopa Regional Trail segment identified on the north side of the RID, and south along the Watson System to the Gila River have been identified in the project PAAC meetings and should be achieved through project implementation.

5. *Special Considerations*

Portions of the 231st Channel to be constructed by the District will require interim landscape treatments to mitigate the water velocities prior to the installation of the final turf lining. Objectives for the interim condition include:

> Objective 1: Accomplish the stormwater mitigation requirements of the Watson System Pre-Design Project.
> Objective 2: Accommodate both an interim earthen channel with hydroseed lining condition and a final build-out condition with a turf lining.
> Objective 3: Not preclude the opportunity for open space credits to adjacent developer by imposing limiting conditions in the interim design.

Design guidelines associated with the interim conditions channels are described in *Section III.D.1.a*.

Sensitive Land Parcels - Just north of Broadway Road, the 231st Channel passes between two sensitive land parcels. On the east side of the 231st Avenue alignment lies a cemetery. The parcel on the west side of the 231st Avenue contains remnants of sheep herders' quarters which have been deemed structures of historic interest. In order to avoid impacts to these parcels, the 231st Channel system has been designed as a box culvert through this reach.

RID Crossing- The 231st Channel is designed to cross under the RID Canal and provide an outfall for the proposed Rainbow Basin. This crossing is proposed to consist of a 36" pipe. The crossing of the RID Canal must be coordinated with the RID, and will require certain improvements to the Canal.

G. *Apache Channel*

1. *Description*

(See Pre-Design Plans, Sheets 46-57)

The Apache Channel serves as the outfall for the proposed Apache Basin and Maricopa Basin. It extends from the UPRR just west of the Walmart Distribution Center to the RID Canal at Apache Road. The channel will require a ROW corridor ranging between 68 and 200 feet in width at its widest sections. Key features of the channel include the connection to the Apache Basin outfall, connection to the Maricopa Basin outfall, a box culvert, six (6) underground pipe sections including two (2) locations

where pipes are utilized to avoid existing structures, and sixteen (16) vertical drop structures. Further design details of the Watson Channel Reach are contained in the Pre-Design Plans on sheets 46-57.

Design flows and proposed channel section types for the Apache Channel are listed in **TABLE 12**.

TABLE 12 – APACHE CHANNEL FLOWS AND SECTIONS

Station Limits	Design Flow	Channel Section
Sta 625+23 to Sta 634+00	240 CFS	Industrial (Concrete)
Sta 634+00 to Sta 659+20	240 CFS	Maricopa (Rock Mulch)
Sta 755+75 to Sta 740+65	230 CFS	Apache (Gunite)
Sta 740+65 to Sta 710+32	280 CFS	Apache (Gunite)
Sta 710+32 to Sta 666+35	340 CFS	Apache (Gunite)

2. *Utility Conflicts*

Sta 659+50 to Sta 764+75 (Sheet 49-57): An existing RID irrigation delivery ditch is located parallel to the proposed channel along the east side of Apache Road. This ditch delivers irrigation water to the agricultural fields on the east side of the proposed channel. To facilitate the continued delivery and functionality of the irrigation system, the ditch is proposed to be relocated underground in a pipe along the east side of the proposed Apache Channel. The final solution to this conflict must be coordinated with RID.

Sta 687+30 (Sheet 51): There is an existing 12" waterline located in the Southern Avenue corridor. The Apache Channel is proposed to cross Southern Avenue via a pipe culvert. The 12" waterline may need to be realigned at this location.

Sta 714+59 (Sheet 53): There is an existing 12" waterline crossing the proposed system at this location. The system is proposed to enter a storm drain pipe and swing out into the Apache Road corridor for approximately 300 feet to avoid conflict with an existing structure and well site. The waterline may need to be realigned to avoid conflict with the proposed storm drain pipe.

Sta 727+50 (Sheet 54): The existing RID irrigation delivery ditch along the east side of Apache Road, (which is proposed to be relocated in a pipe along the east side of the Apache Channel), receives inflow from another RID delivery ditch on the west side of Apache Road. In order to maintain the irrigation system connectivity and functionality, a siphon structure is proposed at this location to cross the Apache Channel. The final solution to this conflict must be coordinated with RID.

Sta 740+74 (Sheet 55): There is an existing RID irrigation delivery ditch located along the south side of Broadway Road. The Apache Channel is proposed to cross Broadway Road via a pipe culvert. The delivery ditch is proposed to be relocated underground in a pipe crossing above the proposed pipe culvert. Final design of this crossing must be coordinated with RID.

Sta 741+40 (Sheet 55): There is an existing 12" waterline located in the Broadway Road corridor. crossing the proposed system at this location. The Apache Channel is proposed to cross Broadway Road via a pipe culvert. The waterline may need to be realigned to avoid conflict with the proposed culvert.

Sta 763+41 (Sheet 57): The proposed irrigation ditch undergrounding and relocation to the east side of the Apache Channel crosses the system alignment at this location. The Apache system is planned to be underground in a storm drain pipe from the Apache Basin for approximately 1,000 feet. The proposed irrigation pipe will cross over the top of the storm drain. Final design of this crossing must be coordinated with RID.

3. *Environmental and Permit Issues*

Environmental considerations for this reach are similar to those described for the 231st Channel.

4. *Landscape and Multi-Use*

The Apache Road Channel shall be constructed in accordance with the recommendations of *Section III.F.2.* and *Section III.F.3* where designated on the plans. Landscape should be installed with a permanent drip irrigation system with ornamental shrubs and native or native adapted trees complementary to adjacent developments.

FIGURE 17 – CONSTRUCTED GUNITE CHANNEL EXAMPLE WITH IRRIGATED LANDSCAPE

The confluence of the Apache Channel, Maricopa Channel and the Maricopa Basin presents an opportunity for developing a multi-use gateway connecting the various Town of Buckeye Trail segments and inviting pedestrians and cyclists and others into the downtown along the multi-use pathway. Coordination between the Town, adjacent land owners, and other special interests should be facilitated as part of the development of this segment of the reaches to accomplish the Town's goal of inviting pedestrians and trail users into the downtown along Maricopa Road.

5. *Special Considerations*

RID Crossing- The Apache Channel is designed to cross under the RID Canal and provide an outfall for the proposed Rainbow Basin. This crossing is proposed to consist of a 2-24" pipe. The crossing of the RID Canal must be coordinated with the RID, and will require certain improvements to the Canal.

Structure Avoidance- There are two locations between Southern Avenue and Broadway Road where the Apache Channel enters a short reach of storm drain and shifts the alignment to the Apache Road corridor. This is done to avoid conflict with an existing irrigation well site and an existing residence.

H. Maricopa Lateral

1. Description

(See Pre-Design Plans, Sheets 59-62)

The Maricopa Channel collects and conveys flow from west of Apache Road. It extends from the Apache Road to just west of the Miller Road along the Maricopa Road alignment. The channel will require a ROW corridor ranging between 208 and 222 feet in width at its widest sections. Key features of the channel include the connection to the Maricopa Basin, an irrigation siphon structure, a storm drain section for the crossing of Apache Road, and a box culvert section for the crossing of Miller Road. Further design details of the Watson Channel Reach are contained in the Pre-Design Plans on sheets 59-62.

Design flows and proposed channel section types for the Apache Channel are listed in **TABLE 13**.

TABLE 13 – MARICOPA CHANNEL FLOWS AND SECTIONS

Station Limits	Design Flow	Channel Section
Sta 813+73 to Sta 851+11	360 CFS	Maricopa (Rock Mulch)

2. Utility Conflicts

Sta 813+00 to Sta 829+75 (Sheets 59-60): An existing RID irrigation tailwater and delivery ditch is located parallel to the proposed channel along the north side of Maricopa Road. This ditch delivers irrigation water to the agricultural fields on the north side of the proposed channel. To facilitate the continued delivery and functionality of the irrigation system, the ditch is proposed to be relocated underground in a pipe along the north side of the proposed Maricopa Channel. The final solution to this conflict must be coordinated with RID.

Sta 661+56 (Sheet 49): There is an existing 15" sanitary sewer located in the east side of the Apache Road corridor. The Maricopa Channel is proposed to cross the Apache Road corridor in a storm drain pipe, and will cross this sewer at this location. The 15" sewer is shallow, and the storm drain pipe will cross just above the sewer. Final design of this crossing should explore methods of creating as much vertical clearance as possible between the storm drain and the sewer.

Sta 661+72 (Sheet 49): There is an existing 16" waterline located in the Apache Road corridor at this location. This waterline may need to be relocated to avoid a conflict with the storm drain crossing.

Sta 829+75 (Sheet 60): At this location, the proposed undergrounding and relocation of the irrigation ditch crosses the Maricopa Channel. This crossing is proposed to be a siphon structure at this location. Final design of this crossing must be coordinated with RID.

Sta 851+94 (Sheet 62): Irrigation tailwater from the agricultural field to the north has historically flowed overland to a tailwater ditch near this location. The Maricopa Channel is proposed to enter a box culvert in this area to avoid conflict with the APS Valencia Sub Station. A pipe is proposed to cross above

the box culvert to capture and convey these tailwater flows to the historic system. The final design of this crossing must be coordinated with RID.

Sta 856+87 (Sheet 62): There is an existing RID irrigation delivery ditch located along the east side of Miller Road. This ditch is proposed to be relocated underground in a pipe crossing above the box culvert at this location. The final design of this crossing must be coordinated with RID.

Sta 857+23 (Sheet 62): There is an existing 18" sewer located in Miller Road crossing the proposed box culvert at this location. It is anticipated that the sewer is sufficiently deep to avoid a conflict with the box culvert.

Sta 857+67 (Sheet 62): There is an existing 2" natural gas line located in Miller at this location. This gas line will need to be relocated to avoid conflict with the box culvert crossing Miller Road.

3. *Environmental and Permit Issues*

Environmental requirements for this reach are limited and expected to be coordinated by the Town and developers during final design.

4. *Landscape and Multi-Use*

The Maricopa Road Channel shall be constructed in accordance with the recommendations of *Section III.F.3* where designated on the plans. Landscape should be installed with a permanent drip irrigation system with ornamental shrubs and native or native adapted trees complementary to adjacent developments.

As described above, multi-use for this reach should opportunities to encourage pedestrians and other multi-use trail users to visit the downtown area from Maricopa Road as well as provide visitors to the downtown with multi-modal access to the rest of the Town of Buckeye trail system.

5. *Special Considerations*

APS Valencia Substation- The Maricopa Channel is proposed to enter a box culvert storm drain just east of the APS Valencia Substation. This will allow the system to be routed around the substation. Coordination should be conducted with APS to determine any special requirements they may have for horizontal clearance, vehicular loading, etc...

I. Apache Basin

1. *Description*

The Apache Basin is proposed to be located just north of the RID Canal and just east of Apache Road. Refer to **FIGURE 14 – RECOMMENDED PLAN** for a graphical depiction of the proposed location of the Apache Basin.

2. *Environmental and Permit Issues*

Environmental requirements for this reach are limited and expected to be coordinated by the Town and developers during final design.

3. *Landscape and Multi-Use*

a. *Landscape*

Landscape Design Theme: Sonoran Desert Park (if partnering with developer) or Natural Lower Sonoran Desert (if Town of Buckeye maintained)

Plant Palette: To be determined by the developer. If partnering is not possible and the Town must maintain the basin, the basin should be designed using tall pot trees and hydroseed mixes with no supplemental irrigation.

Flood Protection Method: Semi-Soft Structural. This basin should include sufficient right-of-way to accommodate the engineering need, a 30' buffer and an additional 30% of the engineering need to allow for basin shaping and design to accomplish the semi-soft structural forms and context sensitivity within the setting that it is placed.

Side-Slopes: 6:1 average, varied between 4:1 and 8:1

b. *Multi-Use*

Passive open space, but may include other uses if partnering is possible. The Town may offer the developer incentives to help facilitate implementation of the basin such as open space credits, density credits, or allow co-location of some of their on-site retention. The basin could provide additional neighborhood park-level recreation since Monte Verde has a low recreation level-of-service for neighborhood park needs per the Town planning staff.

4. *Special Considerations*

Coordination with planned development- The Apache Basin is located in an area of a planned development with a plat. Given the Town's current open space requirements and development standards, it is possible that the Apache Basin can be incorporated into the development plat with minor impacts. The Town has indicated a willingness to allow developments that are directly impacted by the locations of proposed regional basins to discharge on-site stormwater to the basin, as long as the development excavates commensurate additional storage volume. Coordination should be conducted with the planned development for this site to determine an acceptable configuration for the basin.

Capturing water in the basin- The Apache Basin is designed to collect runoff reaching the RID canal from the north between 247th Ave, which is the mid-section line between Miller Road and Apache Road, and Watson Road. During final design the means for collecting the off-site runoff and safely conveying it into the basin will need to be developed and included in the design. This will include conveying runoff from the west across Apache Road, likely through a culvert, and collecting sheet flow from north of the basin as well as runoff that has accumulated along the upstream side of the RID east of the basin. It is recommended that offsite flows be prevented from flowing over the basin sideslope by constructing spillways at planned locations where runoff can be safely directed into the basin. Ideally, the means and

inlet location for collecting offsite flows would be coordinated with the landowner/developer in accordance with current development plans.

J. Maricopa Basin

1. Description

The Maricopa Basin is proposed to be located just north of Maricopa Road and just west of Apache Road. Refer to **RECOMMENDED PLAN** for a graphical depiction of the proposed location of the Maricopa Basin.

2. Environmental and Permit Issues

Environmental requirements for this reach are limited and expected to be coordinated by the Town and developers during final design.

3. Landscape and Multi-Use

a. Landscape

Landscape Design Theme: Enhanced Desert (if partnering with developer) or Natural Lower Sonoran Desert (if Town of Buckeye maintained)

Plant Palette: To be determined by the developer. If partnering is not possible and the Town must maintain the basin, the basin should be designed using tall pot trees and hydroseed mixes with no supplemental irrigation.

Flood Protection Method: Semi-Soft Structural. This basin should include sufficient right-of-way to accommodate the engineering need, a 30' buffer and an additional 30% of the engineering need to allow for basin shaping and design to accomplish the semi-soft structural forms and context sensitivity within the setting that it is placed. Terracing of the basin between 3-feet in depth to 6-feet in depth allows for greater flexibility in the design and the option to include a natural low-flow between the basin inlet and outlet from the Maricopa Channel.

Side-slopes: 7:1 average, varied between 4:1 and 10:1 to create natural forms as depicted on plan sheet 67.

b. Multi-Use

Multi-use opportunities for this basin should be determined through discussions with the Town and the adjacent developments. This may include partnering with the Odyssey Elementary School. Multi-use opportunities discussed in the PAAC meetings include an outdoor classroom/environmental education area, sports practice fields, passive open space areas with trails, or active recreation for the school.

The basin could also function as a gateway feature into the downtown as part of the Maricopa Channel alignment. It will provide a buffer between the future residential and industrial areas.

In the event no partner is available to implement multi-use within the basin, the multi-use for this site will be passive open space.

4. *Special Considerations*

Basin inlet/outlet configuration- The Maricopa Basin inlet is designed to allow flows to enter the basin only after flows in the adjacent channel exceed 50 CFS. The invert of the box culvert inlet is set above the bottom of the channel, which effectively functions as side weir. The outlet from the basin is a single pipe culvert connecting to the storm drain crossing of Apache Road.

Open space near basin- The confluence of the Apache Channel, Maricopa Channel and the Maricopa Basin presents an opportunity for developing a multi-use gateway connecting the various Town of Buckeye Trail segments and inviting pedestrians and cyclists into the downtown along the multi-use pathway. Coordination between the Town, adjacent land owners, and other special interests should be facilitated as part of the development of this segment of the reaches to accomplish the Town's goal of inviting pedestrians and trail users into the downtown along Maricopa Road.

K. *Rainbow Basin*

1. *Description*

The Rainbow Basin is proposed to be located just north of the RID Canal and just west of the 231st Avenue Alignment. This basin is proposed to be adjacent to the Town of Buckeye's Rainbow park, of which the 1st phase has already been constructed. Refer to **RECOMMENDED PLAN** for a graphical depiction of the proposed location of the Apache Basin.

2. *Environmental and Permit Issues*

Environmental requirements for this reach are limited and expected to be coordinated by the Town and developers during final design.

A Town of Buckeye Native Plant Inventory should be included for the basin as part of the final design, and will be most beneficial if completed at the commencement of the 30% design as a tool for identifying existing trees that may be left in place. Native tree salvage should be included where supplemental irrigation will allow for the reestablishment of the trees back into project. Where supplemental irrigation is not feasible, tree salvage and replanting is no likely to be successful.

3. *Landscape and Multi-Use*

The Town of Buckeye has identified the Rainbow Basin as an active recreation area that will be integrated into Sundance Park – Phase I and expand the recreation facilities the existing park provides.

a. *Landscape*

Landscape Design Theme: Desert Park

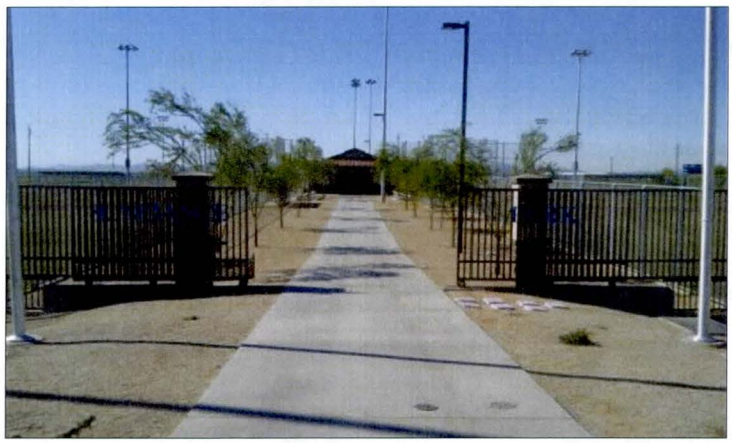
Plant Palette: Landscape materials for the basin shall match the plant palette , rock mulch color, and site furnishings used on the Sundance Park Phase 1.

Flood Protection Method: Semi-soft structure. Right-of-way to accomplish the intended method includes the engineering need plus 30' buffer and an additional 30% of right-of-way for basin shaping desired by the Town and recommended to form the basin in an aesthetic manner. The Town may need to acquire even more land to provide access to the park/basin site from Lower Buckeye Road and accommodate the park program elements.

Side-slopes: 6:1 average, 5:1 maximum to maintain mowable slopes. Vary side-slope conditions to create visual interest and form. Basin form should include long, sweeping curves that create graceful lines suggestive of a park setting.

b. Multi-Use

FIGURE 18 – SUNDANCE PARK PHASE I



The multi-use for this basin is active recreation to include unprogrammed, open turf. The Town of Buckeye does not want sports field lighting in detention basin. The Town intends the basin site to most likely become part of the larger Sundance Park complex and provide for the Town's need for additional ball fields on this site as there is a higher demand for this use than can be met by the existing park. The Town is also planning a multi-generational center and aquatics center on the parcel currently owned by the Town that would be between the Rainbow Basin site and the existing Sundance Park.

4. Special Considerations

Basin Terracing- Terracing of the basin has the benefit of allowing some of the planned active multi-use to remain useable during minor storm events. However, this can require extensive basin grading for minimal effective storage benefit required to catch grade upstream of the proposed basin site. Final design of the basin will require the Town of Buckeye and the designers to determine the best balance between basin costs, desired facility access during or following storm events, and sizing requirements.

Capturing water in basin- The Rainbow Basin is designed to collect runoff reaching the RID canal from the north between Watson Road and Dean Road. During final design the means for collecting the off-site runoff and safely conveying it into the basin will need to be developed and included in the design. This will include collecting off-site runoff from the west, north, and east. Runoff from the east will include runoff accumulated along the upstream side of the RID canal that is making its way west. The means for runoff reaching the basin from the east should be reviewed and confirmed during final design. This includes the stormwater crossing Rainbow Road from east to west. There may also be low spots along the RID that result in ponding of runoff before it reaches the basin. These offsite conditions will need to be coordinated with the Town of Buckeye and the landowner/developer in accordance with current development plans. It is recommended that offsite flows be prevented from flowing over the

basin sideslope in an uncontrolled manner by constructing spillways at planned locations where runoff can be safely directed into the basin.

L. Railroad Basin

1. Description

The Railroad Basin is proposed to be located just north of Southern Avenue and just east of 231st Avenue. In the ADMP, as well as in the Pre-Design Alternatives Analysis, this basin was proposed to be located just north of Southern Avenue and just west of 231st Avenue. Subsequent to coordination with the planned development for that parcel, the Town of Buckeye directed the consultant team to relocate the location of the proposed Railroad Basin to the east. Refer to **RECOMMENDED PLAN** for a graphical depiction of the proposed location of the Railroad Basin.

2. Environmental and Permit Issues

Environmental requirements for this reach are limited and expected to be coordinated by the Town and developers during final design.

3. Landscape and Multi-Use

a. Landscape

Landscape Design Theme: Natural Lower Sonoran Desert

Plant Palette: Native tall pot trees and hydroseed mixes with no supplemental irrigation.

Flood Protection Method: Semi-hard Structural. This basin should include sufficient right-of-way to accommodate the engineering need and a 30' buffer only, resulting in a basin form that is engineered in appearance. The inclusion of a low-flow feature in the basin bottom will help soften the basin form, but would also impede the implementation of potential active recreation in the future if desired by the development.

b. Multi-Use

Passive open space, but may include other uses if partnering is possible. The Town may offer the developer incentives to help facilitate implementation of the basin such as open space credits, density credits, or allow co-location of some of their on-site retention. The 231st Channel was identified as a potential location for an equestrian trail and this basin could include an equestrian trailhead.

4. Special Considerations

Accomodating future development stormwater- A pipe connection has been provided from the basin to the existing vacant land west of 231st Avenue. The purpose of this pipe is to allow the adjacent future development a point of discharge for stormwater flows from their site. Coordination should be performed with the adjacent development to ensure the pipe connection is appropriately sized and designed.

M. Dean Basin and Outlet

1. Description

The Dean Basin is proposed to be located just north of Southern Avenue and just east of 223rd Avenue. The Dean Basin is the only proposed basin that was not included in some form in the ADMP recommendations. Recall that the outfall channel for the White Tanks FRS #4 was planned to connect to the Watson Drainage System at the time of the ADMP. This channel was also planned to intercept flow from the northeast quadrant of the Watson watershed. When the White Tanks FRS #4 Outfall Channel was rerouted, The Watson system was left without a collection and conveyance mechanism for this northeast area of the watershed. Thus, the Dean Basin and Outlet is proposed.

2. Environmental and Permit Issues

Environmental requirements for this reach are limited and expected to be coordinated by the Town and developers during final design.

3. Landscape and Multi-Use

a. Landscape

Landscape Design Theme: Sonoran Desert Park (if partnering with developer) or Natural Lower Sonoran Desert (if Town of Buckeye maintained)

Plant Palette: To be determined by the developer. If partnering is not possible and the Town must maintain the basin, the basin should be designed using tall pot trees and hydroseed mixes with no supplemental irrigation.

Flood Protection Method: Semi-Soft Structural. This basin should include sufficient right-of-way to accommodate the engineering need, a 30' buffer and an additional 30% of the engineering need to allow for basin shaping and design to accomplish the semi-soft structural forms and context sensitivity within the setting that is placed.

Side-Slopes: 6:1 average, varied between 4:1 and 8:1

b. Multi-Use

Passive open space, but may include other uses if partnering is possible. The Town may offer the developer incentives to help facilitate implementation of the basin such as open space credits, density credits, or allow co-location of some of their on-site retention. The Henry Park development plat may have expired. If so, the Town will be renegotiating the development agreements for the site which will provide opportunity for the Town to work with the developer to determine basin requirements.

4. Special Considerations

Capturing water in basin- The Dean Basin is designed to collect runoff from the area between Rainbow Road and Dean Road extending from Southern Avenue north to the RID Canal. During final design the means for collecting the off-site runoff and safely conveying it into the basin will need to be developed and included in the design. These offsite conditions will need to be coordinated with the Town of

Buckeye and the landowner/developer in accordance with current development plans. It is recommended that offsite flows be prevented from flowing over the basin side slope in an uncontrolled manner by constructing spillways at planned locations where runoff can be safely directed into the basin.

Coordination with existing plat- The Town has indicated that at some point in the past, a preliminary plat was developed for the parcel on which the Dean Basin is proposed to be located. This plat has most likely expired in the time that has passed. Coordination should be performed with the planned development in order to design the Dean Basin in a way that minimizes impact to the development while still providing the required storage volume.

Outlet profile- The outlet from the Dean Basin is planned to be a 48" pipe that will drain to the west in Southern Avenue and then to the south in Rainbow Road. The outlet pipe will chase the grade of the 231st Channel south of Southern Avenue. It will enter the 231st Channel just upstream of the UPRR. The alignment in Southern Avenue will "buck grade" at times, although maximum depth of cover on the outfall pipe will be approximately 10 feet. An alternative alignment was considered that went south from the basin to the railroad and thence westerly along the UPRR. The extremely flat grade of the area adjacent to the UPRR and the location of an industrial enterprise on the east side of Rainbow Road, including a railroad spur, make this alignment infeasible.

VI. REFERENCES

Bentley Flowmaster, V8i, *User's Manual*, 2009.

Dibble Engineering, *Buckeye ADMP Recommended Design Report*, FCD 2004CO58, June 2009

Dibble Engineering, *Watson Pre-Design Data Collection Memorandum* , FCD 2012C003, Sept. 2012.

Dibble Engineering, *Watson Pre-Design Hydrology Memorandum*, FCD 2012C003, March 2013.

Dibble Engineering, *Watson Pre-Design Preliminary Alternatives Memo*, FCD 2012C003, April 2013.

FCDMC, Shimin Li, *Watson Pre-Design: Preliminary Geotech Evaluation* ("*maximum permissible velocity*", April 2013.

FCDMC, Gary Wesch, *Watson Pre-Design: Watson/Gila River Confluence Hydraulics Memo*, February 2012.

FCDMC, Gary Wesch, *Watson Pre-Design: Value Analysis Report*, July 2013.

Federal Highway Administration, *HY-8 Culvert Hydraulic Analysis Program* (Ver. 7.2), July 14, 2010.

Flood Control District of Maricopa County, Engineering Division, *Drainage Design Manual for Maricopa County, Arizona Volume I, Hydrology*, September, 2013.

Flood Control District of Maricopa County, Engineering Division, *Drainage Design Manual for Maricopa County, Arizona Volume II, Hydraulics*, September, 2013.

Flood Control District of Maricopa County, Engineering Division, *Drainage Policies and Standards for Maricopa County*, January 4, 2007.

Ninyo & Moore, *Geotechnical Evaluation Watson Drainage System Pre-Design*, December 2013.

Town of Buckeye, *Storm Water Drainage System Design Manual (DM-500)*, August 2007.

U.S. Army Corps of Engineers, *HEC-1 ver. 4.1, Flood Hydrograph Package, Users Manual, June 1998.*

VII. APPENDIX

Appendix A – Supplemental Memoranda

Appendix B – Project, PAAC & Stakeholder Meeting Minutes

Appendix C – Recommended Plan Hydrology

Appendix D – Normal Depth Calculations

Appendix E – Hydraulic Structures Calculations

Appendix F – Detention Basin Volume Report

Appendix G – Conceptual Plan Cost Estimate

- Data Collection Memorandum (9/11/2012)
- Downtown Storm Water Outfall Memo (8/14/2012)
- Watson / Gila River Confluence Hydraulics (2/11/2012)
- Maximum Storm Recurrence Interval to be contained within the Watson Drain Memo (2/7/2014)
- Preliminary Geotechnical Evaluation Report Review Comments (4/16/2013)
- Value Analysis Report (4/2/2013)
- Final Geotechnical Evaluation (12/3/2013)

Appendix A

Supplemental Memoranda

Dibble Engineering

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Memorandum

To:	Gary Wesch, P.E., Project Manager	**Date:**	September 11, 2012
Copy:		**Client Project:**	Watson Drainage Pre-Design
From:	Kevin Roberts, P.E.	**Project #:**	FCD: 2012C003 / DE: 101206
	Justin Beeler, P.E., CFM		
Subject:	Watson Drainage System Pre-Design: Data Collection Memorandum (Task 2.4)		

Overview:

The purpose of the Watson Drainage System Pre-Design (PRE-DESIGN) project is to provide the initial design steps for the Town of Buckeye regional drainage improvements, as recommended in the Buckeye Area Drainage Master Plan (ADMP). The Watson Drainage System extends from upstream of the Roosevelt Irrigation District (RID) canal to the Gila River between Miller Road and Rainbow Road. The ADMP identified a Recommended Plan for regional drainage improvements to alleviate existing flooding hazards, provide conveyance for runoff accumulation along irrigation canals, and provide drainage outfalls for local developments. The Watson Drainage System is one of the drainage systems recommended in the ADMP. The study area is located within the Town of Buckeye and unincorporated Maricopa County. It is bounded by I-10 and Buckeye FRS No. 2 and 3 to the north, Miller Road to the west, Dean Road to the east and the Gila River to the south.

The Pre-Design project will refine and firmly establish the project alignment and drainage features, determine design constraints, resolve unknowns, and clearly establish the final design criteria for the project. The project tasks include collection of field data, identification of potential major utility conflicts, refinement of hydrologic and hydraulic models, development of preliminary plans and refinement of project costs.

The Data Collection Phase of the Watson Pre-Design project includes collecting data regarding existing and proposed drainage facilities, existing utilities, and existing and planned developments within the study area.

The purpose of this Data Collection Report is to describe the data collection process and to present the findings. Results from this report will be used in later phases of the study.

Scope Requirements:

The scope of work outlines a number of directs tasks for scope item 2.0 Data Collection. These tasks are listed below.

- (2.1) The Consultant shall be provided or obtain the existing plans, studies and reports pertinent to the project from FCD, Buckeye, irrigation districts, utilities, UPRR, landowners, developers, and other sources. Provide a list summarizing the collected data.
- (2.2) Make at least 2 site visits to become familiar with the existing conditions.
- (2.3) Prepare an existing conditions base map.
- (2.4) Develop a Data Collection Memo that shall list relevant documents, plans, reports, utilities and improvements planned utilities, and drainage facilities inventory of facilities within the project area.

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In addition to these tasks, three optional tasks were listed in the scope regarding supplemental survey, pot holing, and geotechnical investigations. While these optional tasks have not yet been authorized, it is anticipated that each of these tasks will be authorized and performed during the Pre-Design project..

Electronic Data Provided:

The following is a list of documents that were listed in the scope to be provided by FCDMC:

- Buckeye Sun Valley Mapping 2001C020, 2002
- Gillespie mapping 2007C045, 2008
- Buckeye Area Drainage Master Plan – Recommended Design Report by Dibble 2009 (includes HEC-1 hydrology)
- Buckeye Area Drainage Master Plan – Data Collection Report by Dibble 2008
- Buckeye Area Drainage Master Plan- Historic Landscape Themes by ACS 2007
- Buckeye Sun Valley ADMS 2006
- El Rio Watercourse Master Plan and Area Drainage Master Plan 2006
- White Tanks FRS #4 Outlet Facility Design Concept Report 2010
- Loop 303 Corridor/White Tanks Area Drainage Master Plan Update 2010
- GIS information

Several of the items related to the Buckeye ADMP were already possessed by Dibble Engineering. The other items were provided by the District to Dibble Engineering in electronic format via the Dibble Engineering FTP site.

GIS Data Provided:

The GIS data provided for this project was sizeable and too large to discuss in detail for this memo. Over 4 Gigabytes of data and 2,187 files were collected for the project. Shapefile data included data for items such as floodplains, jurisdictional boundaries, infrastructure, natural/environmental, survey control, soils, land use/ownership, transportation, contours, hydraulic structures, wells, and others. A general list showing data types prepared by the District has been attached with the memo. Aerial imagery (2010/2011) for the project area was also provided.

The Town of Buckeye provided a clipped water and sewer shapefile based on the original base alignments and a given buffer zone. This data was entered into GIS by a technician and asbuilt data and is meant to be used for planning purposes.

No other planned utility alignments within the study area were provided by the Town of Buckeye or FCDMC.

Site Visits:

Two site visits have been completed so far to collect information for the Pre-Design project. The theme for the first field visit held on June 14, 2012 was to review the project watershed boundary and flow patterns and identify anything that might impact the update to the project hydrology model. This site visit was attended primarily by the FCDMC hydrology staff and select members of the consultant team. Several photos were taken and observations were made by the consultant team and FCDMC staff present. The second site visit was held on June 20, 2012 and attended by the larger consultant team and District staff

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with the goal to visit each of the proposed alignments, identify any issues with the proposed channel alignments and basin locations, and to observe alternative alignments to be explored during the alternatives analysis portion of the project. Photographs were taken by various attendees and shared with the project team via the Dibble FTP site.

Downtown Buckeye Outfall:

The majority of Downtown Buckeye does not have adequate storm water infrastructure or 100-year, 2-hour retention. This has resulted in flooding during small storm events and the potential for major flooding during large storm events. The topography of the land in the downtown area falls to the south, storm water runoff is conveyed southerly down the various streets running north to south. A majority of the runoff from the downtown area flows towards Beloat Road and converges at the intersection of Beloat Road and 7th Street. The Town of Buckeye has a Downtown Storm Water Plan with a goal to mitigate the storm water flooding and safely convey the storm water out of the Downtown Area to the Gila River.

The Town of Buckeye (Town) and W.C. Scoutten, Inc. (WCS) met with Dibble Engineering (Dibble) and the Flood Control District of Maricopa County (FCDMC) on July 18th, 2012 to discuss the Watson Drainage System. During the meeting the Town brought up the desire to convey the Downtown Storm Water Runoff to the Watson Drainage System channel which is proposed to outfall to the Gila River.

WCS prepared HEC-1 models for the 100-year, 6-hour and the 100-year, 24-hour storm event for the Downtown Storm Water Plan watershed. Two discharge locations have been identified as outfall locations with the intent to convey these flows to the Watson Drainage system. One discharge point is at the intersection of the Apache Road alignment and the Monroe Avenue alignment ("DET"). The other is at the intersection of the Apache Road alignment and Beloat Road ("DRAINA"). The discharge at point DET is 153 and 188 cfs, respectively, for the 100-year, 24-hour & 6-hour models. The discharge at point DRAINA is 535 and 703 cfs, respectively, for the 100-year, 24-hour & 6-hour models.

WCS has prepared DSS files for the unit hydrographs for these two discharge points which will be used to evaluate the feasibility of connecting the Downtown discharge into the Watson Drainage System.

Base Maps and Data Collection Logs:

The Existing Conditions Base Map Exhibits have been prepared at 1"=100' scale, showing detailed utility locations (based on owner provided information), existing and ultimate roadway configuration, existing and ultimate right of way configuration, and any other features that may impact the proposed drainage system.

The scope included various requirements for the base maps which specified the inclusion of the aerial imagery, 2' contours, wet and dry utilities, the APS APNN 96" cooling supply pipeline, irrigation pipes/canals/ROW, railroad facilities and ROW, Town of Buckeye General Plan Land Use, future roadway sections, and existing property lines with APN numbers. There were 24 base map sheets prepared for this deliverable.

Data collection logs documenting the items provided by the District and reviewed by Dibble are attached with this memo. The various log sheets provided include: Electronic files, GIS files, Town of Buckeye Drainage Reports, and a list of utility files collected to date. An excerpt from the Town of Buckeye General plan documenting the land use data collected for the hydrology update is also included with this memo.

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As one reviewer noted, the Watson Pre-Design watershed land use is still primarily agricultural. These farms could have other wells and septic systems that are not accounted for among the other utilities identified for this project.

Data Collection Logs

DEVELOPMENT DRAINAGE STUDY COLLECTION LOG

	Subdivision	PDF TITLE	Status	Report Date	Consultant	Client	Location	Impact Area?	Notes
1	Anderson Parc	Anderson Parc Final Drainage Report - REVISED	Approved	2/7/2007	CVL	Buckeye 60 LLC	260 ac, Apache rd b/w Yuma and Lower Buckeye	Y - north area	Based on offsite hydrology prepared by Dibble, DCF, Anderson Parc See Drainage map pg 117 of 117 of PDF
2	Apache Farms	Apache Farms Final Drainage Report	R&R	Mar-05	M2 Group	Evergreen Communities	277 lot, 68 ac, NEC Broadway/Apache Rd.	Y - Apache Rd	
3	Bentridge	Bentridge Preliminary Drainage Report	Approved	Aug-06	RBF	Sunstone Homes	64 Ac, Resid parcel, N of RID, b/w Lower Buckeye & Watson	Y, RID crossing	Resid area north or RID at Watson Rd alignment
4	Broadway Estates	Broadway Estates Preliminary Drainage Report	Approved	Nov-05	KHA	AGO Investments	230 Ac, SE corner Miller/Broadway	N	
5	Buckeye Industrial Rail Park	Buckeye Industrial Rail Park		Nov-11	Hubbard	Globe Corp	260 Ac, Watson Rd - Southern Ave to UPRR	Y - UPRR	
6	Copper Falls	Copper Falls Final Drainage Report	?	Feb-06	Stantec	KB Homes	176 Ac, Miller Rd, b/w Broadway & Southern	N	
7	Cotton Meadows	Cotton Meadows - Phase 1-6 Final Drainage Report	R&R	Nov-05	M2 Group	Evergreen Communities	252 ac, SE corner Southern/Apache	Y - Apache Rd	
8	Cotton Meadows	Cotton Meadows - Phase 7-12 Final Drainage Report	?	Jan-06	M2 Group	Evergreen Communities	252 ac, NE corner Southern/Apache	Y - Apache Rd	
9	Crystal Vista	Crystal Vista Final Drainage Report	Approved	Jun-06	Musser	Intercontinental Dev & Cons.	80 ac, Apache Rd, b/w Broadway & Southern	Y - Apache Rd	Development started
10	Desert Moon Estates	Desert Moon Estates - Phase 1 Drainage Report		Oct-06	Core Group		201 ac, SE of Yuma/Apache	Y - north area	No Offsite/onsite drainage map included with PDF
11	Desert Moon Estates	Desert Moon Estates - Phase 2 Drainage Report			Core Group		201 ac, SE of Yuma/Apache	Y - north area	Offsite Map included in report
12	Hayden Valencia	Hayden Valencia Preliminary Drainage Report		Jun-06	RBF	Stratland Homes	239 Ac, SWC Southern/Apache	Y - Apache Rd	
13	Henry Park	Henry Park - Parcel 12, 15 & 16 Preliminary Drainage Study	?	May-07	Can-Am Eng	Omega Mngmt Servcs	74 Ac, Dean Rd, B/w, Broadway & Southern	N	
14	Miller Manor	Miller Manor - Phase 1 Drainage Report	?	Sep-03	Manhard	Southwestern Invest Grp	66.4 Ac, NEC Miller & Southern	N	
15	Miller Manor	Miller Manor - Phase 2 Drainage Report	?	Sep-03	Manhard	Southwestern Invest Grp	66.4 Ac, NEC Miller & Southern	N	
16	Miller Manor	Miller Manor - Phase 3 Drainage Report	?	Sep-03	Manhard	Southwestern Invest Grp	66.4 Ac, NEC Miller & Southern	N	
17	Miller Park	Miller Park Final Drainage Report	Approved	Dec-05	CVL	Scott Comm.	25 Ac, SWC Miller/Southern	N	
18	Montana Vista	Montana Vista Final Drainage Report		Mar-06	Musser	Montana Vista Ranch	72 Ac, Apache Rd, B/W Broadway & Southern @ S of Roeser	Y - Apache Rd	
19	Montana Vista	Montana Vista-Sonoran Vista		Jun-04	RBF	Sonoran Vista Investors	80Ac & 163 Ac, S of Broadway B/W Apache & Watson	Y - Apache Rd	
20	Monte Verde	Monte Verde Preliminary Drainage Report	Approved	Aug-06	CVL	Shea Homes	853 Ac, Along S of Lower Buckeye, Miller to Watson	Y - north area	South of Lower Buckeye, so not berm related, but general area
21	Mystic Vista	Mystic Vista Final Drainage Report	Signed	Jun-07	Carter-Burgess	CHI Construction	145 Ac, NWC Apache and Southern	Y - Apache Rd	
22	Cipolla	Preliminary Drainage Report for Cipolla		Nov-05	CMX	Magee Holdings	S of RID, Rainbow to Dean	N	East of Rainbow Channel
23	Rainbow Ranch	Rainbow Ranch Final Drainage Report		May-06	Stantec	DR Horton	154 ac, NEC Rainbow & Broadway	N	East of Rainbow Channel
24	Riata West	Riata West Final Drainage Report		Dec-05	RBF	DR Horton	221 ac, NWC Southern & Watson	N	Development completed
25	San Madera	San Madera Final Drainage Report		Aug-07	M2 Group	Evergreen Communities	151 ac, NWC Broadway & Watson	Y	May impact proposed Watson RID crossing
26	Siesta Lago Estates	Siesta Lago Estates Drainage Report	Approved	Aug-06	Sunrise	Sunstone Homes	30 ac, AEC Watson and Elwood St (Broadway)	Y	May impact proposed Watson alignment
27	Sonora Vista	Sonora Vista Final Drainage Report		Apr-06	RBF	DR Horton	163 ac, SWC Broadway & Watson	Y	May impact proposed Watson alignment
28	Sundance	Sundance - Phase 1 Infrastructure Master Drainage Study	Archived	Sep-01	RBF	Hancock Comm.	NWC Watson & Yuma	N	Development completed
29	Sundance	Sundance - Phase 2 Infrastructure Master Drainage Study	Archived	May-02	RBF	Hancock Comm.	NWC Watson & Yuma	N	Development completed
30	Tyler Ranch	Tyler Ranch Final Drainage Report	Approved	Mar-07	UEG	Buckeye 50 LLC	72 Ac, NEC of Apache & Broadway	Y - Apache Rd	
31	Ventana Ranch	Ventana Ranch - Phase 1 Final Drainage Report	Approved	Mar-07	V3	Concordia Homes	284 Ac, Watson Rd, Broadway to Southern	Y	May impact proposed Watson alignment
32	Ventana Ranch	Ventana Ranch Preliminary Drainage Report	Approved	Jul-06	RBF	Concordia Homes	284 Ac, Watson Rd, Broadway to Southern	Y	May impact proposed Watson alignment
33	Vista Del Sol	Vista Del Sol Final Drainage Report		Oct-06	Sage Eng	Capital Pacific Homes	NWC Rooks & Southern	N	
34	Watson Estates	Watson Estates Final Drainage Report	Approved	May-06	CVL	Buckeye 229 LLC	238 ac, SWC Yuma & Watson	Y - north area	Development started
35	Wingate	Wingate - Phase 1-6 Final Drainage Report	?	Jul-07	M2 Group	Evergreen Communities	83 Ac, SEC Watson & MC85	Y-Watson	May impact new Watson outfall alignment
36	Wingate East	Wingate East Final Drainage Report		Nov-06	M2 Group	Evergreen Communities	83 Ac, SEC Watson & MC85	Y-Watson	May impact new Watson outfall alignment

DA 101206

DATA COLLECTION LOG SHEET - (Electronic)

Dibble Engineering

Flood Control District of Maricopa County

ITEM #	PROJECT TITLE	PROJECT NO.	ITEM DATE	CONSULTANT	MEDIA TYPE	DATE RECEIVED	SOURCE	COMMENTS
1	FCDMC GIS DATA	Varies	Varies	FCD	*.shp, dxf, etc	5/22/2012	GW	Various GIS content via FTP
2	White Tanks FRS #4 Outlet DCR (Report)	FCD 2008 C013	5/10/2010	OLSSON	PDF	6/6/2012	GW	WT#4 DCR Report
3	White Tanks FRS #4 Outlet DCR (Const Docs)	FCD 2008 C013	5/10/2010	OLSSON	PDF	6/6/2012	GW	Conceptual Plans only (~15%)
4	El Rio Watercourse Master Plan	FCD 2001C024	September-05	Stantec	PDF, various	6/6/2012	GW	Total of 10 folder (discs) of all Master Plan docs
5	APS Palo Verde Pipeline docs (7 items)	N/A	August-98	N/A	PDF	6/14/2012	GW	Asbuilt files for APNN pipe
6	APS Quarter Section Maps (OH & UG Elec) (13 items)	N/A	12/19/2011	APS	PDF	6/14/2012	GW	QS maps for APS elect utilities
7	Buckeye Drainage Reports (36 items)	Various	Various	Various	PDF	6/14/2012	GW	Various Buckeye Area drainage reports (see report log)
8	Cox utility Quarter Section Maps (24 items)	N/A	6/30/1905	Cox	PDF	6/14/2012	GW	QS maps for COX utilities
9	Kinder Morgan Record Drawings & letter from KM	N/A	12/31/1955	Kinder Morgan	PDF	6/14/2012	GW	4 asbuilt drawing sheets with letter from KM
10	Roosevelt Irrigation District (RID) asbuilts (3 files)	82000332 & 82000355	7/2005 & 8/2006	Stantec	PDF	6/14/2012	GW	1 overview map of RID Laterals and 2 plan sets (_332 = N-S between Watson & Apache, 1/2 mile south of Broadway to Southern) & (_355 = N-S, b/w W&A, Broadway to 1/2 mile south)
11	Southwest Gas QS Utility maps (7 sheets)	N/A	1/16/2009	Southwest Gas	PDF	6/14/2012	GW	QS maps for Southwest Gas utilities
12	"Updated ADMP HEC1 & DDMSW FILES"	N/A	N/A	FCD	*.ZIP	6/14/2012	JH	DDMSW/HEC-1 models from ADMP FCDMC revisions/updates
13	Loop 303 Outfall Drainage System	FCD 2011C015	2/1/2012	Wood/Patel	PDF	6/22/2012	GW	99% Construction drawings for L303 outfall channel

UTILITY COLLECTION LOG SHEET

Dibble Engineering

Flood Control District of Maricopa County

ITEM #	Utility	DATE RECEIVED	ITEM DATE	SOURCE	MEDIA TYPE	DESCRIPTION	SOURCE	COMMENTS
1	APS	6/14/2012	12/19/2011	FCDMC	PDF	QS MAPS	GW	13 SHEETS FROM APS
2	APS-PALO VERDE	6/14/2012	4/27/1975	FCDMC	PDF	ASBUILTS	GW	6 SHEETS
3	COX	6/14/2012	2008	FCDMC	PDF	QS MAPS	GW	24 SHEETS
4	KINDER-MORGAN	6/14/2012	12/31/1955	FCDMC	PDF	Record Dwgs	GW	1 PDF, 4 pgs, P&P
5	R.I.D.	6/14/2012	10/21/2011, varies	FCDMC	PDF	Plans, Map	GW	3 SOURCES, by Stantec
6	SOUTHWEST GAS	6/14/2012	1/16/2009	FCDMC	PDF	QS MAPS	GW	1 PDF, 7 pgs
7	SPRINT/ERICKSON	Not yet received						
8	BWCDD	Not yet received						
9	CENTURYLINK	Not yet received						
10	VERIZON	8/21/2012	11/4/1987	FCDMC	PDF	ASBUILTS	GW	6 pg PDF
11	LEVEL III	8/22/2012	8/8/2002	FCDMC	PDF	ASBUILTS	GW	13 pg PDF
12	UPRR	Not yet received						
13								

LAYER

AERIAL PHOTOGRAPHY DATA
- Historic Areials - Various years
- Aerial Photography Index - Various years

ALERT DATA
- Forcast Zone
- Rain Gage (ADWR)
- Rain Gage (FCDMC)
- Repeater Gage

CENSUS DATA
- Population 1970 (Census)
- Population 1980 (Census)
- Population 1985 (Census)
- Population 1990 (Census)
- Population 1995 (Census)

DAM & SPILLWAY DATA
- Baseline Spillway
- Cross Section Spillway 1-3rd Capacity
- Cross Section Spillway 2-3rd Capacity
- Cross Section Spillway Full Capacity
- Dam (FCDMC)
- Dam National Inventory 1999 (USACE)
- Dam National Inventory 2005 (USACE)
- Inundation Area Spillway 1-3rd Capacity
- Inundation Area Spillway 2-3rd Capacity
- Inundation Area Spillway Full Capacity
- Ponding Area Dam

ENVIRONMENTAL DATA
- Biotic Community (ASLD)
- Character Type (AGS)
- Desert Space (MAG)
- Environmental Monitoring Site
- Gap Vegetation (ASLD)
- Landfill
- Mine (ASLD)
- Preserve Initiative Boundary (ASLD)
- Riparian Vegetation (ASLD)

FEMA DATA
- Baseline Current (FEMA)
- BFE Current (FEMA)
- Cross Section Current (FEMA)
- Flood Zone Current (FEMA)
- Flood Zone Pending (FCDMC)
- LOMR Boundary (FEMA)

FLOODPLAIN DATA
- Baseline (FCDMC)
- BFE (FCDMC)
- Cross Section Floodplain Study
- Elevation Certificate
- Flood Zone Current (FEMA)
- Flood Zone Pending (FCDMC)

HYDROLOGY AND WATERSHED DATA
- Active Management Area (ADWR)
- Canal
- Drainage Basin Dam
- Drainage Basin Floodplain Study
- Drainage Path
- Drainage Point
- Ground Water Site Inventory (ADWR)
- Hydrologic Unit Code (ASLD)

LAYER

HYDROLOGY AND WATERSHED DATA
- Irrigation Nonexpansion Area (ADWR)
- Lake (ASLD)
- Lateral (SRP)
- Ponding Area Dam
- River (ASLD)
- River (FCDMC)
- River 10 ft. Countywide
- River With Name (ASLD)
- Spring (ASLD)
- Waters of the U.S.
- Watershed (ADWR)
- Watershed (FCDMC)
- Watershed Dam
- WBDHU_12 (USDA)
- Well (ADWR)
- Well (SRP)
- Wet Crossing (City of Scottsdale)

LAND USE DATA
- Development (MAG)
- Development Subdivision (MAG)
- Land Use 1990 (MAG)
- Land Use 1995 (MAG)
- Land Use 2000 (MAG)
- land Use 2004 Draft (MAG)
- Land Use 2009 (MAG)
- Land Use Development Subdivision (MAG)
- Land Use Future 2007 (MAG)
- Land Use Future 2009 (MAG)
- Land Use General Plan 2007 (MAG)

NOAA ATLAS 14 DATA

NOAA ATLAS 2 DATA

PLANNING & ANALYSIS DATA
- ADMP
- ADMS
- Municipal Planning Area 2008 (MAG)
- Page Layout for Study
- Regional Analysis Zone 2008 (MAG)
- Socioeconomic Analysis Zone 2008 (MAG)
- Traffic Analysis Zone 2003 (MAG)

POLITICAL BOUNDARY DATA
- City (ASLD)
- City (Election)
- City by Ordinance (Election)
- City Limit Map Index
- City Point (ASLD)
- Congressional District (ASLD)
- Vounty - Maricopa
- County
- Legislative District 2004 (ASLD)
- Military Reservation
- Native American Land
- Place (ASLD)
- Preserve Initiative Boundary (ASLD)
- School District Elementary (ASLD)
- School District Secondary (ASLD)
- School District Unified (ASLD)
- State Park (ASLD)
- Supervisorial District

LAYER

POLITICAL BOUNDARY DATA
- Urban Cluster & Area (ASLD)
- Urban Edge Historic (MAG)
- Urban Edge Projected (MAG)
- Wilderness Area (ASLD)
- Zip Code (Election)

PROPERTY OWNERSHIP DATA
- Employer (MAG)
- Land Management (ASLD)
- Parcel (Assessor)
- Parcel (FCDMC)
- Residential Completion (MAG)
- Sand & Gravel Operation
- Subdivision (Assessor)
- Zip Code (Election)

RAIN & FLOOD EVENT DATA
- Average Rain Area (USGS)
- Average Rain Area (USGS)
- Flood Event
- Forecast Zone
- Paper 2433 Figure 7 (USGS)
- Precipitation Event 1954-Aug (USACE)
- Precipitation Event 1963-Aug (USACE)
- Precipitation Event 1970-Sep (USACE)
- Precipitation Event 1972_Jun (USACE)
- Precipitation Event 1978-Dec (USACE)
- Precipitation Event 1978-Feb (USACE)
- Precipitation Event 1980-Feb (USACE)
- Precipitation Event 1992-Jul (USACE)
- Precipitation Event 1993-Feb (USACE)
- Precipitation Event 1993_Jan (USACE)
- Precipitation Event 1993-Oct (USACE)
- Report 944002 Figure 1 (USGS)

SOIL AND GEOLOGY DATA
- Fault (ASLD)
- Geology (ASLD)
- Land Stability
- Land Subsidence 2008 (ADWR)
- Land Sunsidence 2009 (ADWR)
- Land Subsidence 2010 (ADWR)
- landform
- Physiography (AGS)
- Soil Erosion (NRCS)
- Soil Precipitation Runoff (NRCS)
- Soil SSURGO 2003-Oct (NRCS)
- Soil SSURGO 2010-Apr (NRCS)
- Soil STATSGO (NRCS)

STRUCTURE DATA
- Building
- Civil Engineering As-Built
- DAM (FCDMC)
- Dam National Inventory 1999 (USACE)
- Dam National Inventory 2005 (USACE)
- Health Facility (ADHS)
- Industry Site
- Structure (FEMA)
- Structure O&M maintained (FCDMC)

SURVEY SYSTEM DATA
- Section

LAYER

SURVEY SYSTEM DATA
- Survey Point (NGS)
- Survey Point Corner (ADOT)
- Survey PointCorner (MCDOT)
- Survey Point Corner Recorded (MCDOT)
- Survey Point Mapping (FCDMC)
- Survey Point Misc (MCDOT)
- Township & Range
- Vertcon Vertical Datum Difference

TERRAIN MODELING DATA
- Contour Index NAVD88
- Contour NAVD88
- Contract Boundary
- Spot Elevation NAVD88
- Terrain NAVD88

TRANSPORTATION DATA
- Bridge over Salt River
- Railroad
- Street & Highway (MCDOT)
- Street (ASLD)
- Street (MCDOT)
- Street Detail

USGS QUAD DATA
- Quad Feature
- Quad Index (ASLD)
- USGS Quad 100K Image
- USGS Quad 24K Image
- USGA Quad 250K Image

UTILITY DATA
- Gas Company Service Area (SRP)
- Misc. Utility (SRP)
- Power Company Service Area (SRP)
- Transmission Line (SRP)
- Transmission Substation (SRP)

WRR FACILITY DATA
- Maricopa County Landfill
- Maricopa County Transfer Station
- Non-Maricopa county Facility
- Non-Maricopa County Landfill
- Tire Recycling Facility

Town of Buckeye
General Plan
Land Use Excerpt

Land Use Plan

The General Plan Land Use (Figure 3-4) identifies the land use framework for future development within the Buckeye Planning Area. It is intended to provide a balance between residential, commercial, and employment uses to foster a *live, work, educate, and play* community.

Land Use Concepts The Land Use Plan addresses the following key concepts:

1. All neighborhoods within the Town of Buckeye are connected and are an integral part of Buckeye.

2. A comprehensive mix of housing choices and styles are encouraged.

3. A regionally balanced employment center within the Buckeye Planning Area is identified to achieve the targeted jobs-to-housing ratio balance (i.e., 1.3 jobs available for each household). The Land Use Plan identifies and preserves employment corridors and areas where current and future employment opportunities can be developed.

4. Land use planning must encourage the development of self-sustaining, mixed use activity centers throughout the Planning Area to create a *live, work, educate, and play* lifestyle within close proximity to home.

5. Diverse, transit and pedestrian-friendly Mixed Use Areas are encouraged, to include higher intensity mixed use development at the center, with the intensity of uses decreasing as development moves away from the center.

6. Land use patterns conserve, protect, and connect the Planning Area's natural resources and parks to promote livability and sense of community.

7. A multimodal transportation system effectively connects activity centers within the Planning Area and extends the regional transportation network to Buckeye.

8. Transit-oriented development is promoted along corridors integrating land use and multimodal transportation.

9. Attractive gateway and high capacity roadway corridors are included.

Town of BUCKEYE

Adopted January 18, 2008
Ratified May 20, 2008

Notes:

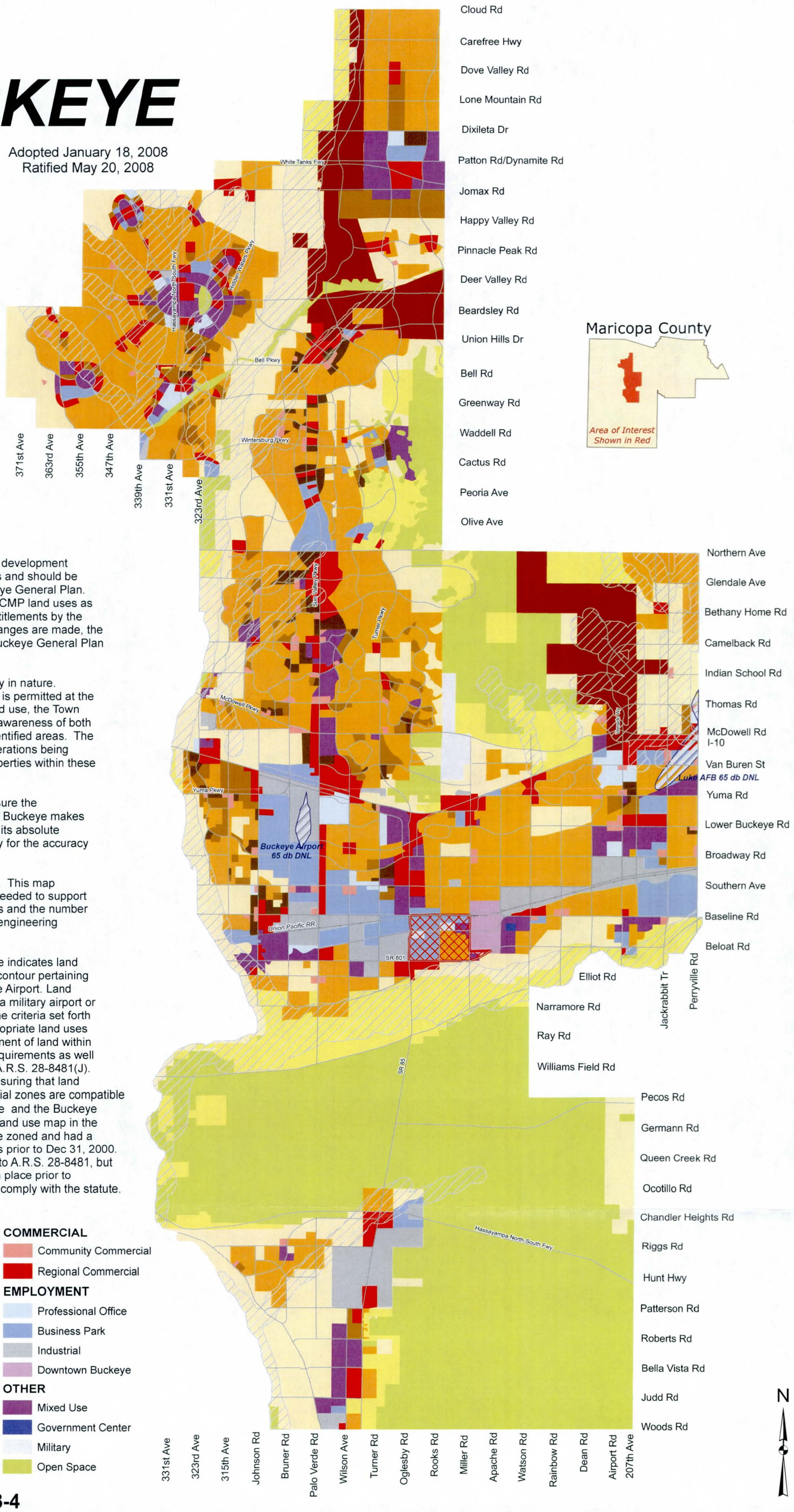
All Community Master Plans (CMP) and development agreements remain as valid entitlements and should be referred to in conjunction with the Buckeye General Plan. The Land Use Map strives to reflect the CMP land uses as accurately as possible. The adopted entitlements by the Town of Buckeye are valid and if any changes are made, the policies and guidelines outlined in the Buckeye General Plan will be followed.

Floodway Transitional Areas are advisory in nature. Though development within these areas is permitted at the level of the designated General Plan land use, the Town wishes to emphasize the importance of awareness of both the hazards and sensitivities in these identified areas. The Town strongly encourages these considerations being addressed in development plans for properties within these areas.

While every effort has been made to ensure the accuracy of this information, the Town of Buckeye makes no warranty, expressed or implied, as to its absolute accuracy and expressly disclaims liability for the accuracy thereof.

Arterial / River crossings are conceptual. This map demonstrates the number of crossings needed to support development at build-out. Final locations and the number of crossings will be determined through engineering and water studies.

Town of Buckeye General Plan Land Use indicates land within the 65 day-night noise level (dnl) contour pertaining to Luke Air Force Base and the Buckeye Airport. Land within the designated 65 dnl adjacent to a military airport or ancillary military facility is restricted by the criteria set forth in A.R.S. 28-8481(J) which outlines appropriate land uses for such land. Any General Plan Amendment of land within these areas must also comply with all requirements as well as the compatible land uses outlined in A.R.S. 28-8481(J). The Town of Buckeye is committed to ensuring that land uses in the high noise or accident potential zones are compatible with the operation of Luke Air Force Base and the Buckeye Airport. Residential uses shown on the land use map in the 65 dnl area for Luke Air Force Base were zoned and had a development plan in place for those uses prior to Dec 31, 2000. These properties continue to be subject to A.R.S. 28-8481, but the development plans that have been in place prior to December 31, 2000 for these properties comply with the statute.



Floodway Transitional Areas
65 db noise contour
Downtown Expansion Area

RESIDENTIAL
- Very Low Density 0-1 du/ac
- Low Density 1.01-3 du/ac
- Medium Density 3.01-6 du/ac
- Medium High Density 6.01-10 du/ac
- High Density 10.01-15 du/ac
- Master Planned Community

COMMERCIAL
- Community Commercial
- Regional Commercial

EMPLOYMENT
- Professional Office
- Business Park
- Industrial
- Downtown Buckeye

OTHER
- Mixed Use
- Government Center
- Military
- Open Space

FIGURE 3-4

TOWN OF BUCKEYE GENERAL PLAN LAND USE

One Town, One Vision!
General Plan and Development Code

Build-Out Concept The Land Use Plan also outlines the future land use and transportation network at "build-out." Build-out is defined as all land within the Planning Area being designated with appropriate land use based on a series of criteria, including land ownership patterns, topographic and environmental constraints and opportunities, development opportunities, infrastructure support, and private property rights. Build-out does not occur at any certain date, since development and growth are dependent upon cyclical market trends and private property owner interests.

The location and amount of development will have significant implications on the ability to provide services such as infrastructure, public safety, transportation, and parks. It is critical that the Town of Buckeye be able to plan for and serve future growth, and monitor growth rates over time in order to adjust plans accordingly.

Though the Town is experiencing a tremendous amount of growth in a smaller-scale development pattern, it is also seeing large-scale master planned development. Historically, the Town of Buckeye has used the following planning tools, in addition to the ***Buckeye General Plan***, to facilitate the development of large master planned communities:

a. Land Use Designations Land use designations as outlined on Figure 3-5 define the various types of development that might be allowed within each classification. Designations correlate spatially to areas indicated on the Land Use Map and are intended to describe the intensity of development that is desired. It is important to note that these designations are not zoning classifications. Property owners must go through a zoning process if there is a desire to make changes to specific zoning on their property before development.

The Proposed Land Use Map is not specific to any time period. For areas with adopted area plans, it is a build-out plan. In areas that require more detailed planning, it provides generalized land use.

Figure 3-5: Land Use Designations

Very Low Density Residential (Up to 1 du/ac)
Low Density Residential (1.01 to 3 du/ac)
Medium Density Residential (3.01 to 6 du/ac)
Medium High Density Residential (6.01 to 10 du/ac)
High Density Residential (10.01 to 15 du/ac)
Urban Density Residential (over 15 du/ac)
Mixed Use
Community Commercial
Regional Commercial
Professional Office Employment
Business Park
Industrial
Downtown Buckeye
Government Center
Open Space
Military
Master Planned Community

du/ac = dwelling units per acre

The Land Use Map does not reflect the intended zoning of individual parcels but rather generalized desired future land use. The boundaries between use and density designations notes on the map are not fixed precisely. Rather, they indicate general areas wherein the goals of the ***Buckeye General Plan*** will be pursued through more detailed planning decisions.

b. Determining Boundaries The land use designation boundaries shown on the Buckeye Land Use Map are located along significant natural or man-made features whenever possible, to assist in identification. These features, including drainageways, washes, roadways, existing subdivisions, and existing development areas, represent general recommendations for future development.

Boundary locations are not precise. Variations within 500 feet, particularly where significant natural or man-made features are present, may be acceptable. It will be the responsibility of the Town Council, with recommendation from the Buckeye Development Board and staff, and guidance provided in the ***Buckeye General Plan***, to establish and more accurately define the boundaries if questions arise.

c. Land Use Buffering and Transitioning

Special considerations should be given to areas where the intensity of adjacent land uses differ in a manner that may negatively impact one use or the other. Buffering or integrating a transitional land use between differing land use types will increase the compatibility, and provide a level of protection for each use. Examples of situations where buffering or transitioning should be used include where residential uses are located adjacent to commercial, office or employment uses, or where various levels of residential densities are adjacent to each other.

Depending on the community's needs, a variety of techniques may be used to ensure land use compatibility, such as:

- Site planning techniques addressing building heights, orientation, setbacks, ingress, and egress
- Screening through the use of block walls, fencing, plant materials, or earth berming
- Integration of landscaped open space areas and easements
- Landscaping along rights-of-way and variations in setbacks
- Any combination of the above

Land Use Analysis Assumptions

In completing the Land Use Plan analysis, a series of assumptions were created. These assumptions are made on expected average build out and are not intended to show limits or maximum development. Individual projects will vary.

Residential Assumptions

- 80 percent of each parcel's acreage can be used
- 60 percent of Mixed Use Designation is High Density with an overall average density of 10 dwelling units per acre (it is anticipated that there will be a combination of both High Density and Urban Density Residential in the Mixed Use Designation.)
- Average/mid-range densities are assumed for each residential land use designation (e.g., Low Density 1.01 to 3 dwelling units per acre has been calculated at 2 dwelling units per acre; the average dwelling units for Very Low Density Residential has been calculated at .5)

Commercial Assumptions

- 80 percent of each parcel's acreage can be used
- .20 is used as the floor to area ratio (i.e., amount of building space in relation to the total land parcel)
- 56 square feet of commercial space is allocated per resident
- 20 percent of the Mixed Use Designation is in commercial uses
- 25 percent of the Business Park is in commercial uses

Employment Assumptions

- 80 percent of each parcel's acreage can be used
- .20 is used as the floor to area ratio (i.e., amount of building space in relation to the total land parcel)
- 350 square feet is allocated for non-industrial employee
- 500 square feet is allocated for industrial employee
- Industrial and Business Park land is assumed to be one story in height
- Professional Office Employment land is assumed to be two stories average
- 20 percent of the Mixed Use Designation is in employment uses
- 75 percent of the Business Park is in employment uses

Land Use Analysis Figure 3-6 graphically depicts all of the various land use categories that are shown on the Land Use Map and the acreage for each category. The majority of the residential land uses are in Medium and Low Density Residential categories.

Figure 3-6: Land Use Designation Acreage^^

Land Use Designation	Acreage	% of Area
Very Low Density Residential	33,996	8.82
Low Density Residential	71,412	18.53
Medium Density Residential	84,504	21.92
Medium High Density Residential	9,965	2.59
High Density Residential	4,368	1.13
Urban Density Residential	0	0
Mixed Use:		
Commercial**	2,897	0.74
Employment**	2,897	0.74
Residential (assumes 10 du/ac.)	8,691	2.25
Community Commercial	2,583	0.67
Regional Commercial	15,254	3.96
Professional Office Employment	3,131	0.81
Business Park	14,304	3.71
Industrial	10,963	2.84
Downtown Buckeye	1,150	0.30
Government Center	55	0.01
Open Space	102,729	26.65
Military	1,438	.37
Master Planned Community^	19,168	4.92
TOTAL	**389,242**	**100.00**

* Total augmented by Residential Land Uses Mixed Use Designation assumption
** Assumed amount of Commercial and Employment Uses in Land Use Designation
^ Recognizes Verrado and Festival Ranch unique development agreements and land use budgets; commercial and employment within Master Planned Community designation have not been included in the analysis; 1.6 du/ac assumed residential density for Verrado, 2.4 du/ac assumed residential density for Festival Ranch.
^^Numbers accurate as of ± 2%

Population Projection[1] The total projected dwelling units at build-out are 639,722. Using 2.7 persons per household (which is the current Maricopa County average) the total projected population is 1,727,248 people.

Commercial Projection[2] The total commercial square footage at build-out (Figure 3-7) is anticipated to be approximately 169 million square feet of space that can serve a population of more than 3 million people. Based on this analysis, the Buckeye Land Use Plan achieves its goal of becoming a regional commercial hub for the Hassayampa Valley.

Figure 3-7: Commercial Projection

	Square Footage	Population Served
Community Commercial	18,002,477	321,473
Regional Commercial	106,314,278	1,898,469
Mixed Use*	20,190,931	360,552
Business Park*	24,923,290	445,059

* Assumed amount of Commercial Uses in the Land Use Designation

Employment Projection[3] The total square footage of employment-related land use designations at build-out is 193,190,342 square feet (Figure 3-8). This can accommodate approximately 486,480 non-retail/commercial jobs. With a job target of 831,639 (or, 1.3 jobs per household), 58 percent of jobs required can be accommodated in the employment designated area (exceeding the goal of 50 percent non-retail/commercial jobs.) When retail/commercial jobs are added to this total, Buckeye will exceed its 1.3 jobs-per-household target and be positioned to be a job importer, not an exporter.

Figure 3-8: Employment Projection

Land Use	Square Footage	Number of Jobs
Industrial	76,407,725	152,815
Professional Office	21,821,818	62,348
Business Park	74,769,869	213,628
Mixed Use*	20,190,931	57,688

* Assumed amount of Employment Uses in the Land Use Designation

[1] Total dwelling units were calculated using the average dwelling units per usable acre for each residential land use designation, including residential Mixed Use.

[2] Total commercial square footage includes Community Commercial, Regional Commercial, 25% of Business Park and 20% of Mixed Use.

[3] Potential employment was calculated by dividing employment square footage by either 500 sq ft (for industrial) or 350 sq ft (for non-industrial); see "employment assumptions."

RESIDENTIAL DEVELOPMENT

The Buckeye Planning Area has a wide range of residential neighborhoods at various densities and diverse housing products. The Town prides itself in quality neighborhoods, and the location of future residential areas will be designed to protect and strengthen existing residential areas. As the Town continues to evolve, neighborhood revitalization and housing rehabilitation will become a priority. When determining the appropriateness of residential development, the Town will evaluate the availability of utilities and other public infrastructure, development impact on the transportation system and roads, access to public services and facilities, and impact on schools, parks, trails, and open space.

Calculating Residential Density

The net residential density is calculated using the following equation:

$$D = \frac{DU}{A - (C + OS + A^*)}$$

D = Residential Density
DU = Total number of dwelling units in proposed development
A = Total site area (gross acres)
C = Total commercial land area (acres)
A* = Arterial rights of way (acres)
OS = Designated Open Space

Baseline Densities Though residential land use designations are expressed as a range of densities, it is important to stress that the Town of Buckeye strongly supports residential development at the lowest level of the range within each of the designations. For example, the Low Density Residential designation ranges between 1.01 and 3 dwelling units per acre, but its baseline density is 1.01 dwelling unit per acre. The baseline density may be increased up to a maximum of 3 dwelling units per acre by providing enhanced public facilities or amenities deemed appropriate by the Town. The specific listing of appropriate enhancements (Figure 3-9) will be determined by the Town based on the characteristics of the development proposal, site, surrounding uses, and area character.

NOTE: Although densities are used to quantify residential intensities, it does not necessarily correlate directly to quality residential development. One house per 5 acres can be just as detrimental to the environment and the area's quality of life as a 20 houses per acre residential project if it is not designed well. The goal is to have a proper balance of densities, design, and transitions of uses.

Figure 3-9: Potential Project Enhancements

Community Identity

- Significantly enhanced landscaping treatments (size and tree density) and entry signage
- Public facilities
- Joint school/park sites (20 acres or more)
- Diversity in signage options and integration into the overall project design

Product Design

- Variation in lot sizes, housing elevations, housing choices, and four sided design criteria
- Variation in site design

Open Space

- Desert, riparian, river, drainageways, and hillside preservation
- Minimization of open space disturbance area
- Dedicated preserve areas
- Joint-use educational facilities and parks
- Native plant salvage
- Public trail extensions
- Dedication of trail heads for equestrian, hiking and mountain biking areas

Environmental Conservation

- Alternative fuel facilities or neighborhood electric vehicle charging stations
- Effluent reuse
- Solar orientation, roof reflectivity, and other energy efficient design characteristics

Infrastructure

- Extension of off-site utilities
- Exceeding required right-of-way standards for enhanced landscaping with sidewalks/trails or additional open space
- Park-and-ride land dedication
- Additional transit amenities
- Joint use regional infrastructure facilities,

Other as deemed appropriate by the Town Community Development Director and/or Town Manager

Residential Neighborhood Character

Neighborhoods are more than just a conglomeration of housing; they are about the interaction of people walking to the mailbox to pick up mail, sitting in the neighborhood park watching children or grandchildren play, or catching a bus at the neighborhood transit stop. Quality neighborhoods are experienced by those who visit, and valued by those who live within them. Residential land use classifications as identified in the Buckeye Land Use Plan are described below, and are grouped into three types of neighborhoods in terms of their character: rural, suburban, and urban, as follows:

Rural Neighborhoods
Very Low Density Residential

Suburban Neighborhoods
Low Density Residential
Medium Density Residential

Urban Neighborhoods
Medium High Density Residential
High Density Residential
Urban Density Residential

Residential classifications covering large areas are not meant to preclude appropriate neighborhood and community commercial services needed to support the population.

Rural Neighborhood Character

It is important to recognize that the Buckeye area has a long agricultural history, and farming will continue to be a viable land use well into the future. Though the Buckeye Land Use Plan does not designate a specific agricultural land use designation, it may occur in several different land use designations (e.g., Very Low Density Residential and Industrial). If development does occur in or near agricultural areas, it should minimize the impact on the agricultural use by providing adequate buffering.

Very Low Density Residential (Up to 1 du/ac) includes areas that allow up to one house per acre lot. The intent is to provide for a rural lifestyle as well as to encourage large lot development due to environmental constraints, such as hillsides, rivers, washes, and other features.

The basic character of development is rural with most natural features of the land retained. Typically, the keeping of horses or other livestock is permitted. Public services are not required at a level as great as those required in higher density development. No commercial or industrial development (other than farming) is permitted in rural neighborhoods.

Suburban Neighborhoods

The majority of the residential land use pattern reflected on the Buckeye Land Use Plan is suburban development. Much of this land use pattern has received approvals, and is currently being developed or already built. This land use pattern is a continuation of the residential development pattern occurring throughout the Phoenix metropolitan area. Zoning codes encourage the separation of land uses, and market trends have encouraged the continuation of the suburban neighborhood development type. This type of development pattern is not just a function of density, as it traditionally has also suffered from the absence of diversity and character. A new type of neotraditional planning (non-garage dominated facades, front porches, and walkable neighborhoods) is emerging and encouraged in Buckeye to promote the creativity and character that has historically been missing from this development type.

In light of these changes, as neighborhoods evolve and change or as new neighborhoods are planned, the large-scale, suburban-type residential development pattern should be reconsidered. Neighborhood design that promotes diversity in housing products, promotes multi-modal transportation options, and allows for neighbor interaction is encouraged.

The Town of Buckeye's goal is to encourage a new residential neighborhood development pattern that encourages a mix of housing types and cluster of densities that preserve meaningful, connected open space and the location of residents in walking distance to schools, jobs, and support services. The encouragement of social interaction of the people within neighborhoods will get as much attention during the planning process as the physical design of each model home.

Low Density Residential (1.01 to 3 du/ac) includes residential development on lots from 1/3 acre to just over one house per acre with the intent to provide for a larger lot development pattern. These larger lot areas are identified where environmental constraints such as hillsides, rivers, washes, and other features are present and in areas that are currently zoned for large lot suburban-type development.

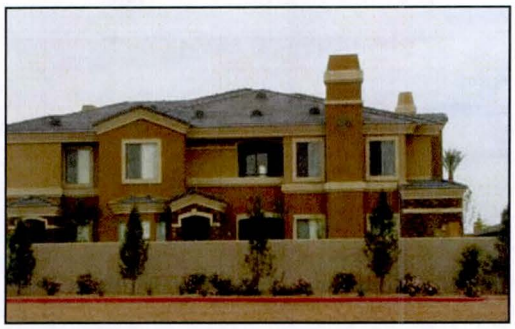
Suitability for Low Density Residential development is determined on the basis of location, access, existing land use patterns, and natural and man-made constraints. This designation may also include such supporting land uses as neighborhood shops and services, parks and recreation, religious institutions, and schools to serve local residents where deemed appropriate by the Town. A full range of suburban services and infrastructure is required.

Medium Density Residential (3.01 to 6 du/ac) includes suburban-type development that is intended to be predominantly single-family detached residential development. Residential densities of up to six dwelling units per acre are typical within this land use designation. In general, these areas are residential, single-family neighborhoods; however, in appropriate areas, they may include a mix of single-family units, duplexes, and townhouses. This designation may also include such supporting land uses as neighborhood shops and services, parks and recreation, religious institutions, small offices, and schools to serve local residents where deemed appropriate by the Town. A full range of urban services and infrastructure is required. These areas must have an adequate street network to support the amount of residential density.

Urban Neighborhoods

In general, urban neighborhoods are residential, single-family neighborhoods which also include a mix of single-family units, duplexes, townhouses, and multi-family developments. Supportive commercial and public facilities are also allowed within this classification.

Medium High Density Residential (6.01 to 10 du/ac) intends to include detached or attached single-family residential developments. The category may also include a mix of single-family homes, duplexes, apartments, and other housing product types. The gross density range for this category is six to ten dwelling units per acre. This designation may also include such supporting land uses as neighborhood shops and services, parks and recreation, religious institutions, and schools to serve local residents where deemed appropriate by the Town. A full range of urban services and infrastructure is required. These areas must have an adequate street network to support the amount of residential density.



High Density Residential (10.01 to15 du/ac) provides areas for apartments and condominium complexes ranging from 10 to 15 gross dwelling units per acre. This designation may also include such supporting land uses as neighborhood shops and services, parks and recreation, religious institutions, and schools to serve local residents where deemed appropriate by the Town. A full range of urban services and infrastructure is required. These areas must have an adequate street network to support the amount of residential density.

Urban Density Residential (over 15 du/ac) provides areas where intense multi-family residential development is desired as either stand alone or part of a mixed-use project of 15 or greater gross dwelling units per acre. Approximate locations should be in close proximity to employment or activity centers, adjacent to high density residential, and along high capacity or major arterial corridors. Transit-oriented development concepts should be incorporated into project design and sensitive buffering or transitioning from adjacent land uses should be achieved.

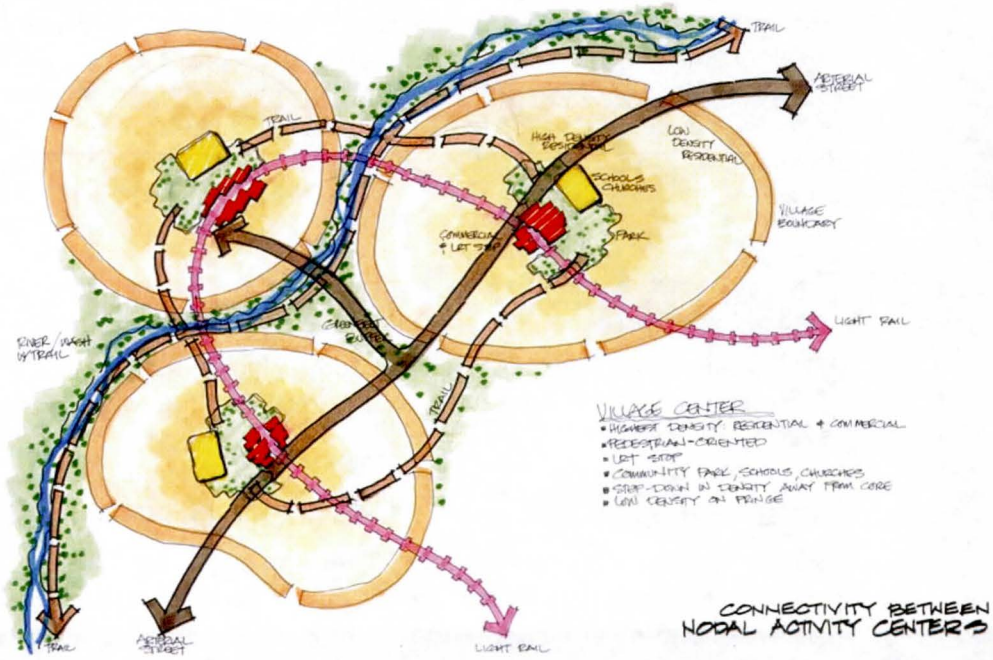
MIXED USE DEVELOPMENT

Mixed use development is encouraged in areas designated on the Proposed Land Use Map along major multimodal corridors within the Buckeye Growth Area, within Downtown Buckeye, and in other designated major activity areas.

> A development may be phased only if the end product contains a combination of residential, commercial and employment uses.

Mixed Use is intended to include a mix of office, retail, high, and urban density residential uses in a master planned, integrated manner. These uses may be located within a development, either horizontally or vertically in form. This may be accomplished on multiple parcels of land with multiple owners as long as the site is planned and developed as one integrated development.

Mixed Use designations are located in areas with an excellent multimodal transportation network to support the intensity of development. Commercial and employment uses that serve the region such as community colleges, hospitals, civic facilities, and major employment/office centers are appropriate examples.



Compatibility with the surrounding neighborhoods is determined by a transition based on scale of development using (but not limited to) articulation in building height, required setbacks, building materials, and building massing.

Alternative modes of transportation (such as light rail, bus, bicycle or pedestrian connections) are required with access and integration of transit facilities into mixed use developments. The provision of shaded sidewalks within and around the development, shaded transit stops, drinking fountains, bicycle lockers, or other accommodations are encouraged. Uses are not segregated; instead, cross access between uses and shared parking opportunities is encouraged.

COMMERCIAL DEVELOPMENT

The commercial designation, as shown on the Land Use Plan, denotes retail areas larger than 20 acres.

Neighborhood Commercial This development type is defined as less than 20 acres and is not shown on the Land Use Plan, but may be included in appropriate land use designations determined by the Town and within the ***Buckeye General Plan*** guidelines. Criteria for locating commercial in non-commercial land use designations may include, but is not limited to market feasibility, adequate access, buffering, and compatibility to surrounding land uses.

Community Commercial This development type is intended to be small-scale (approximately 20 to 40 acres) retail, service, and office that typically serve a 3- to 5-mile market area and service a population of 25,000 to 100,000 people. These commercial uses are intended to have direct access to major roadways.

Regional Commercial This development type is intended to include retail centers that draw from a regional market area such as power centers, big box retail, and auto malls. Other supportive uses include, but are not limited to hotels, theaters, and restaurants. These large-scale commercial developments serve a market area typically greater than 10 miles and more than 100,000 in population. Regional commercial developments must be located on major arterials or higher capacity transportation corridors to ensure good transportation access to support this large-scale development. The area could include supportive professional office employment and business parks.

EMPLOYMENT

Ensuring adequate employment opportunities within the Planning Area is critical for the community's long-term sustainability and to mitigate traffic congestion.

Professional Office Employment Small office-type uses such as attorneys, medical, finance, and real estate with good arterial access and appropriately integrated with residential areas are considered as part of this employment type. In many cases, offices are a good buffer between residential and other higher uses, such as commercial or industrial. Lighting, setback, and the

location of parking must be sensitively designed to minimize any possible negative impacts from these activities or developments.

The definition of quality employment includes the following components:

- Jobs paying wages higher than the Maricopa County average
- Jobs providing full benefits for employees
- Jobs offering continuing educational opportunities
- Employment that provides advancement and career-type jobs
- Employment that is environmentally-safe
- Jobs that are regional wealth generators

Business Park Activities such as office and/or light manufacturing in a planned park-like setting with clustered buildings and inward focused activity are classified as business parks. Uses may include a mix of light industrial, professional offices, office/showroom, office/warehouse, retail support, services, and other related uses.

Industrial Activities such as warehousing, distribution centers, mining or extraction, landfill, large dairy operations and other factory farming activities, recycling, and other heavy industrial uses are classified together as industrial land uses. A compatibility analysis of surrounding land uses and an evaluation to ensure adequate infrastructure including the transportation network and environmental integrity will be required prior to the approval of specific industrial use.

Downtown Buckeye The historic townsite of Buckeye is known as downtown and is considered the heart of the Buckeye Planning Area. Development of this are will be guided by the ***Buckeye General Plan*** Policies, Downtown Buckeye Master Plan, and Downtown Buckeye District Zoning. The intent is to encourage a mix of land uses and increased intensity while creating a well-planned, pedestrian-oriented and multimodal transportation activity center.

Downtown Expansion Area This area is intended to be set aside for major commercial projects that require large parcels footprints not available in existing Downtown Buckeye along Monroe Avenue. Expanding from Downtown, this area will serve as a vital pedestrian-oriented area with multi-story urban buildings that will accommodate a mix of retail, office, and residential uses.

OTHER LAND USES

Several other land use designations exist in Buckeye, including Agriculture, Open Space, Military and Government Center.

Agriculture This land use designation is currently not shown on the Land Use Map. It is not the intent of the Town of Buckeye to eliminate agriculture from the Planning Area prematurely. The Town of Buckeye recognizes agriculture as a farming business and that farming will continue as a viable land use well into the future. Therefore, the Town will ensure that new developments locating near or next to farming operations are aware and steps are taken to protect and buffer the existing agricultural use. Agriculture is an intensive use that may be classified as an industrial land use but may also occur in the Very Low Density Residential classification. The Town will review any new developments for compatibility and appropriateness in relationship to any existing farming operations.

Open Space Areas include public recreational facilities or nature preserves are considered open space. The Buckeye Planning Area's natural beauty has tremendous value and good planning benefits the private property owners as well as the entire area. Open space areas should be left in a natural state due to topographic, drainage, vegetative, and landform constraints or the need to provide buffers between potentially incompatible land uses. The Land Use Plan strives to create a linked open space system through the preservation of washes, public utility easements, and major corridors that link to the regional park and trail systems.

Floodway Transitional Areas as noted in Figure 3-10, Floodways and Floodway Transitional Corridors, are areas where flooding is a potential hazard, or where native flora and fauna habitat may exist due to their proximity to existing and known floodways. These Floodway Transitional Areas are identified by buffering the Federal Emergency Management Administration (FEMA) designated floodway corridor generally by an additional one-quarter mile on either side. It is important to note that these areas are advisory in nature, and that the General Plan land uses designated on the Land Use Map are the allowable uses for those properties. The Town wishes to reiterate the importance of the Floodway Transitional Areas, and strongly encourages that landowners and developers consider, and address, the protection of this important, irreplaceable, resource in their development plans. All landowners have the right to continue to request floodway revisions per the FEMA Map Revision Process. Such requests shall not constitute an amendment to the Town's General Plan.

This will include revisions to the text and to the language in the map.

High Noise or Accident Potential Zones Figure 3-4 Town of Buckeye General Plan Land Use indicates land within the 65 day-night noise level (dnl) contour pertaining to Luke Air Force Base and the Buckeye Airport. Land within the designated 65 dnl adjacent to a military airport or ancillary military facility is restricted by the criteria set forth in A.R.S. 28-8481(J) which outlines appropriate land uses for such land. Any General Plan Amendment of land within these areas must also comply with all requirements as well as the compatible land uses outlined in A.R.S. 28-8481(J). The Town of Buckeye is committed to ensuring that land uses in the high noise or accident potential zones are compatible with the operation of Luke Air Force Base and the Buckeye Airport. Residential uses shown on the land use map in the 65 dnl area for Luke Air Force Base were zoned and had a development plan in place for those uses prior to Dec 31 2000. These properties continue to be subject to A.R.S. 28-8481, but the development plans that have been in place prior to December 31, 2000 for these properties comply with the statute.

MEMORANDUM

To: Dibble Engineering

From: W.C. Scoutten, Inc.

Date: August 14, 2012

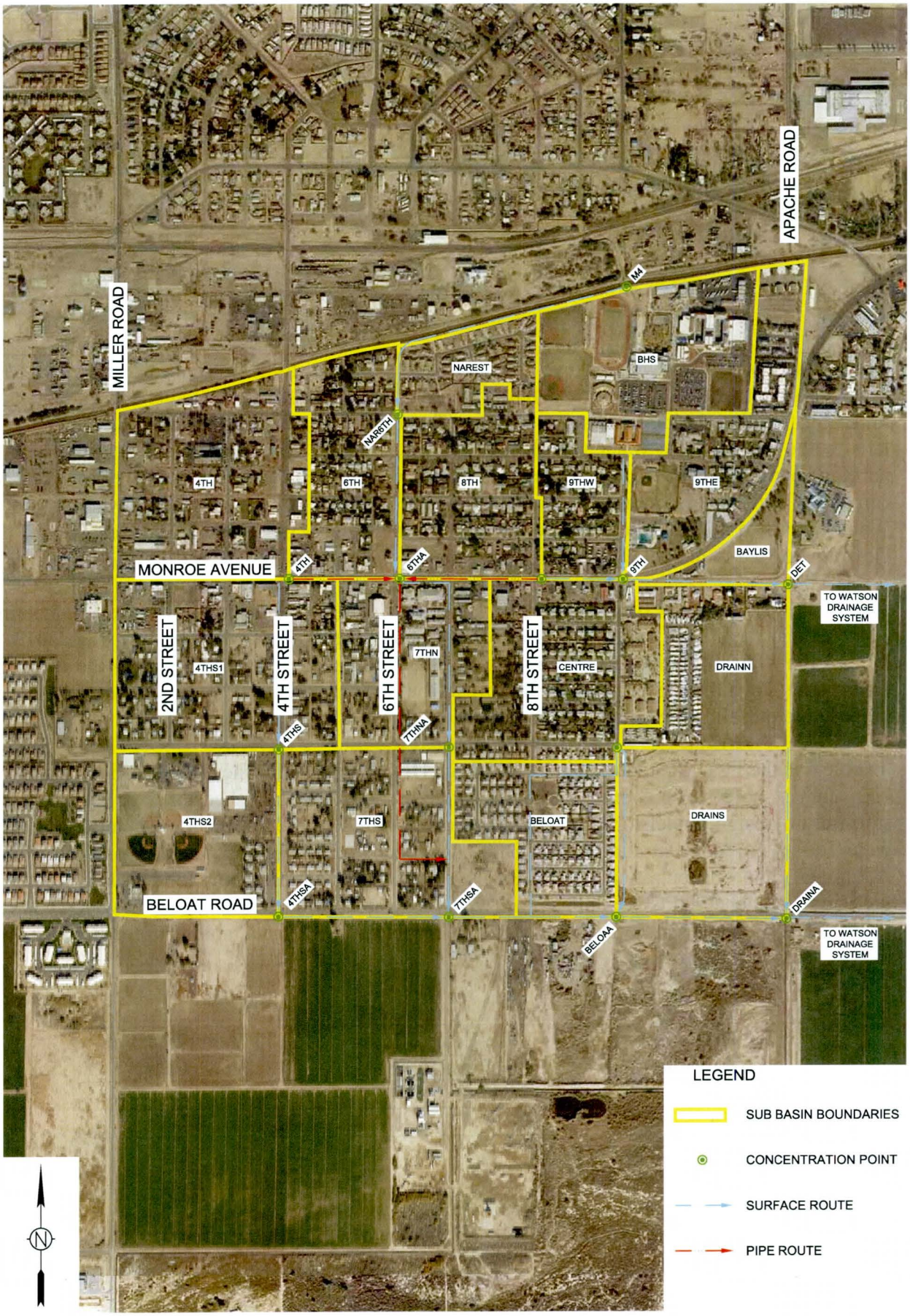
Subject: Downtown Storm Water Outfall

The majority of Downtown Buckeye does not have adequate storm water infrastructure or 100-year, 2-hour retention. This has resulted in flooding during small storm events and the potential for major flooding during large storm events. The topography of the land in the downtown area falls to the south, storm water runoff is conveyed southerly down the various streets running north to south. A majority of the runoff from the downtown area flows towards Beloat Road and converges at the intersection of Beloat Road and 7th Street. The goal of the Downtown Storm Water Plan is to mitigate the storm water flooding and safely convey the storm water out of the Downtown Area to the Gila River.

The Town of Buckeye (Town) and W.C. Scoutten, Inc. (WCS) met with Dibble Engineering (Dibble) and the Flood Control District of Maricopa County (FCDMC) on July 18th, 2012 to discuss the Watson Drainage System. During the meeting the Town brought up the desire to convey the Downtown Storm Water Runoff to the Watson Drainage System channel which is proposed to outfall to the Gila River.

Dibble and the FCDMC requested that WCS run HEC-1 models for the 100-year, 6-hour and the 100-year, 24-hour storm event. The basis of the model was established utilizing the proposed storm drain design model for Downtown Buckeye produced by Dibble. Two points of interest were identified, concentration point DET (Apache Road Alignment and Monroe Avenue Alignment) and concentration point DRAINA (Apache Road Alignment and Beloat Road) as seen on the attached HEC-1 exhibit. The two hydrographs from each storm event were exported to HEC-DSSVue and sent to Dibble via email. Below you will find a table with the flow data for the two concentration points.

HEC-1 Concentration Point	**100-Year, 6-Hour Flow (CFS)**	**100-Year, 24-Hour Flow (CFS)**
DET	188	153
DRAINA	703	535



W.C. Scoutten, Inc.
Municipal Engineers and Planners
1626 North Litchfield Road, Suite 310, Goodyear, AZ 85395
Office (623) 547-4661 Fax (623) 547-4662

BUCKEYE OUTFALL

DOWNTOWN STORM WATER
HEC-1 EXHIBIT
TOWN OF BUCKEYE, ARIZONA

DATE :	AUGUST 14, 2012
DRAWN BY :	P.E.M.
DESIGN BY :	
CHECKED BY :	

Flood Control District
of Maricopa County

INTEROFFICE MEMORANDUM

Date: February 11, 2012

To: Watson Drainage System Pre-Design Project Team

From: Gary Wesch

Subject: Watson/Gila River confluence hydraulics

Purpose

This memorandum is to document assumptions used in the Preliminary Design of the Watson Drainage System for the starting Water Surface Elevations (WSEL) at the confluence of the Watson System with the Gila River.

Background

The Buckeye ADMP proposed the Watson Drainage System component with an outlet to the Gila River coincidental with the existing Watson Drain (owned by BWCDD) that also serves as an outfall for pumped groundwater from waterlogged upstream agricultural properties. This outfall is located adjacent to the Watson Road alignment south of Beloat Road.

The District practice for hydraulic design of confluences of channel with receiving waters is:

1. Assume 100-year WSEL in Gila River with 10-year design flow in Watson channel

2. Assume 10-year WSEL in Gila River with 100-year design flow in Watson channel

The *Salt-Gila River Floodplain Delineation Restudy, Michael Baker, Jr, May 1999* (FCDMC library ref # A126.014.011) provides 100-year floodplain and floodway WSEL information. The 100-year discharge is 210,000 cfs. Cross Sections RS=183.96 and RS=184.05 bracket the existing Watson Drain outfall. The Watson Drain outlets into a braided channel on the north side of the Gila River floodplain.

FCDMC Hydrology & Hydraulic branch staff utilized the HEC-RAS model for the Baker *Delineation Restudy* and ran the model using HEC-RAS version 4.1.0 (current version of HEC-RAS) using a 10-yr discharge of 46,000 cfs per the USACE Section 7 Report for the "With Project" conditions. The 10-yr discharge was simply placed in the model developed for the 100-yr flow conditions and run. There was no attempt to redefine effective/ineffective flow areas based on the 10-yr discharge.

The following table provides the WSEL information for the two Cross Sections:

2801 West Durango Street Phoenix, Arizona 85009 Phone: 602-506-1501 Fax: 602-506-4601

Gila River Cross Section	100-year Floodplain WSEL*	100-year Floodway WSEL*	10-year Floodplain WSEL*
RS=183.96	848.35	848.44	842.10
RS=184.05	848.82	848.89	842.47

*NGVD 1929

Note: Elevation adjustment = -2.10 from NAVD88 to NGVD29 (John Stock, FCDMC).

Enclosures:

Excerpts of *Salt-Gila River Floodplain Delineation Restudy, Michael Baker, Jr. May 1999:*

1. Vol 1 pp 145, 146 Sheets 13 and 13A cross section layout
2. Vol 3 pp 111, 112 cross section profile plots with 100-yr and Floodway WSEL
3. Vol 4 pp 315,675,727,2007, & 2008 HEC-RAS output for 100-yr floodplain and Method 1 floodway
4. Supplemental 10-yr HEC-RAS run Cross Section profile plots

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Flood Control District
of Maricopa County

INTEROFFICE MEMORANDUM

Date: 2/7/2014

To: Watson Drainage System Pre-Design Project Team

From: Jennifer Thorne, P.E., Hydrologist

Subject: Maximum Storm Recurrence Interval to be contained within the Watson Drain

Purpose:

This memorandum is to document the results of a model created to determine the maximum storm contained within the Watson Drain

Procedure:

To determine the maximum storm contained within the Watson Drain, a HEC-RAS model was created for the lower areas of the projects (to approximately Station 40+00). Once created, the starting water surface elevation was increased until the cross section corresponding to station 30+00, the shallowest cross section, was overtopped. This resulted in a starting water surface elevation of 846.43 (NAVD88).

Once this starting water surface was determined, it was compared with the 10-year and 100-year water surface elevations in the Gila River (from the *Salt-Gila River Delineation Restudy, Michael Baker, Jr, May 1999)*, in order to determine the recurrence interval. However, it was soon discovered that the 10- and 100- year water surface elevations listed in the Watson Drainage System Pre-Design plans were based on the NGVD29 datum, not the NAVD88 datum, which the rest of the plans had been designed to. The water surfaces were then converted to NAVD88 and plotted on a log-log chart. Based on those results, it appears that the system will be able to contain the **100-year storm for the system along with the 25 year storm in the Gila River.**

	NGVD29 Elevation	NAVD88 Elevation
Gila 10-yr WSEL	842.35	844.46
Gila 100-yr WSEL	848.51	850.85
WSEL to break out at 30+00		846.43

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Flood Control District
of Maricopa County

INTEROFFICE MEMORANDUM

Date: April 16, 2013

To: Gary Wesch, PE, Project Management Branch, Planning and Project Management Division

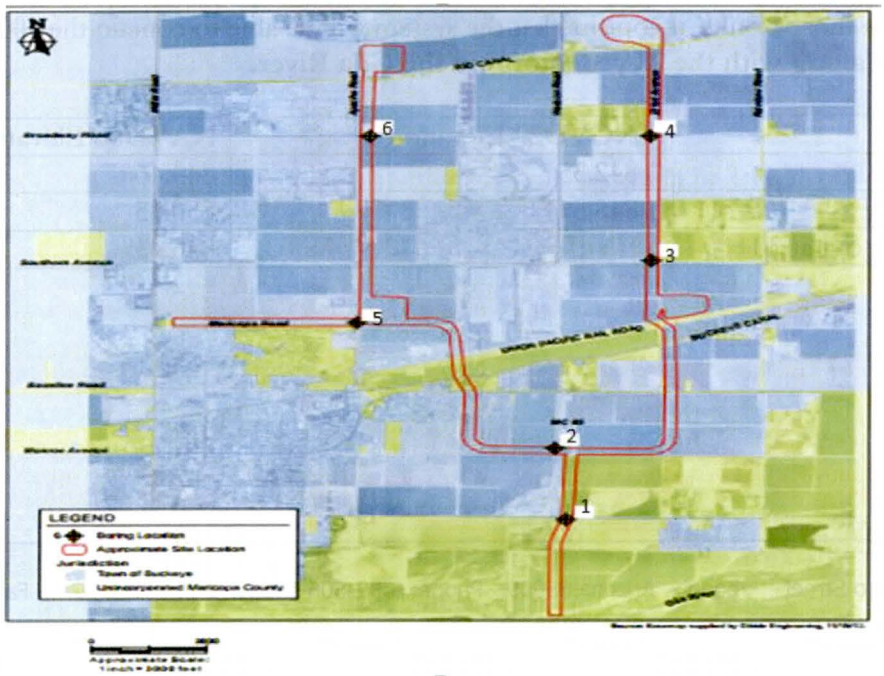
From: Shimin Li, PhD, PE, Engineering Application Development and River Mechanics Branch, Engineering Division

CC: Bing Zhao, PhD, PE, Engineering Application Development and River Mechanics Branch Manager, Engineering Division

Subject: Preliminary Geotechnical Evaluation / Watson Drainage System Pre-Design / Buckeye, Arizona, prepared by Ninyo & Moore Geotechnical and Environmental Sciences Consultants and dated March 18, 2013

The electronic report was received on April 8, 2013. The review is focused on whether a conclusion can be made about maximum permissible velocities. Below are our review comments.

1. **(FCD 4/16/2013):** After analyzing the boring logs and gradation results presented in the report, we found that the fine sand soil classification in Table 6.1 of the Hydraulics Manual (1/28/1996) is the most suitable one to be chosen to represent the soil erosion characteristics of the soils encountered in the six borings. Based on Table 6.1, a maximum permissible velocity of 2.5 ft/s is recommended for fine sand. We recommend a permissible velocity of 2.5 ft/s for the channel reaches represented by the six soil samples that have locations shown in below figure, if these channel reaches will be earthen. The detailed reasons are given as follows.



Soil sample B-1 was collected at a depth range of 3.5 ft to 5 feet and was classified as clay in accordance with Unified Soil Classification System (USCS) based on the gradation test results. In the boring log for this location, the soil at the depth range of 0 ft to 5 ft was classified as Stiff Clay based on field observations. The soil below the Stiff Clay (5 to 10 ft) at this location was classified as Silty Sand based on field observations. Although the permissible velocity for Stiff Clay is 5 ft/s per our effective 1996 hydraulics manual Table 6.1 (see page 2 of this memo), it is recommended to use 2.5 ft/s as the permissible velocity for the segment of channel because the clay layer is not thick and may be removed for channel excavation. Underneath the clay layer, it is all sand. In addition, Dr. Yasanayake at MCDOT (geotechnical engineer) said that the other parameters suggest that it is on the borderline of stiffness, therefore, not really stiff.

Soil sample B-2 was collected at a depth range of 6 ft to 7.5 feet and was classified as clay in accordance with (USCS) based on the gradation test results. In the boring log for this sampling location, the soil at the depth range of 3 ft to 10 ft was classified as Clay with sand based on field observations. The soil above the clay (0 to 3 ft) at this location was classified as Silty Sand based on field observations. Due to the uncertainty in proposed channel depth, we recommend using the least erosion resistant soil parameter for the design. The least erosion resistant soil at this location is Silty Sand. We will assume the erosion resistance of the Silty Sand can be approximated by that of the fine sand listed in Table 6.1 and assign a 2.5 ft/s permissible velocity to the Silty Sand.

Gradation test was not done on samples collected from boring B-3. In the boring log for this sampling location, the soil at the depth range of 0 ft to 3 ft was classified as Silty Sand based on field observations and 3 ft to 10' was classified as clayey sand. We assume the Silty Sand is the least erosion resistant soil at this location and can be approximated by that of the fine sand in Table 6.1.

Soil sample B-4 was collected at a depth from 6 ft to 7.5 feet and was classified as Silty Sand. In the boring log for this sampling location, the soil at the depth range of 0 ft to 1 ft was classified as Silty Sand fill, 1 ft to 8 ft as Silty Sand, and 8 ft to 10 ft as Clayey Sand. The least erosion resistant soil at this location is the Silty Sand fill. We assume again the Silty Sand fill in the boring log can be approximated by the fine sand in Table 6.1 (this assumption is, to some extent, supported by the 0.6 mm D75).

Soil sample B-5 was collected at a depth range of 0 ft to 5 feet and was classified as Clayey Sand in accordance with USCS. In the boring log for this location, the soil at the depth range of 0 ft to 5 ft was classified as Clayey Sand fill, and 5 ft to 10 ft as Clayey Sand. We assume the erosion resistance of Clayey Sand fill is less erosion resistant than the Clayey Sand undisturbed, and can be approximated by that of fine sand in the Table 6.1 (this assumption is not well supported by the 1.75 mm D75, but no other better soil classification can be chosen in Table 6.1).

Soil sample B-6 was collected at a depth range of 6 ft to 7.9 feet and was classified as Clay. In the boring log for this sampling location, the soil at the depth range of 0 ft to

1 ft was classified as Silty Sand fill, 1 ft to 5.5 ft as Silty Sand, 5.5 ft to 10 ft as Sandy Clay. We assume the Silty Sand fill is the least erosion resistant soil at this location and can be approximated by fine sand in Table 6.1

Table 6.1
Maximum Permissible Velocities for Roadside Drainage Channels with Erodible Linings
(USDOT, FHWA, 1961 and 1983)

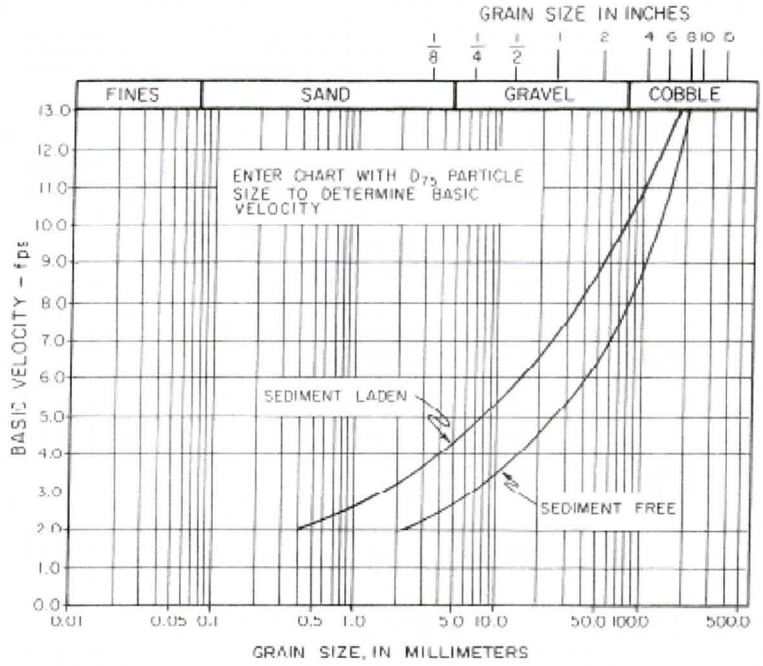
Soils Type of Lining (Earth, No Vegetation)	Permissible Velocity [1], ft/s
Fine Sand (noncolloidal)	2.5
Sandy Loam (noncolloidal)	2.5
Silt Loam (noncolloidal)	3.0
Ordinary Firm Loam	3.5
Fine Gravel	5.0
Stiff Clay (very colloidal)	5.0
Graded, Loam to Cobbles (noncolloidal)	5.0
Graded, Silt to Cobbles (noncolloidal)	5.5
Alluvial Silts (noncolloidal)	3.5
Alluvial Silts (colloidal)	5.0
Coarse Gravel (noncolloidal)	6.0
Cobbles and Shingles	5.5
Shales and Hard Pans	6.0

(1) For sinuous channels multiply permissible velocity by:
0.95 for slightly sinuous;
0.90 for moderately sinuous; and
0.80 for highly sinuous

Summary of Maximum Permissible / Allowable /Recommended Permissible Velocity Results

Boring or Sample ID	Boring Location	Log Depth (ft)	Sample Depth (ft)	Soil Type (USCS)	[1]V_{mp} (ft/s)	D75 (mm)	[2]V_a (ft/s)	[3]V_{rp} (ft/s)
B1	Intersection of Beloat RD and Watson RD	0-5.5	3.5-5 (driven)	Stiff CL (Clay)	5		[7]Not applica ble.	2.5
		5.5 to 10	NST (Not sampled/tes ted)	SM (Silty Sand)	[4]?	[5]?	[6]?	2.5
B2	Intersection of Monroe Ave and Watson RD	0-3	NST	SM	?	?	?	2.5
		3-10	6-7.5 (driven)	CL	5		Not applica ble	2.5
B3	Intersection of Southern Ave and 231st Ave	0-3	NST	SM	?	?	?	2.5
		3-10	NST	SC (Clayey Sand)	?	?	?	2.5
B4	Intersection of Broadway RD and 231st Ave	0-1	NST	Fill w/ SM	?	?	?	2.5
		1-8	6-7.5 (driven)	SM	?	0.6	2.3	2.5
		8-10	NST	SC	?	?	?	2.5
B5	Intersection of Maricopa RD and Apache RD	0-5.5	0-5 (bulk sample)	Fill w/SC	?	1.7	3.0	2.5
		5.5-10	NST	SC	?	?	?	2.5
B6	Intersection of Broadway RD and Apache RD	0-1	NST	Fill w/SM	?	?	?	2.5
		1-5.5	NST	SM	?	?	?	2.5
		5.5-10	6-7.9 (driven)	CL	?	0.6	2.3	2.5

[1] V_{mp}: Maximum permissible velocity in accordance with Table 6.1 of Hydraulics Manual (January 28, 1996).
[2] V_a: Allowable velocity in accordance with USDA Soil Conservation Services relationship (see page 5)
[3] V_{rp}: Recommended permissible /allowable velocity for the boring location after considering the uncertainty in soil classifications and in channel bottom depths, and the need to be conservative.
[4]?: V_{mp} cannot be determined from Table 6.1 based on the USCS soil classification.
[5]?: D75 is not known due to no gradation test done.
[6]?: V_a cannot be determined due to unknown D75.
[7]Not applicable: The USDA Soil Conservation Services relationship appears applicable only to soils having a D75 $\geq$ 0.4mm for sediment laden flow.



BASIC ALLOWABLE VELOCITY FOR EARTHEN CHANNELS

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

VALUE ANALYSIS REPORT

WATSON DRAINAGE SYSTEM 15% PRE-DESIGN PHASE

JULY 2, 2013

Gary Wesch, P.E.

VALUE ANALYSIS WORKSHOP 6/17-18/2013

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VALUE ANALYSIS SUMMARY-WATSON DRAINAGE SYSTEM

The Value Analysis (VA) for Watson Drainage System Pre-Design was conducted June 17-18, 2013. Participants included Town of Buckeye (TOB) management and Flood Control District of Maricopa County (FCDMC) staff. See Appendix A for attendees list. John Pucetas of SiteTek Financial Arts was retained by FCDMC to facilitate the VA. He had prepared for the VA but passed away the weekend prior to the VA session. The participants self-conducted the VA using principles learned in previous project VA's. This report summarizes the proposals in a format similar to previous VA efforts.

PROJECT DESCRIPTION

The Watson Drainage System is a component of the 2009 Buckeye ADMP. The ADMP recommended a system of basins and channels extending from the Roosevelt Irrigation District (RID) canal to the Gila River between Miller Road and Rainbow Road in the eastern portion of the Town of Buckeye. The system will address some existing flood hazards and accommodate future development within the 22 square mile watershed.

In 2012 and in partnership with the Town of Buckeye, FCDMC commenced a Pre-Design effort for the Watson Drainage System with Dibble Engineering the prime consultant. Alternatives were identified and evaluated and in April 2013, Alternative A was selected as the recommended plan. The VA developed proposals for refinements of Alternative A to improve effectiveness and/or reduce project costs.

ORIGINAL RECOMMENDED PLAN

The Alternative A original recommended plan:

1. Major components: 10+ miles of channels/storm drains and five detention basins
2. Estimated cost $58 million plus 30% contingencies of $18 million
3. The TOB CIP 2010 prioritization request proposed the Town implement the upstream (North) portion general north of the Union Pacific Railroad (UPRR) and FCDMC implement the downstream (Outfall) portion based on an approximate 50-50 split of estimated costs. Alt A estimates resulted in a $30 M TOB North portion and a $28 M FCDMC Outfall portion. The Outfall includes a channel running about 2 miles east-west along the north side of the UPRR; crossing the UPRR/BWCDD corridor where the alignment crosses the UPRR, Kinder-Morgan (KM) petroleum pipeline, several fiber optic lines, the Arizona Nuclear Power Plant (ANPP) 96" reclaimed water pipeline, and the Buckeye Water Conservation and Drainage District (NWCDD) canal. The Outfall continues south from the UPRR/BWCDD corridor to the Gila River, is co-located with BWCDD's existing Watson Drain, and crosses properties owned by sand and gravel extracting companies.
4. Cost breakdown (without contingencies) :

$	5,886,863	10%
$	15,882,243	27%
$	9,994,926	17%
$	8,432,296	14%
$	18,298,954	31%
$	58,495,281	TOTAL

VA PROPOSALS

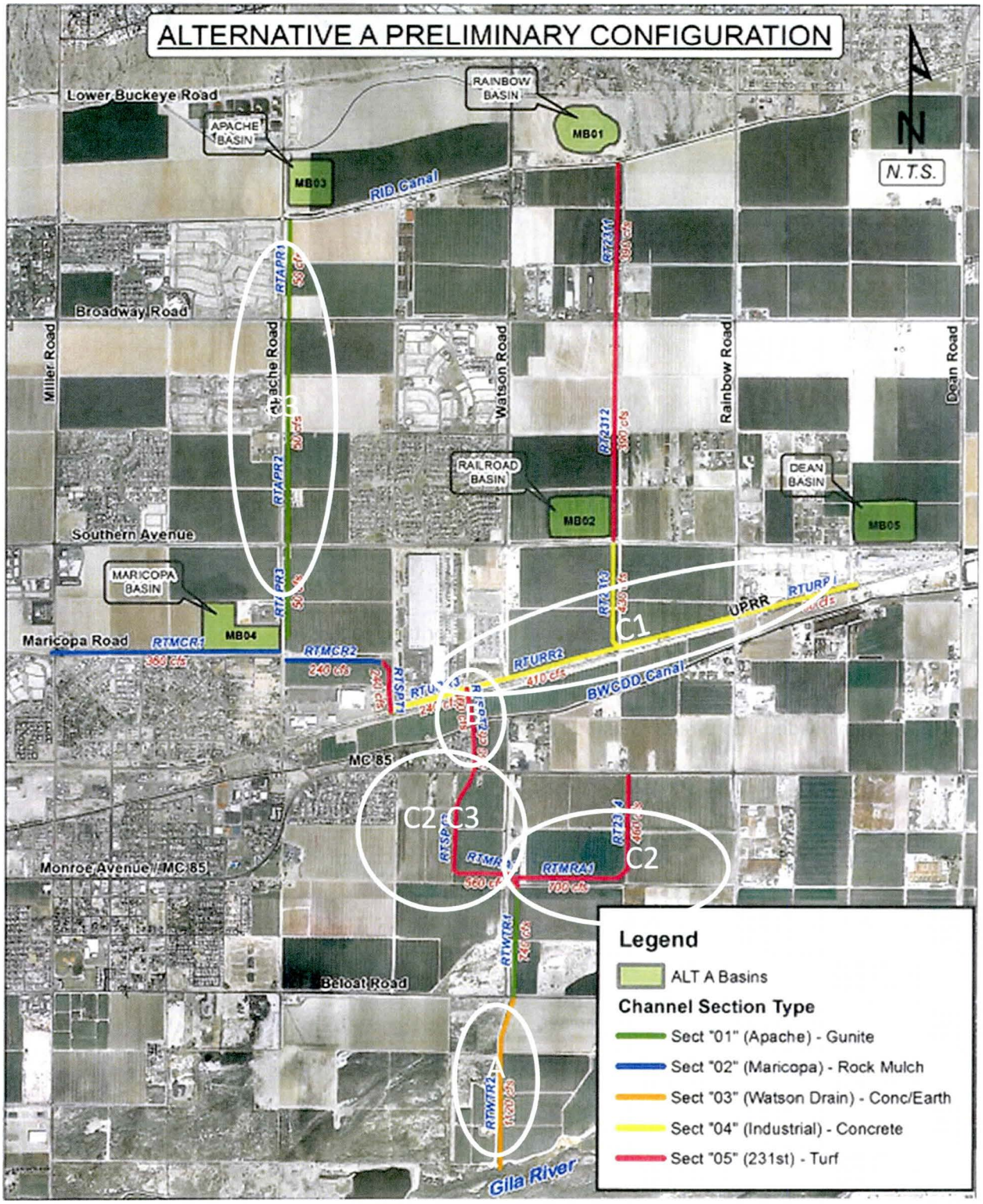
The VA team identified the following focus areas for identification and analysis of VA opportunities:

A-The outlet to the Gila River through future sand & gravel extraction properties
B-The crossing of the UPRR/BWCDD corridor where significant relocations are anticipated
C-Miscellaneous items including:
- C1- PCC channel north of UPRR
- C2- Interim conditions channel linings for turf reaches
- C3- Water quality treatments for adjacent roadway first flush

The VA team divided into three groups to analyze each set of subject areas:

Group A: Art Glover, Mark Lewis, Shimin Li
Group B: Scott Zipprich, Kevin Roberts, Mike Duncan
Group C: John Griffin, Richard Waskowsky, Gary Wesch, Jeff Riddle

Each group developed several proposals and analyzed potential costs. These are summarized in Table 1.



VA PROPOSALS SUBJECT AREAS

TABLE 1: SUMMARY OF VA PROPOSALS

PROPOSAL	DESCRIPTION	ORIGINAL PLAN COST $	PROPOSAL COST $	POTENTIAL SAVING $	ADOPT ?	COMMENT
A-A	Outlet to Gila R Opt A	4,573,471	2,254,900	2,318,600	Yes, if agreements done	Needs BWCDD & Cemex agreements
A-A W/ BASIN	Outlet to Gila R Opt A w/basin	4,573,471	3,897,900	675,600	Possibly	Basin reduces impact to existing Watson Drain
A-B	Outlet to Gila R Opt B	4,573,471	6,547,000	(1,973,500)	No	More costly
A-C	Outlet to Gila R Opt C	4,573,471	5,316,000	(742,529)	No, but good fallback	More costly
B-1	No relocation K-M & FO	1,080,000	0	1,080,000	unlikely	Depends on pothole information
B-2	Separate tailwater from drainage	NA	NA	NA	probably	Pending detailed design
B-3	Temporary diversion of BWCDD canal	337,500	101,500	236,000	maybe	
B-4	Box culvert vs channel BWCDD-MC85	4,017,800	3,496,500	521,300	Needs further study	Savings only if channel results in severance
C-1	Steeper side slopes and thinner section on concrete channel	10,039,517	7,741,800	2,297,700	Yes	Add fencing or railings
C-2	Interim condition initial channel construction instead of turf	1,704,100	1,134,300	569,800	Yes	
C-2 w/ rock mulch	Interim with rock mulch	1,704,100	1,635,700	68,400	No	
C-3	Water Quality treatments	NA	NA		Yes	No significant cost to adopt

CONCLUSIONS AND RECOMMENDATION

The Value Analysis identified potential savings of over $7 million to the $58 million original project, about 12%. The following proposals should be considered for inclusion in the Pre-Design Recommended Plan if the conditional considerations can be satisfied:

A-A: Utilize the existing Watson Drain south of Piedmont Road alignment, upgrade the existing culverts and terminate major channelization at Piedmont. This is conditional on working out agreements with BWCDD, Cemex, and Town of Buckeye. The impact on the future El Rio levee should be considered.

B-2: Separate irrigation tailwater collection and delivery from stormwater conveyance where necessary to maintain delivery hydraulic grade requirements. This may require additional piping, overshoots, or flumes but avoids pumping costs. Meet with BWCDD and RID to discuss this.

C-1: Modify typical section for Industrial channel to minimize concrete lining thickness and topwidth.

C-2: Pre-design to show interim channel lining in Outfall reaches based on non-irrigated hydroseeding, collection swales, reinforced downdrains, and grade control structures. Follow up with revised typical sections and a detailed reach example for review by design team to verify feasibility and effectiveness.

C-3: The channel designs for reaches adjacent to roadways should accommodate first flush basins to be constructed with future road improvements. Coordinate the overflows of first flush basins with collection swales and downdrains.

The following proposals need further design development and review to determine whether potential costs savings can be realized:

B-3: A temporary diversion of the BWCDD canal may be cost effective if ROW can be reduced. This requires follow up with BWCDD, constructability analysis, and further review by real estate staff. This can be considered in final design when more design development has been completed and more information is available.

B-4: A box culvert versus a channel may result in cost savings if the channel requires compensation for severance. Further collaboration by the design team with real estate staff will determine if this proposal should be adopted.

APPENDIX A-Participants

Attendees:

Name	Firm
Kevin Roberts	Dibble Corp
John Griffin	EPG
Michael Duncan	FCDMC (1st Day)
Art Glover	FCDMC
Jeff Riddle	FCDMC (1st Day)
Mark Lewis	FCDMC
Scott Zipprich	Buckeye
Richard M. Waskowsky	FCDMC
Shimin Li	FCDMC
Gary Wesch	FCDMC

VALUE ANALYSIS

APPENDIX B- DETAILED VA PROPOSALS AND ESTIMATES

Value Analysis Study Recommendation

Project: **Watson Drainage System** — **VA No.**

Item: **A- Outlet to Gila River, Option A** — **A-A**

Function (verb noun): ***Control Flooding***

Original Design

Reach RTWTR2: Channel from Beloat to Gila River onto AZ G&F-owned parcels, co-located with existing BWCDD Watson Drain; side slopes shallowed to 6H:1V; concrete invert for low flows; multi-use path both side; 320 ft-wide ROW required; crosses Cemex-owned property-ROW cost include mineral rights for lost material mining; future mining will create a lake that results in channel remaining across lake or thrown away; culvert required to maintain irrigation pipe across channel and connet west Cemex parcel to east parcel; earth-moving equipment would cross between parcels over culvert in conflict with maintenance and trail users.

Proposed Design

Utilize existing BWCDD Watson Drain from Cemex north property line south to Gila River as interim channel, replace existing pipe culverts to carry 1100 cfs design flow.

Advantages and Disadvantages

Advantages:

- avoids most costs of "throw-away" channel
-
-
-
-

Value Indicator:

Disadvantages:

- dependent on working deals with BWCDD & Cemex, may not be feasible
- no trail connection to Gila River along channel, existing side slopes substandard
-
-

Discussion

Existing Watson Drain has capacity for 1100 cfs design flow if existing pipes at farm road/irrigation crossing are upsized. Option A Using existing Watson Drain for interm conveyance until Cemex mines a lake avoids builidng a "throw-away" channel. Timing of Cemex mining depends on the market for sand & gravel. FCDMC/TOB and BWCDD need to have agreement where BWCDD allows increased drainage flows in existing ditch and increased maintenance of earthlined ditch is likely. After the VA, this concept was presented to BWCDD and the reponse was promising. The cost of potentially acquirin BWCDD rights was esitmated to $350k.

Life Cycle Cost Summary

	Initial Cost	Life Cycle Cost
Original Design	**4,573,471**	
Proposed Design	**2,254,900**	**0**
Potential Savings	**2,318,600**	**#VALUE!**

Sketch Worksheet

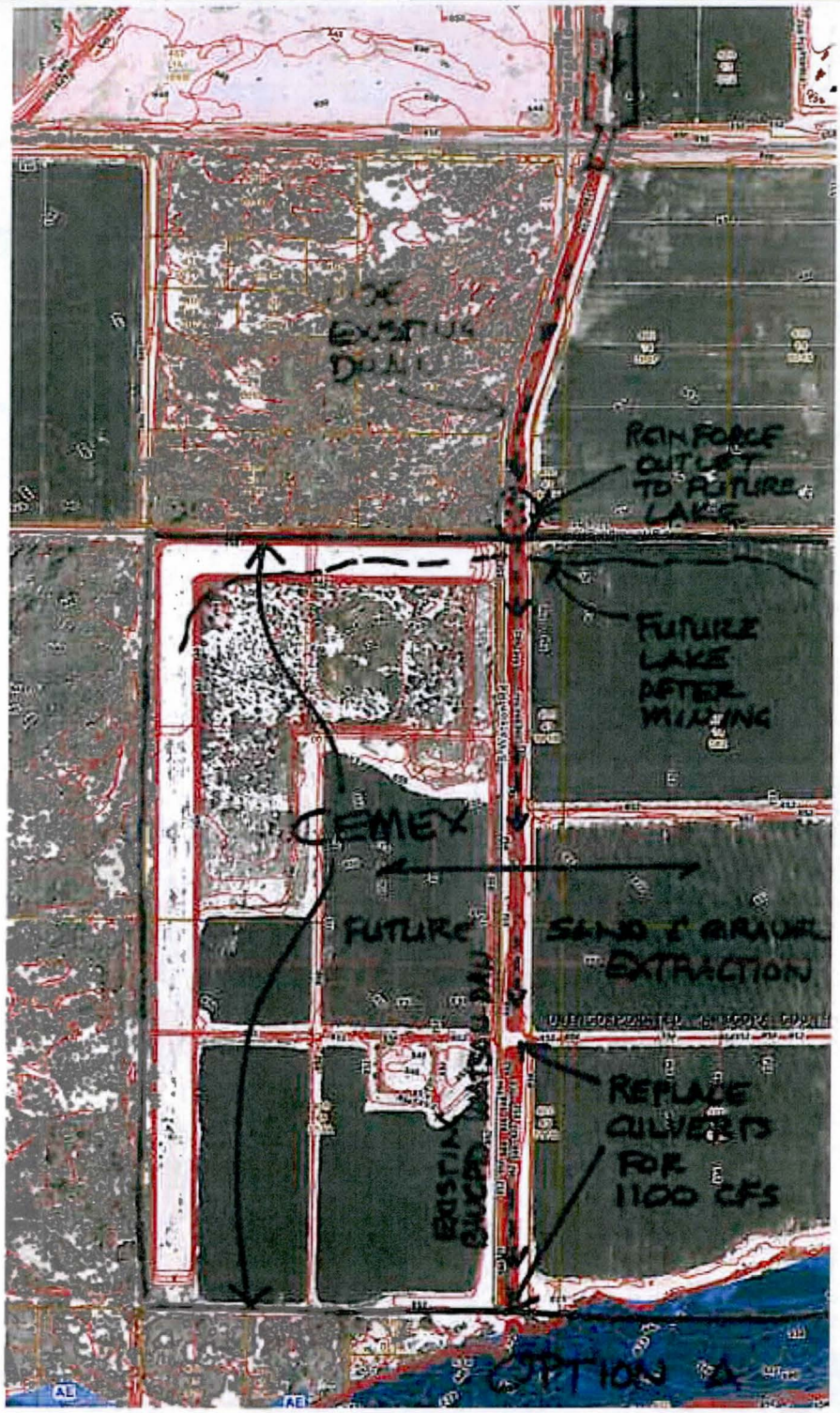
Project: Watson Drainage System

Item: A- Outlet to Gila River, Option A

VA No.
A-A

Function (verb noun): *Control Flooding*

■ Original Design ☐ Proposed Design



Cost Worksheet

Project: **Watson Drainage System** | **VA No.**
Item: **A- Outlet to Gila River, Option A** | **A-A**

Function (verb noun): ***Control Flooding***

Original Design reach RTWTR2

Dibble Alt A estimate w/o contingencies	3,606,204
Mineral Rights for Cemex	967,267
Total Cost	**$4,573,471.00**

Proposed Design

ID			Quantity	Unit	Unit Cost	Total
201		Clear and Grub	1	LS	$16,055.00	16,055
205		Misc. Removals	1	LS	$8,030.00	8,030
207		Replace Pavement	0			
215		Remove Pipe	464	LF	$21.00	9,744
220		Ditch	157	LF	$30.00	4,710
252		Relocation (30")	310	LF	$109.00	33,790
301		Excavation	20843	CY	$6.00	125,058
305		Preparation	14788	SY	$6.30	93,164
317		Riprap (D50 = 12")	1	LS	$86,000.00	86,000
319		Riprap (D50 = 18")	1	LS	$230,000.00	230,000
331		PCC invert (8" thick)	1571	SY	$99.00	155,529
339		Weep holes	236	EA	$10.00	2,360
342		Concrete Cutoff wall	2600	CY	$4.70	12,220
343		Structure	2	EA	$31,000.00	62,000
344		Wall (3x15x200)	2	EA	$30,000.00	60,000
351		AC Maintenance Road	2082	SY	$15.80	32,896
428		**CMP pipe** (not 10 x 6 CBC)			$67,000.00	67,000
458		**CMP End Treatments** (not 10 x 4 Concrete Wing Walls)			$10,400.00	10,400
602		Hydroseed	30633	SY	$0.34	10,415
610		Tree (24" Box)	134	EA	$184.00	24,656
613		gal)	268	EA	$22.00	5,896
614		gal)	402	EA	$10.90	4,382
630		(3.5x2.5x2)	67	EA	$119.00	7,973
631		Boulder4x3x2.5)	40	EA	$153.00	6,120
		Low Density Residential F	557,700	SF	$1.50	836,550
		BWCDD rights	1	LS	$350,000.00	350,000
Subtotal						2,254,948
Markup	#REF!		0.0%			0
	0				**Total Cost**	**2,254,900**

Potential Savings

Potential Savings	**2,318,600**

Value Analysis Study Recommendation

Project: **Watson Drainage System** — **VA No.**

Item: **A- Outlet to Gila River, Option A with basin** — **A-A w basin**

Function (verb noun): ***Control Flooding***

Original Design

Reach RTWTR2: Channel from Beloat to Gila River onto AZ G&F-owned parcels, co-located with existing BWCDD Watson Drain; side slopes shallowed to 6H:1V; concrete invert for low flows; multi-use path both side; 320 ft-wide ROW required; crosses Cemex-owned property-ROW cost include mineral rights for lost material mining; future mining will create a lake that results in channel remaining across lake or thrown away; culvert required to maintain irrigation pipe across channel and connect west Cemex parcel to east parcel; earth-moving equipment would cross between parcels over culvert in conflict with maintenance and trail users.

Proposed Design

Utilize existing BWCDD Watson Drain from Cemex north property line south to Gila River as interim channel, replace existing pipe culverts to carry 360 cfs design flow. Acquire 35 AC land and construct an off-line 159 AF basin south of Beloat to reduce 1100 cfs design flow to 360 cfs, the existing condition flows intercepted by existing Watson Drain per the ADMP.

Advantages and Disadvantages

Advantages:

- avoids most costs of "throw-away" channel
- compared to Option A, reduced outflows match existing conditions
- potential water quality treatment
-
-

Value Indicator:

Disadvantages:

- dependent on working deals with BWCDD and Cemex
- no trail connection to Gila River
-
-

Discussion

advantages of Option A with reduced impact on existing Watson Drain due to lower outflows; potential to treat pollutants if low flows diverted to basin for wetland-type treatment

Life Cycle Cost Summary

	Initial Cost	Life Cycle Cost
Original Design	**4,573,471**	
Proposed Design	**3,897,900**	**0**
Potential Savings	**675,600**	**#VALUE!**

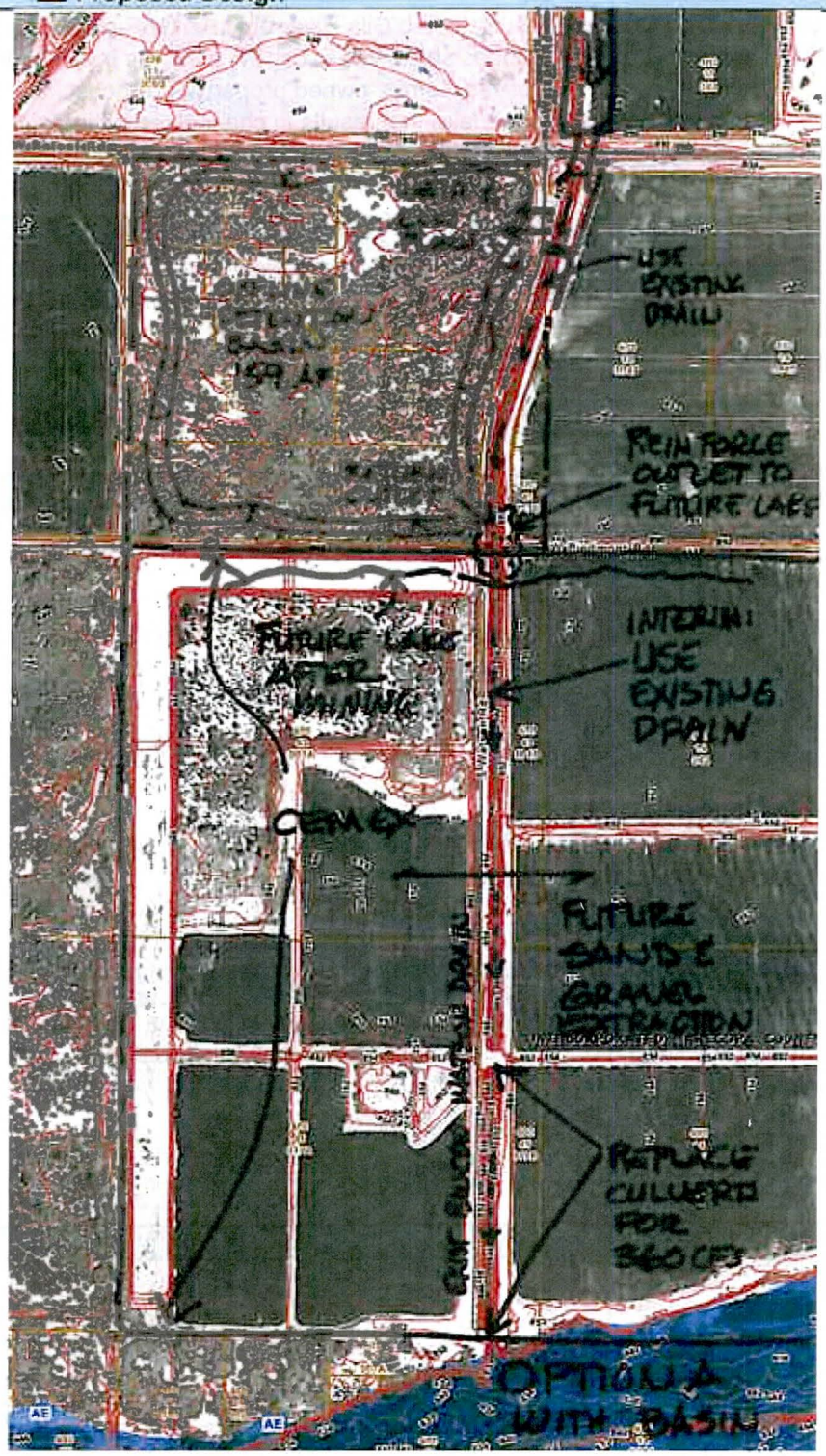
Sketch Worksheet

Project: **Watson Drainage System** **VA No.**

Item: **A- Outlet to Gila River, Option A with basin** **A-A w basin**

Function (verb noun): ***Control Flooding***

■ Original Design □ Proposed Design



Cost Worksheet

Project: **Watson Drainage System** | **VA No.**

Item: **A- Outlet to Gila River, Option A with basin** | **A-A w basin**

Function (verb noun): ***Control Flooding***

Original Design reach RTWTR2

Dibble Alt A estimate w/o contingencies	3,606,204
Mineral Rights for Cemex	967,267
Total Cost	**$4,573,471.00**

Proposed Design

ID			Quantity	Unit	Unit Cost	Total
201		Clear and Grub	1	LS	$16,055.00	16,055
205		Misc. Removals	1	LS	$8,030.00	8,030
207		Replace Pavement	0			
215		Remove Pipe	464	LF	$21.00	9,744
220		Ditch	157	LF	$30.00	4,710
252		Relocation (30")	310	LF	$109.00	33,790
301		Excavation	77503	CY	$6.00	465,018
305		Preparation	14788	SY	$6.30	93,164
317		Riprap (D50 = 12")	1	LS	$106,000.00	106,000
319		Riprap (D50 = 18")	1	LS	$275,000.00	275,000
331		PCC invert (8" thick)	1571	SY	$99.00	155,529
339		Weep holes	236	EA	$10.00	2,360
342		Concrete Cutoff wall	2600	CY	$4.70	12,220
343		Structure	2	EA	$31,000.00	62,000
344		Wall (3x15x200)	2	EA	$30,000.00	60,000
351		AC Maintenance Road	10295	SY	$15.80	162,661
428		**CMP** pipe (not 10 x 6 CBC)			$67,000.00	67,000
458		**CMP End Treatments** (not 10 x 4 Concrete Wing Walls)			$10,400.00	10,400
602		Hydroseed	30633	SY	$0.34	10,415
610		Tree (24" Box)	134	EA	$184.00	24,656
613		gal)	268	EA	$22.00	5,896
614		gal)	402	EA	$10.90	4,382
630		(3.5x2.5x2)	67	EA	$119.00	7,973
631		Boulder4x3x2.5)	40	EA	$153.00	6,120
		Low Density Residential F	1,529,827	SF	$1.50	2,294,741
		Mineral Rights		SF	$1.13	0
Subtotal						3,897,864
Markup	#REF!		0.0%			0
	0				**Total Cost**	**3,897,900**

Potential Savings

Potential Savings	**675,600**

Value Analysis Study Recommendation

Project: **Watson Drainage System** **VA No.**

Item: **A- Outlet to Gila River, Option B route channel on Cemex property around mining area** **A-B**

Function (verb noun): ***Control Flooding***

Original Design

Reach RTWTR2: Channel from Beloat to Gila River onto AZ G&F-owned parcels, co-located with existing BWCDD Watson Drain; side slopes shallowed to 6H:1V; concrete invert for low flows; multi-use path both side; 320 ft-wide ROW required; crosses Cemex-owned property-ROW cost include mineral rights for lost material mining; future mining will create a lake that results in channel remaining across lake or thrown away; culvert required to maintain irrigation pipe across channel and connect west Cemex parcel to east parcel; earth-moving equipment would cross between parcels over culvert in conflict with maintenance and trail users.

Proposed Design

Uses same channel design as original design, routes alignment around north and west sides of Cemex inside Cemex property to avoid cost of culvert and leave mining area unencumbered by the channel; longer route

Advantages and Disadvantages

Advantages:

- avoids conflict with future mining and lake
- avoids outletting onto AZ G&F parcels
- Avoids culvert cost
- provides a facility that connects to river permanently
-

Value Indicator:

Disadvantages:

- longer route
- more expensive, no savings
-
-

Discussion

Option B is a feasible but more expensive option since it allows the channel to be out of the future pond, is completely in FCD's control and the Town of Buckeyes in the future and it has no construction traffic crossing.

Life Cycle Cost Summary

	Initial Cost	Life Cycle Cost
Original Design	**4,573,471**	
Proposed Design	**6,547,000**	**0**
Potential Savings	**(1,973,500)**	**#VALUE!**

Sketch Worksheet

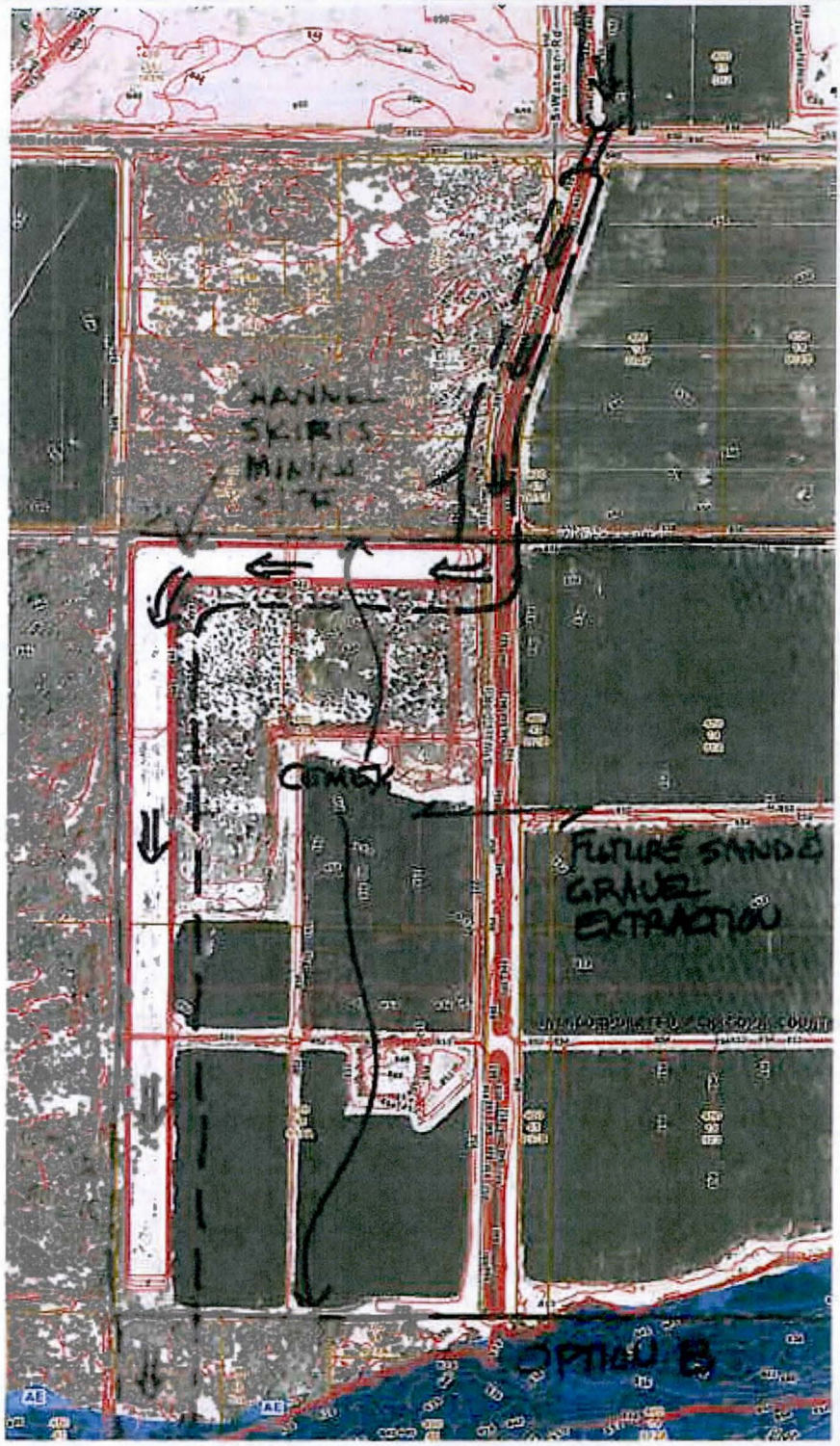
Project: Watson Drainage System

Item: A- Outlet to Gila River, Option B route channel on Cemex property around mining area

VA No. A-B

Function (verb noun): *Control Flooding*

■ Original Design ☐ Proposed Design



Cost Worksheet

Project: **Watson Drainage System** **VA No.**

Item: **A- Outlet to Gila River, Option B route channel on Cemex property around mining area** **A-B**

Function (verb noun): ***Control Flooding***

Original Design reach RTWTR2

Dibble Alt A estimate w/o contingencies	3,606,204
Mineral Rights for Cemex	967,267
Total Cost	**$4,573,471.00**

Proposed Design

ID			Quantity	Unit	Unit Cost	Total
201		Clear and Grub	1	LS	$16,055.00	16,055
205		Misc. Removals	1	LS	$8,030.00	8,030
207		Replace Pavement	0			
215		Remove Pipe	464	LF	$21.00	9,744
220		Ditch	157	LF	$30.00	4,710
252		Relocation (30")	310	LF	$109.00	33,790
301		Excavation	62531	CY	$6.00	375,186
305		Preparation	44364	SY	$6.30	279,493
317		Riprap (D50 = 12")	920.7	LS	$52.00	47,876
319		Riprap (D50 = 18")	2761	LS	$46.00	127,006
331		PCC invert (8" thick)	4713	SY	$99.00	466,587
339		Weep holes	706	EA	$10.00	7,060
342		Concrete Cutoff wall	7070	CY	$4.70	33,229
343		Structure	114	EA	$270.00	30,780
344		Wall (3x15x200)	78.62069	EA	$2,100.00	165,103
351		AC Maintenance Road	2082	SY	$15.80	32,896
???		Gila River Outfall CO Wall (3x15x200)		LS	$67,000.00	67,000
???		AC Maintenance Road		LS	$10,400.00	10,400
602		Hydroseed	91899	SY	$0.34	31,246
610		Tree (24" Box)	402	EA	$184.00	73,968
613		gal)	804	EA	$22.00	17,688
614		gal)	1206	EA	$10.90	13,145
630		(3.5x2.5x2)	201	EA	$119.00	23,919
631		Boulder4x3x2.5)	121	EA	$153.00	18,513
		Low Density Residential F	1,698,404	SF	$1.50	2,547,606
		Mineral Rights	$1,872,000	SF	$1.13	2,106,000
Subtotal						6,547,031
Markup	#REF!		0.0%			0
	0				**Total Cost**	**6,547,000**

Potential Savings

Potential Savings	**(1,973,500)**

Value Analysis Study Recommendation

Project: **Watson Drainage System** **VA No.**

Item: **A- Outlet to Gila River, Option C route channel around Cemex property** **A-C**

Function (verb noun): ***Control Flooding***

Original Design

Reach RTWTR2: Channel from Beloat to Gila River onto AZ G&F-owned parcels, co-located with existing BWCDD Watson Drain; side slopes shallowed to 6H:1V; concrete invert for low flows; multi-use path both side; 320 ft-wide ROW required; crosses Cemex-owned property-ROW cost include mineral rights for lost material mining; future mining will create a lake that results in channel remaining across lake or thrown away; culvert required to maintain irrigation pipe across channel and connect west Cemex parcel to east parcel; earth-moving equipment would cross between parcels over culvert in conflict with maintenance and trail users.

Proposed Design

Uses same channel design as original design, routes alignment around north and west sides of Cemex to avoid cost of culvert, mineral rights; longer route

Advantages and Disadvantages

Advantages:

- avoids Cemex, reduces ROW cost for mineral rights
- avoids outletting onto AZ G&F parcels
- avoids conflict with future mining and lake
- provides a facility that connects to river permanently
- feasible option if no agreement with Cemex & AZ G&F possible

Value Indicator:

Disadvantages:

- longer route
- more expensive, no savings
-
-

Discussion

Option C is a realistic option since it allows the channel to be out of the future pond and is near the same cost as the original alignment A but the advantage is completely in FCD's control and the Town of Buckeyes in the future and it has no construction traffic crossing which removes it from Cemex property.

Life Cycle Cost Summary

	Initial Cost	Life Cycle Cost
Original Design	**4,573,471**	**4,573,471**
Proposed Design	**5,316,000**	**5,316,000**
Potential Savings	**(742,500)**	**(742,529)**

Sketch Worksheet

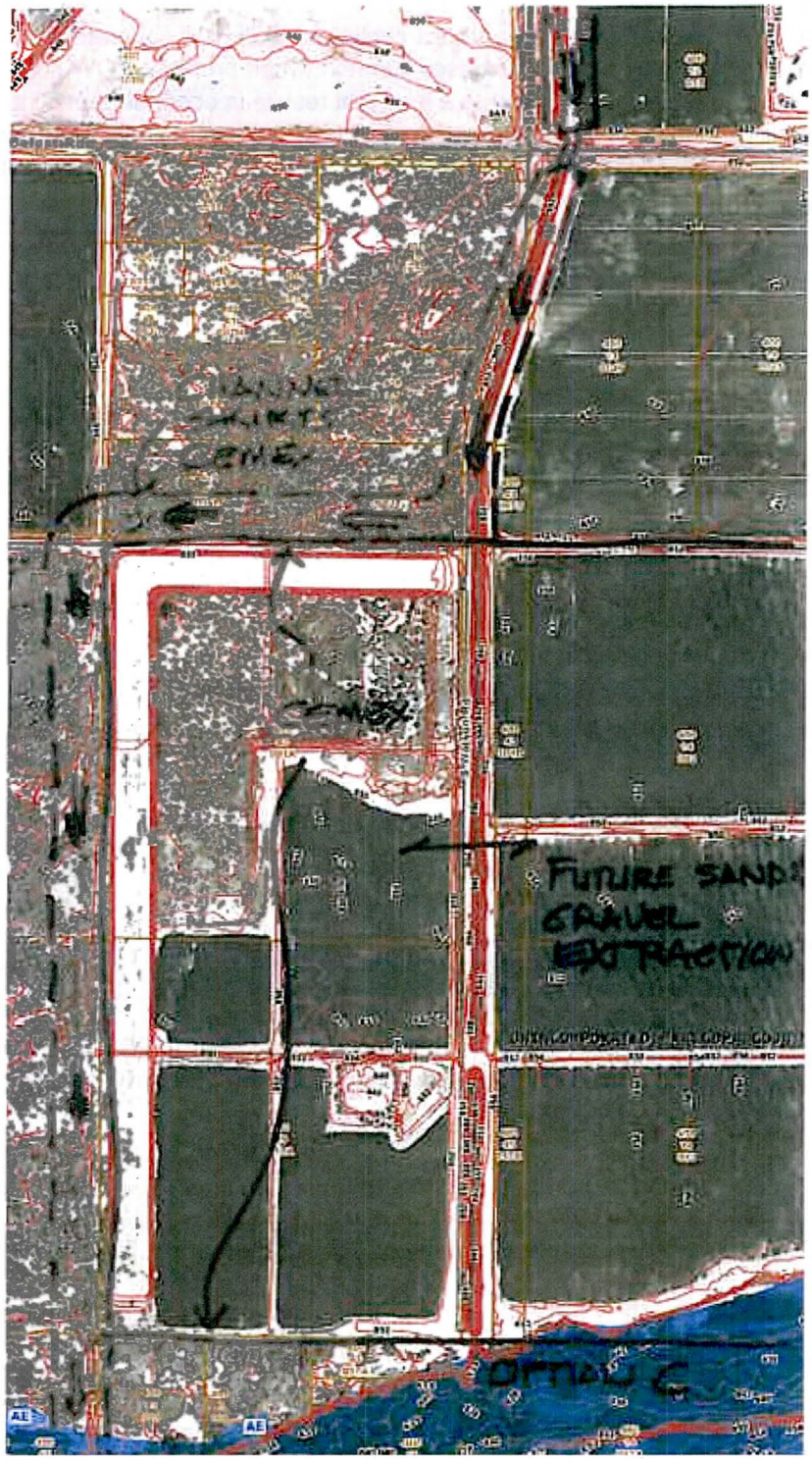
Project: Watson Drainage System

Item: A- Outlet to Gila River, Option C route channel around Cemex property

VA No. A-C

Function (verb noun): *Control Flooding*

■ Original Design ☐ Proposed Design



Cost Worksheet

Project: **Watson Drainage System** **VA No.**

Item: **A- Outlet to Gila River, Option C route channel around Cemex property** **A-C**

Function (verb noun): ***Control Flooding***

Original Design reach RTWTR2

Dibble Alt A estimate w/o contingencies	3,606,204
Mineral Rights for Cemex	967,267
Total Cost	**$4,573,471.00**

Proposed Design

ID			Quantity	Unit	Unit Cost	Total
201		Clear and Grub	1	LS	$16,055.00	16,055
205		Misc. Removals	1	LS	$8,030.00	8,030
207		Replace Pavement	0			
215		Remove Pipe	464	LF	$21.00	9,744
220		Ditch	157	LF	$30.00	4,710
252		Relocation (30")	310	LF	$109.00	33,790
301		Excavation	62531	CY	$6.00	375,186
305		Preparation	44364	SY	$6.30	279,493
317		Riprap (D50 = 12")	920.7	LS	$52.00	47,876
319		Riprap (D50 = 18")	2761	LS	$46.00	127,006
331		PCC invert (8" thick)	4713	SY	$99.00	466,587
339		Weep holes	706	EA	$10.00	7,060
342		Concrete Cutoff wall	7070	CY	$4.70	33,229
343		Structure	114	EA	$270.00	30,780
344		Wall (3x15x200)	78.62069	EA	$2,100.00	165,103
351		AC Maintenance Road	2082	SY	$15.80	32,896
???		Gila River Outfall CO Wall (3x15x200)		LS	$67,000.00	67,000
???		AC Maintenance Road		LS	$10,400.00	10,400
602		Hydroseed	91899	SY	$0.34	31,246
610		Tree (24" Box)	402	EA	$184.00	73,968
613		gal)	804	EA	$22.00	17,688
614		gal)	1206	EA	$10.90	13,145
630		(3.5x2.5x2)	201	EA	$119.00	23,919
631		Boulder4x3x2.5)	121	EA	$153.00	18,513
		Low Density Residential F	2,055,596	SF	$1.50	3,083,395
		Mineral Rights (Gila Rive	$301,511	SF	$1.13	339,200
Subtotal						5,316,019
Markup	#REF!		0.0%			0
	0				**Total Cost**	**5,316,000**

Potential Savings

Potential Savings	**(742,500)**

Value Analysis Study Recommendation

Project: **Watson Drainage System** — **VA No.**

Item: **Install channel/culvert over the top of existing Kinder-Morgan petroleum pipe and fiber optics conduit** — **B-1**

Function (verb noun): ***minimize impact***

Original Design

The current design requires relocating downward the existing Kinder Morgan petroleum pipeline on the south side of the UPRR and associated fiber optic conduits to provide clearance for the channel/culvert.

Proposed Design

locate the channel vertically so relocations do not have to occur.

Advantages and Disadvantages

Advantages:

- avoid time-consuming and expensive relocation costs
-
-
-
-

Value Indicator:

Disadvantages:

- must verify exact locations of existing utilities to verify if feasible
- need concurrence of utility owners
-
-

Discussion

Existing drainage/tailwater pipes under the UPRR near the proposed Watson Drainage System crossing may have already required the vertical location of the K-M pipeline and fiber optics conduits to be lowered locally to clear the existing drainage/tailwater pipes. The Watson facility might be able to be installed to clear the K-M and FO facilities and avoid relocation costs that were expended for the Loop 303 project. Potholing conducted at this location will verify the K-M and FO locations to determine if this proposal if feasible.

Life Cycle Cost Summary

	Initial Cost	Life Cycle Cost
Original Design	1,080,000	1,080,000
Proposed Design	0	0
Potential Savings	1,080,000	1,080,000

Value Analysis Study Recommendation

Project: **Watson Drainage System** **VA No.**

Item: **keep irrigation tailwater system flows separate from drainage flows** **B-2**

Function (verb noun): ***minimize impact***

Original Design

The current design allows for tailwaters from agricultural fields to be collected into the drainage system and mingled with stormwater. Returning tailwater back into the irrigation delivery system may require pumping if drainage system inverts cannot meet elevations at delivery points. The current cost estimate did not specifically include costs for pumping.

Proposed Design

install separate tailwater collection and piping over channels to main tailwater delivery at required elevations

Advantages and Disadvantages

Advantages:

- avoid costs of pumping
-
-
-
-

Value Indicator:

C

P

Disadvantages:

- may increase system cost
-
-
-

Discussion

Constraints of existing topography (very flat along UPRR), crossing existing utilities (ANPP), and the UPRR crossing result in the drainage inverts being lower than adjacent tailwater collection and delivery systems. Tailwater delivery may have to be separated to meet delivery elevation requirements.

Life Cycle Cost Summary

	Initial Cost	Life Cycle Cost
Original Design	0	0
Proposed Design	0	0
Potential Savings	0	0

Sketch Worksheet

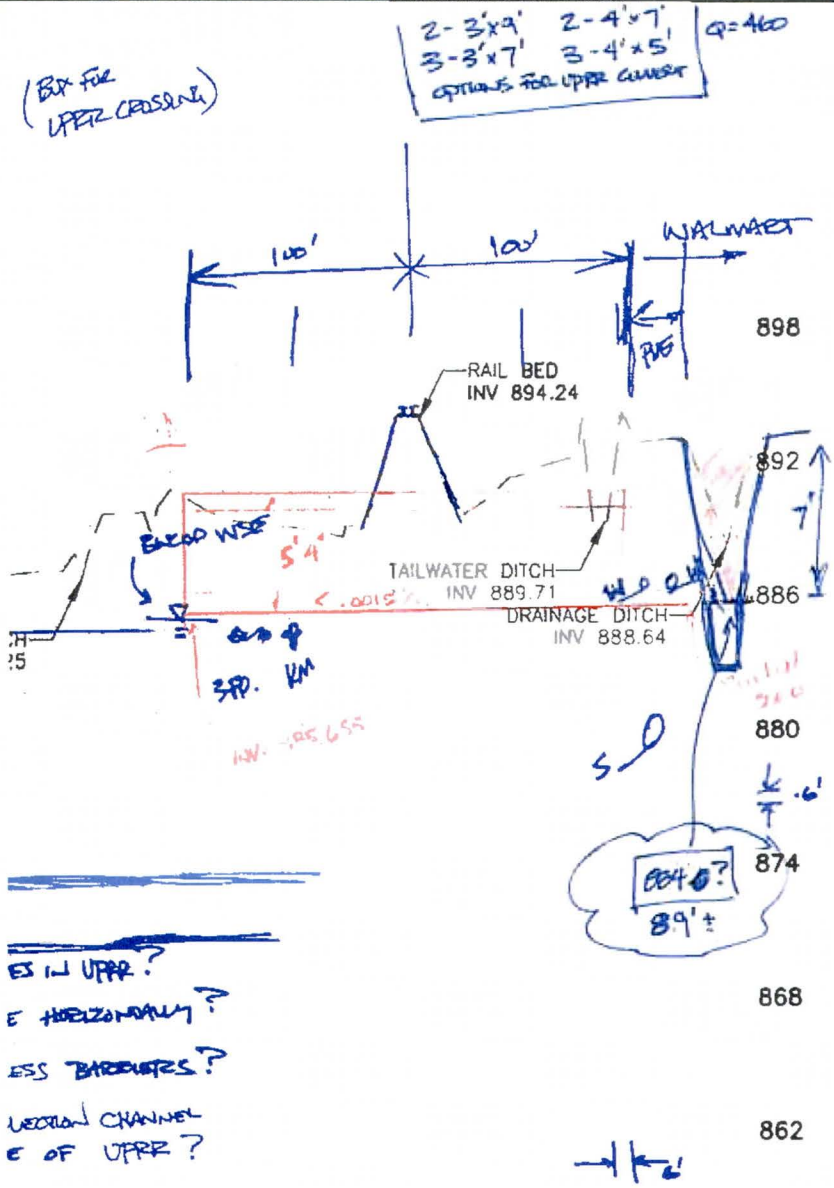
Project: Watson Drainage System

Item: keep irrigation tailwater system flows separate from drainage flows

VA No. B-2

Function (verb noun): *minimize impact*

■ Original Design ☐ Proposed Design



ES IN UPPR?

E HORIZONTALLY?

ESS BARRIERS?

VERTICAL CHANNEL

E OF UPPR?

OTHER:

- OVER SHOT DOESN'T SEEM POSSIBLE
- CROSSING UPPR NEAR EXISTING CULVERT, MAY BE A WAY TO AVOID RELOCATING F.O. (F.O. PROBABLY DIPPED TO CROSS CULVERT)

Cost Worksheet

Project: **Watson Drainage System** **VA No.**

Item: **keep irrigation tailwater system flows separate from drainage flows** **B-2**

Function (verb noun): ***minimize impact***

Original Design RTSPT2 relocations				
ID	Quantity	Unit	Unit Cost	Total
no specific estimate of pumping costs is included in original estimate				
Subtotal				0
Markup (general requirements, design contingency)			**Total Cost**	0

Proposed Design				
	Quantity	Unit	Unit Cost	Total
no relocations				0
Subtotal				0
Markup (general requirements, design contingency)	0.0%			0
			Total Cost	0

Potential Savings	
Potential Savings	0

Value Analysis Study Recommendation

Project: **Watson Drainage System** **VA No.**

Item: **Temporary diversion channel for BWCDD canal crossing in lieu of permanent realignment** **B-3**

Function (verb noun): ***control flooding***

Original Design

The current estimate includes constructing a canal shoo fly to redirect canal flows around the culvert construction. If left in the initial shoo fly alignment, right-of-way to BWCDD need to be conveyed.

Proposed Design

Construct temporary diversion with possibly a visquene liner around culvert construction, when culvert and canal lining completed, remove temporary diversion and restore canal to original alignment.

Advantages and Disadvantages

Advantages:

- may reduce permanent ROW required
- if ROW needs reduced, paying for severance may not be necessary
-
-
-

Value Indicator:

Disadvantages:

- may increase cost to build diversion and canal crossing
- will need to acquire ROW for temporary construction easement anyway
-
-

Discussion

Crossing the canal requires building a culvert under the existing canal and lining the canal over the culvert a distance each side. The canal must remain in service (except during dry-up), so a diversion channel shoo fly is built around the crossing site. The current design assumes the diversion channel would be the permanent canal and ROW would be conveyed to BWCDD over the new location. If the canal can be restored in the existing location, some of the ROW for the shoo fly might be acquired as a temporary TCE or may be sold as excess.

Life Cycle Cost Summary

	Initial Cost	Life Cycle Cost
Original Design	337,500	337,500
Proposed Design	101,500	101,500
Potential Savings	236,000	236,000

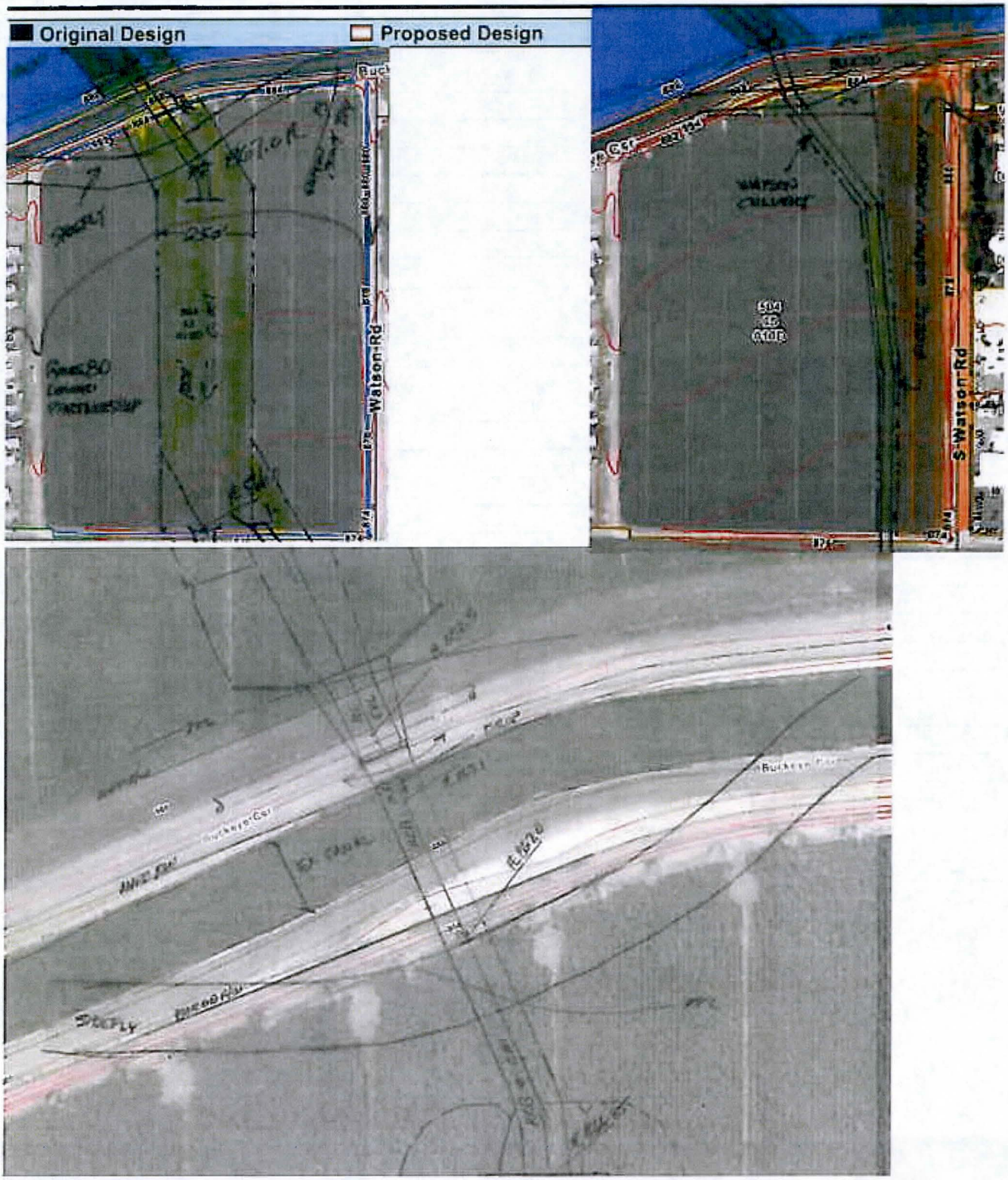
Sketch Worksheet

Project: Watson Drainage System

Item: Temporary diversion channel for BWCDD canal crossing in lieu of permanent realignment

VA No. B-3

Function (verb noun): *control flooding*



Cost Worksheet

Project: **Watson Drainage System** **VA No.**

Item: **Temporary diversion channel for BWCDD canal crossing in lieu of permanent realignment** **B-3**

Function (verb noun): ***control flooding***

Original Design RTSPT2 relocations

ID		Quantity	Unit	Unit Cost	Total
705	industrial property	135,000	SF	2.50	337,500
	150ft x 900 ft ROW				
Subtotal					337,500
Markup	(general requirements,				
	design contingency)			**Total Cost**	**337,500**

Proposed Design

		Quantity	Unit	Unit Cost	Total
705	industrial property	135,000	SF	0.50	67,500
	150ft x 900 ft TCE				
	instead of permanent				
	2 yrs @ 10% fee				
301	excavate temp ditch	4,000	CY	6.00	24,000
	900*20*6/27				
	temp ditch lining	5,000	SY	2.00	10,000
	900*30/9				
Subtotal					101,500
Markup	(general requirements,				
	design contingency)			**Total Cost**	**101,500**

Potential Savings

Potential Savings	**236,000**

Value Analysis Study Recommendation

Project: **Watson Drainage System** **VA No.**

Item: **Construct box culvert from UPRR south to MC85 crossing instead of open channel where culvert dalylights south of** **B-4**

Function (verb noun): ***control flooding***

Original Design

Original design for reach RTSPT2 from UPRR to MC85 includes a 4 barrel 6' x 4' box culvert 1293 long plus a channel 800 feet long from daylight to MC85. The footprint south of the BWCDD canal in combination with the future Watson Parkway may incur severance costs such that the remaining half of the parcel must be paid for.

Proposed Design

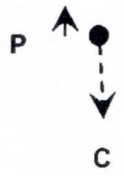
Construct a box culvert the full length of the reach, minimizing the ROW take.

Advantages and Disadvantages

Advantages:

- reduces permanent ROW required
- if ROW needs reduced, paying for severance may not be necessary
- culvert leaves more usable area at "hard" corner for commercial/industrial use
-
-

Value Indicator:



Disadvantages:

- increased culvert cost
-
-
-

Discussion

For original design, if severance is determined, 1/2 half the remainder of the parcel may need to be acquires at a cost of $1.4 million and a potential savings of $500k is possible despite the increased cost of the culvert. If the original does not require severance compensation, then the open channel may be more cost effective.

Life Cycle Cost Summary

	Initial Cost	Life Cycle Cost
Original Design	4,017,800	4,017,800
Proposed Design	3,496,500	3,496,500
Potential Savings	521,300	521,300

Sketch Worksheet

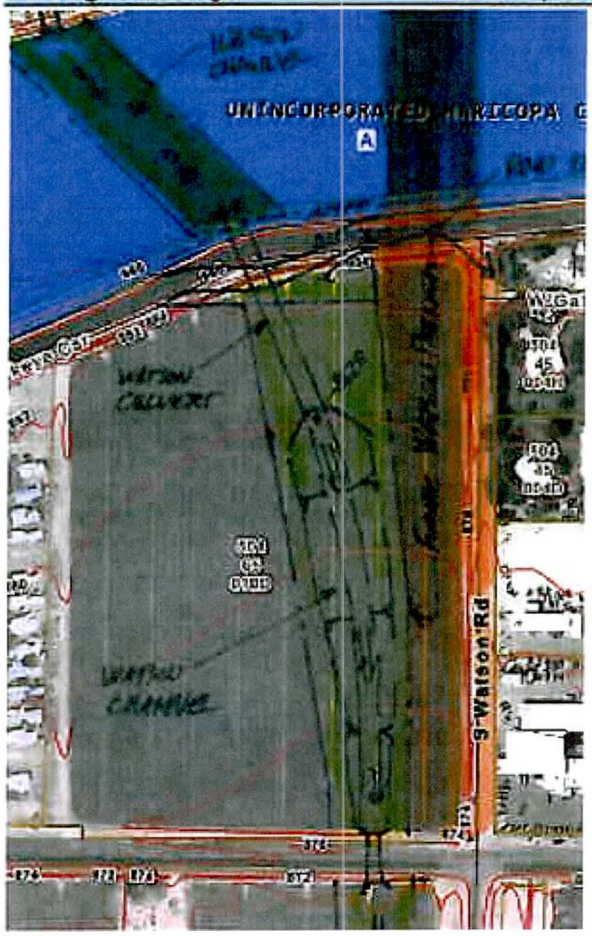
Project: Watson Drainage System

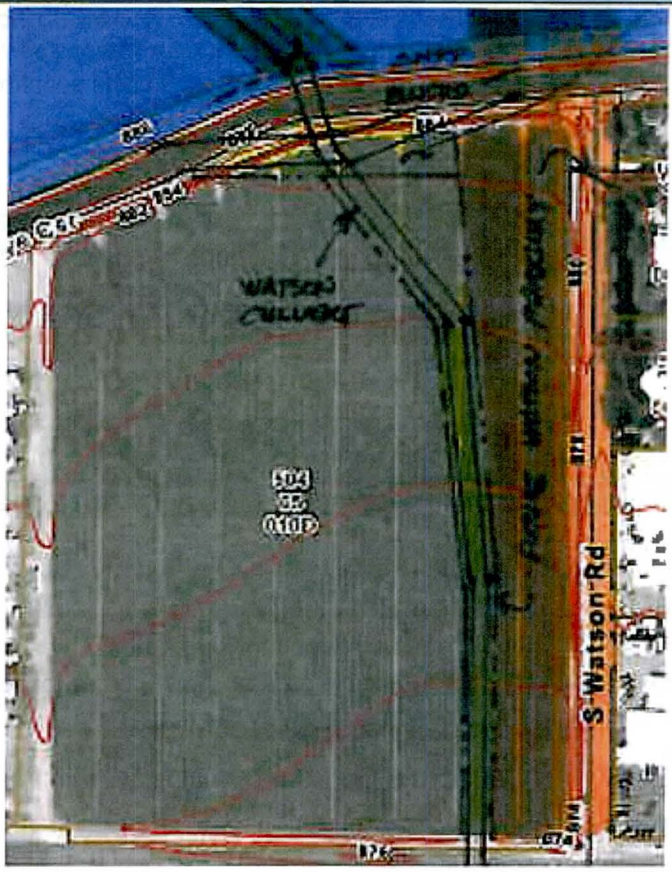
VA No. B-4

Item: Construct box culvert from UPRR south to MC85 crossing instead of open channel where culvert dalylights south of BWCDD Canal

Function (verb noun): *control flooding*

■ Original Design ☐ Proposed Design





Cost Worksheet

Project: **Watson Drainage System** **VA No.**

Item: **Construct box culvert from UPRR south to MC85 crossing instead of open channel where culvert dalylights south of BWCDD Canal** **B-4**

Function (verb noun): ***control flooding***

Original Design RTSPT2 culvert bewteen UPRR and MC85

ID		Quantity	Unit	Unit Cost	Total
420	6x4 Concrete Box Culver	5,172	LF	370.00	1,913,640
	4 bbl, 90 cfs/bbl, 1293 ft				
301	excavation	43,747	CY	6.00	262,480
	CHANNEL: 7' to 13' deep, 4:1 ss, 20 BW wide x 800				
705	industrial ROW	182,790	SF	2.50	456,975
	culvert 30 ft wide x 1293 + channel avg 180 ft wide x 800				
705	severance 1/2 parcel	553,866	SF	2.50	1,384,664
Subtotal					4,017,759
Markup	(general requirements,				
	design contingency)			**Total Cost**	**4,017,800**

Proposed Design

ID		Quantity	Unit	Unit Cost	Total
420	6x4 Concrete Box Culver	8,372	LF	370.00	3,097,640
	4 bbl, 90 cfs/bbl, 2093 ft				
301	excavation	40,310	CY	6.00	241,858
	40 wide x 13 ft deep x 2093				
705	industrial ROW	62,790	SF	2.50	156,975
	30 ft wide x 1300				
Subtotal					3,496,473
Markup	(general requirements,				
	design contingency)			**Total Cost**	**3,496,500**

Potential Savings

Potential Savings **521,300**

Value Analysis Study Recommendation

Project: **Watson Drainage System** **VA No.**
Item: **C-1 UPRR Channel** **C-1**

Function (verb noun): ***Control Flooding***

Original Design

Reaches RTURR1, -2, & -3 are a concrete lined channel, 8" thick, 4:1 sideslopes, 5' to 9' deep, 10 ' bottom width. At an average 7' deep, the topwidth of the conveyance is 66'.

Proposed Design

part 1A: per FCDMC Engineering Division, concrete for channel can be 6" thick; part 1B: revise side slope to 2:1 to decrease material and channel width, FCDMC requires fencing or railing for slopes steeper than 3:1.

Advantages and Disadvantages

Advantages:

- reduces right-of-way required and ROW costs
- reduces excavation and concrete costs
-
-
-

Value Indicator:

Disadvantages:

- adds requiring railing or fencing for safety adjacent to sideslopes
-
-
-

Discussion

Proposed channel north side of UPRR is approximately 10,000 feet long. The available gradient is very flat, an invert gradient of 0.0005 ft/ft may be necessary. It is within existing and planned industrial areas and a concrete-lined channel was used in the proposed typical section for this reach. The design flow is 433 cfs which only requires about 4 feet of depth, but due to the very flat terrain, the channel depth gets to 9 ft deep to get it to drain. With 4:1 side slopes, the topwidth gets very wide and would not be needed to carry flows.

Life Cycle Cost Summary

	Initial Cost	Life Cycle Cost
Original Design	10,039,517	
Proposed Design	7,741,800	0
Potential Savings	2,297,700	#VALUE!

Sketch Worksheet

Project: Watson Drainage System

Item: C-1 UPRR Channel

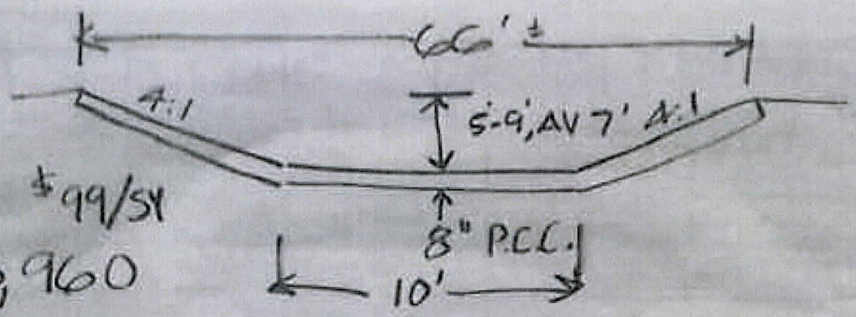
VA No. C-1

Function (verb noun): *Control Flooding*

■ Original Design ☐ Proposed Design

C: (1) UPRR CHANNEL

ALTA



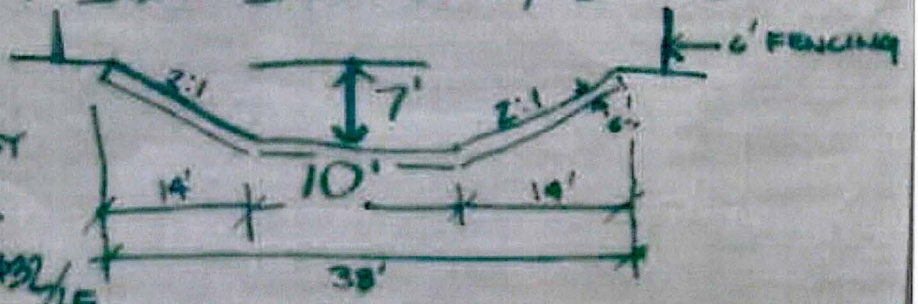
8" PCC $99/SY

$5,723,960

(1A) 6" PCC LINING → $75/SY

$4,272,000 [SAVE $1.5 M]

(1B) 2:1 SIDE SLOPE W/6" PCC



- 6" pcc $75/SY
+ 6' CHAINLINK
$16/LF X 2 = $32/LF
- R/W $2.90/SF

$3,425,000 [SAVE $2.3M]

Cost Worksheet

Project: **Watson Drainage System**
Item: **C-1 UPRR Channel**

VA No.
C-1

Function (verb noun): ***Control Flooding***

Original Design reach RTWTR2

RTURR1 Alt A w/o contingences	4,530,959
RTURR2 Alt A w/o contingences	4,017,933
RTURR3 Alt A w/o contingences	1,490,625
Total Cost	**$10,039,517**

Proposed Design

ID			Quantity	Unit	Unit Cost	Total
201		Clear and Grub	1	LS	$166,600.00	166,600
205		Misc. Removals	1	LS	$83,300.00	83,300
207		Remove and Replace Pa	0			
215		Remove Pipe	56	LF	$21.00	1,176
220		Remove Concrete Ditch	30	LF	$30.00	900
252		Irrigation Pipe Relocation	30	LF	$109.00	3,270
301		Excavation	36,297	CY	$6.00	217,780
305		Channel Subgrade Prepa	45894	SY	$6.30	289,135
331		PCC invert (6" thick)	45894	SY	$75.00	3,442,079
339		Weep holes	1618	EA	$10.00	16,180
342		Concrete Cutoff wall	27106	LF	$4.70	127,398
351		AC Maintenance Road	17456	SY	$15.80	275,805
428		6' x 4' Concrete Box Culv	1628	LF	$370.00	602,360
458		6' x 4' Concrete Box Culv	2	EA	$10,400.00	20,800
		Chain Link Fencing	20000	LF	$16.00	320,000
705		Industrial ROW	870,000	SF	$2.50	2,175,000
Subtotal						7,741,783
Markup	#REF!		0.0%			0
	0				**Total Cost**	**7,741,800**

Potential Savings

Potential Savings	**2,297,700**

Value Analysis Study Recommendation

Project: **Watson Drainage System** — **VA No.**

Item: **Interim condition channel relpacing ultimate turf channel** — **C-2**

Function (verb noun): ***Control Flooding***

Original Design

The 231st Avenue Channel Typical Section applies to reaches that are adjacent to future residential development. On north-south reaches, the existing gradients range from 0.3% to 0.5% resulting in velocities exceeding the allowable 2.5 fps for the soils. The proposed lining is turf that would resist velocities up to 5 fps and it is assumed residential development will install turf to get open space credits in the development footprint. Turf requires irrigation and there are higher maintenance costs that would be borne by the homeowner assocations. Th VA proposal is specific to reaches RTSPT3, RTMRA1, and RT2314, but may be applied elsewhere.

Proposed Design

In the interim until development occurs, the Town would be responsible for maintenance and does not want the expense of maintaining turf. An interim condition design provides some level of erosion control for the invert and side slopes and has some added maintenance due to anticipated increased erosion. It also needs to be easily converted to turf by future developement. The proposed design includes grade control structures (dumped riprap in filter-fabric 3 ft wide x 6 ft deep across channel width at 3 to 4 per 1,000 lf of channel), swales atop the bank intercepting side inflows and directing flows to grouted rock down drains, non-irrigated hydroseeding of the sides and bottom and wattles along the sideslope.

Advantages and Disadvantages

Advantages: — **Value Indicator:**

- allows for conversion to turf without having to remove riprap/rock mulch — P
- avoids initial construction of turf and irrigation by FCDMC for the Outfall portion
- reduced overall maintenance by TOB compared to turf
-
-

Disadvantages:

- reduced erosion protection, potential increased maintenance — C
-
-
-

Discussion

Grade control structures may include dumped riprap (least costly), gabions, or CLSM slurry (most costly). Rock mulch and rip-rap lining were considered but are more expensive and would require costly removal to install turf and may discourage future development to install turf. Some erosion of the invert will need to be tolerated until turf is installed. The number of grade control structures for a reach is determine by its gradient and the allowable maximum scour. Downdrains would be coordinated with the grade control structures.

Life Cycle Cost Summary

	Initial Cost	Life Cycle Cost
Original Design	1,704,100	
Proposed Design	1,134,300	
Potential Savings	569,800	

Sketch Worksheet

Project: Watson Drainage System

Item: Interim condition channel relpacing ultimate turf channel

VA No. C-2

Function (verb noun): *Control Flooding*

■ Original Design ☐ Proposed Design

C: (2) INTERIM CONDITIONS
231 ST AVE SECTION (TURF)

ALT A - TURF CHANNEL LINING

- CHANNEL TO REMAIN EARTHEN UNTIL DEVELOPER INSTALLS TURF/IRRIG.

Q. HOW TO REDUCE O&M/EROSION?

SIDE SLOPE	CHANNEL GRADE CONTROL
1- ROCK MULCH & HYDROSEED	1 - CLSM
$3.90/SY - ROCK $0.10/SF HS. 42' 42 = 84' S.S.	$30,000/1000 LF
[$54,000/1000 LF]	2 - GABIONS $15,200/1000 LF
2- HY. SEED, WATTLES, GROUTED RIPRAP D.D.	3 - ROCK IN TRENCH $3200/1000 LF
[$28,000/1000 LF]	

Cost Worksheet

Project: **Watson Drainage System** **VA No.**

Item: **Interim condition channel relpacing ultimate turf channel** **C-2**

Function (verb noun): ***Control Flooding***

Original Design components of Outfall reaches RTSPT3, RTRMA1, & RT2314					
ID		Quantity	Unit	Unit Cost	Total
301	excavation	78,399	CY	6.00	470,394
603	Decomposed Granite	72,037	SY	4.00	288,148
606	Turf (Sod)	58,172	SY	5.40	314,129
610	Tree (24" box)	740	EA	184.00	136,160
613	Container Shrubs 5 gal	1,480	EA	22.00	32,560
614	Container Shrubs 1 gal	2,220	EA	10.90	24,198
621	Drip irrigation system	72,037	SY	3.10	223,315
622	Turf irrigation System	58,172	SY	3.70	215,236
Subtotal					**1,704,140**
Markup	(general requirements,				
	design contingency)			**Total Cost**	**1,704,100**

Proposed Design					
ID		Quantity	Unit	Unit Cost	Total
301	excavation	78,399	CY	6.00	470,394
603	Decomposed Granite	72,037	SY	4.00	288,148
606	Turf (Sod)	0	SY	5.40	0
610	Tree (24" box)	0	EA	184.00	0
613	Container Shrubs 5 gal	0	EA	22.00	0
614	Container Shrubs 1 gal	0	EA	10.90	0
621	Drip irrigation system	0	SY	3.10	0
622	Turf irrigation System	0	SY	3.70	0
	top of bank swale excava	5,315	CY	6.00	31,888
	riprap 12" grade control	2,133	CY	52.00	110,933
	grouted riprap downdrain	747	CY	125.00	93,333
602	hydroseed	130,209	SY	0.34	44,271
	wattles	31,888	LF	1.25	39,860
	tall pot tree planting	740	EA	75.00	55,500
Subtotal					1,134,328
Markup	(general requirements,	0.0%			0
	design contingency)			**Total Cost**	**1,134,300**
Potential Savings					
				Potential Savings	**569,800**

Notes:

Wattles 2 rows per side slope, $30/24 ft -9" wattle

Swale at each side top of bank 1.5 ft deep, 4:1 ss

Rip-rap filled trench w/filter fabric 3 ft wide x 6 ft deep x 50 ft long, 4/1000 lf channel

grouted rip rap downdrain 3 ft deep x 5ft wide x 42 ft long at 4/1000 ft, each side

Value Analysis Study Recommendation

Project: **Watson Drainage System** — **VA No.**

Item: **Interim condition channel replacing ultimate turf channel** — **C-2 rock mulch**

Function (verb noun): ***Control Flooding***

Original Design

The 231st Avenue Channel Typical Section applies to reaches that are adjacent to future residential development. On north-south reaches, the existing gradients range from 0.3% to 0.5% resulting in velocities exceeding the allowable 2.5 fps for the soils. The proposed lining is turf that would resist velocities up to 5 fps and it is assumed residential development will install turf to get open space credits in the development footprint. Turf requires irrigation and there are higher maintenance costs that would be borne by the homeowner associations. The VA proposal is specific to reaches RTSPT3, RTMRA1, and RT2314, but may be applied elsewhere.

Proposed Design

In the interim until development occurs, the Town would be responsible for maintenance and does not want the expense of maintaining turf. An interim condition design provides some level of erosion control for the invert and side slopes and has some added maintenance due to anticipated increased erosion. It also needs to be easily converted to turf by future development. The proposed design includes grade control structures (dumped riprap in filter-fabric 3 ft wide x 6 ft deep across channel width at 3 to 4 per 1,000 lf of channel), swales atop the bank intercepting side inflows and directing flows to grouted rock down drains, non-irrigated hydroseeding of the sides with 5" thick 3" minus rock mulch

Advantages and Disadvantages

Advantages: — **Value Indicator:**

- allows for conversion to turf without having to remove riprap/rock mulch — P
- avoids initial construction of turf and irrigation by FCDMC for the Outfall portion
- reduced overall maintenance by TOB compared to turf
- side slopes better protected with rock mulch
-

Disadvantages:

- reduced erosion protection, potential increased maintenance
- expense by developer to remove rock mulch for turf — C
-
-

Discussion

Grade control structures may include dumped riprap (least costly), gabions, or CLSM slurry (most costly). Rock mulch and rip-rap lining were considered but are more expensive and would require costly removal to install turf and may discourage future development to install turf. Some erosion of the invert will need to be tolerated until turf is installed. The number of grade control structures for a reach is determine by its gradient and the allowable maximum scour. Downdrains would be coordinated with the grade control structures.

Life Cycle Cost Summary

	Initial Cost	Life Cycle Cost
Original Design	**1,704,100**	
Proposed Design	**1,635,700**	
Potential Savings	**68,400**	

Sketch Worksheet

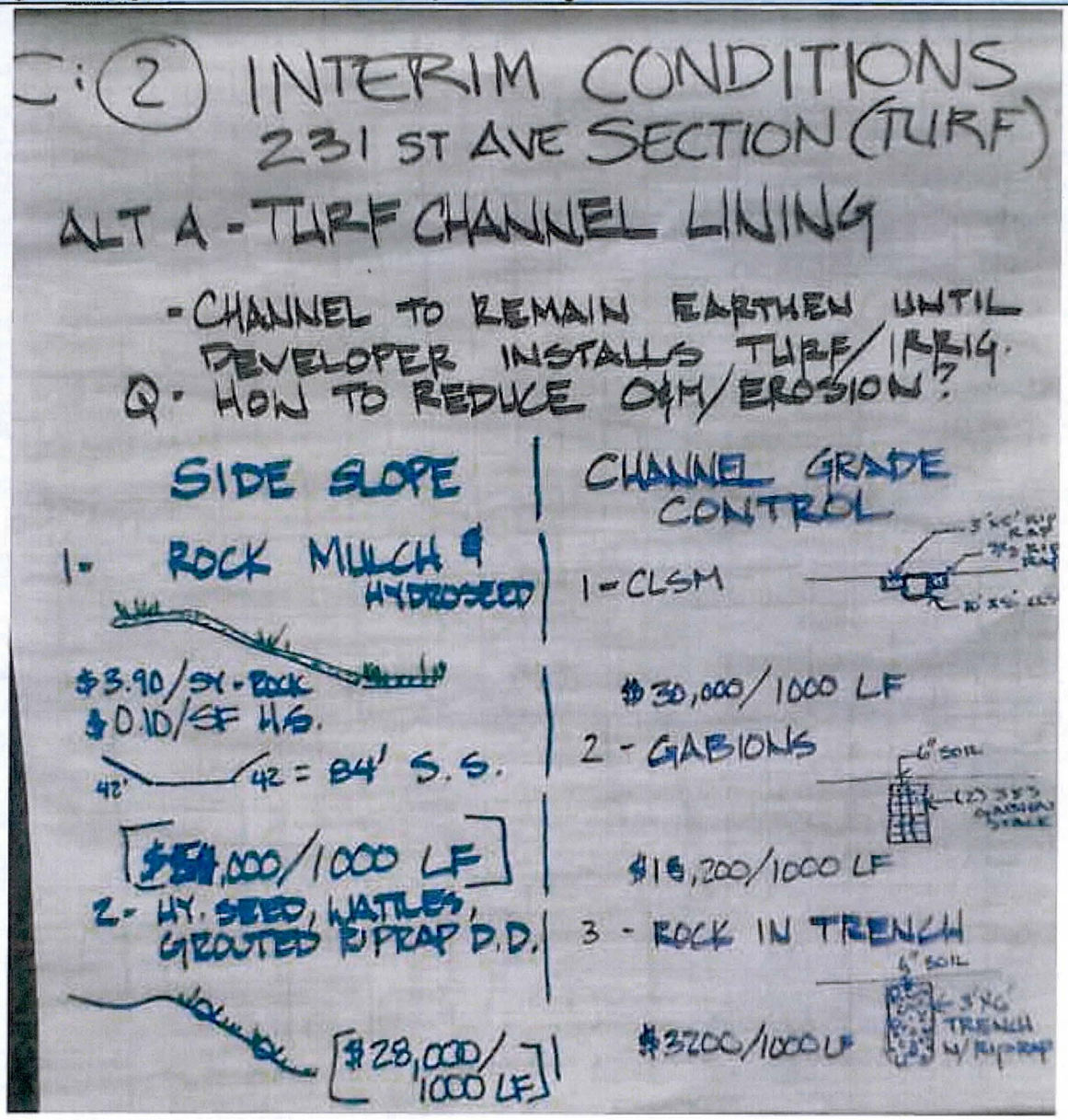
Project: Watson Drainage System

Item: Interim condition channel relpacing ultimate turf channel

VA No. C-2 rock mulch

Function (verb noun): *Control Flooding*

■ Original Design ☐ Proposed Design



Cost Worksheet

Project: **Watson Drainage System** — **VA No.**

Item: **Interim condition channel relpacing ultimate turf channel** — **C-2 rock mulch**

Function (verb noun): ***Control Flooding***

Original Design components of Outfall reaches RTSPT3, RTRMA1, & RT2314					
ID		Quantity	Unit	Unit Cost	Total
301	excavation	78,399	CY	6.00	470,394
603	Decomposed Granite	72,037	SY	4.00	288,148
606	Turf (Sod)	58,172	SY	5.40	314,129
610	Tree (24" box)	740	EA	184.00	136,160
613	Container Shrubs 5 gal	1,480	EA	22.00	32,560
614	Container Shrubs 1 gal	2,220	EA	10.90	24,198
621	Drip irrigation system	72,037	SY	3.10	223,315
622	Turf irrigation System	58,172	SY	3.70	215,236
Subtotal					**1,704,140**
Markup	(general requirements,				
	design contingency)			**Total Cost**	**1,704,100**

Proposed Design					
ID		Quantity	Unit	Unit Cost	Total
301	excavation	78,399	CY	6.00	470,394
603	Decomposed Granite	72,037	SY	4.00	288,148
606	Turf (Sod)	0	SY	5.40	0
610	Tree (24" box)	0	EA	184.00	0
613	Container Shrubs 5 gal	0	EA	22.00	0
614	Container Shrubs 1 gal	0	EA	10.90	0
621	Drip irrigation system	0	SY	3.10	0
622	Turf irrigation System	0	SY	3.70	0
	top of bank swale excava	5,315	CY	6.00	31,888
	riprap 12" grade control	2,133	CY	52.00	110,933
	grouted riprap downdrain	747	CY	125.00	93,333
602	hydroseed	130,209	SY	0.34	44,271
		0	LF	1.00	0
	tall pot tree planting	740	EA	75.00	55,500
312	rock mulch (3" minus 5"th	83,263	SY	6.50	541,210
Subtotal					1,635,678
Markup	(general requirements,	0.0%			0
	design contingency)			**Total Cost**	**1,635,700**
Potential Savings					
				Potential Savings	**68,400**

Notes:
Wattles 2 rows per side slope
Swale at each side top of bank 1.5 ft deep, 4:1 ss
Rip-rap filled trench w/filter fabric 3 ft wide x 6 ft deep x 50 ft long, 4/1000 lf channel
grouted rip rap downdrain 3 ft deep x 5ft wide x 42 ft long at 4/1000 ft, each side
rock mulch (3" minus 5"thick) on side slopes + 5 ft from top of bank

Value Analysis Study Recommendation

Project: **Watson Drainage System** **VA No.**

Item: **Water Quality treatments** **C-3**

Function (verb noun): ***reduce pollution***

Original Design

No specific water quality provisions were include in the original conceptual designs. As ag lands convert to residential, commercial, or industrial development, onsite retention requirements for the 100-yr/2hr rainfall will also contain first flush pollutants. Channels adjacent to roads did not address first flush.

Proposed Design

The original proposed typical sections include a buffer area between the back of curb along adjacent streets to the channel top of bank. This area is up to 60 feet wide and contains the PUE, O&M/Multi-use path. It could incorporate water harvesting sumps that act as first flush treatment with overflows going into collection swales along the channel. Scuppers from the curb would collect road drainage and direct into first flush basins within the buffer.

Advantages and Disadvantages

Advantages: **Value Indicator:**

- addresses Game & Fish questions regarding water quality concerns discharging into the Gila R
- non-project cost associated with road improvements
-
-
-

Disadvantages:

- does not address interim condition for ag runoff
-
-
-

Discussion

A collection swale/basin 2 ft wide at the bottom and 6:1 side slopes provides 296 CY of volume along a 1,000 ft length of road. The first flush volume required is 0.5" rainfall x half street pavement (51 ft) x 1,000 ft= 79 CY. A first flush basin of these dimensions could be located along 266 ft (79/296x1000) of each 1,000 ft of street with little or no added cost. The street improvements would fund these basins, not the channel project. The channel design would accommodate these basins at appropriate locations coordinated with the side inflow downdrains and O&M road.

Life Cycle Cost Summary

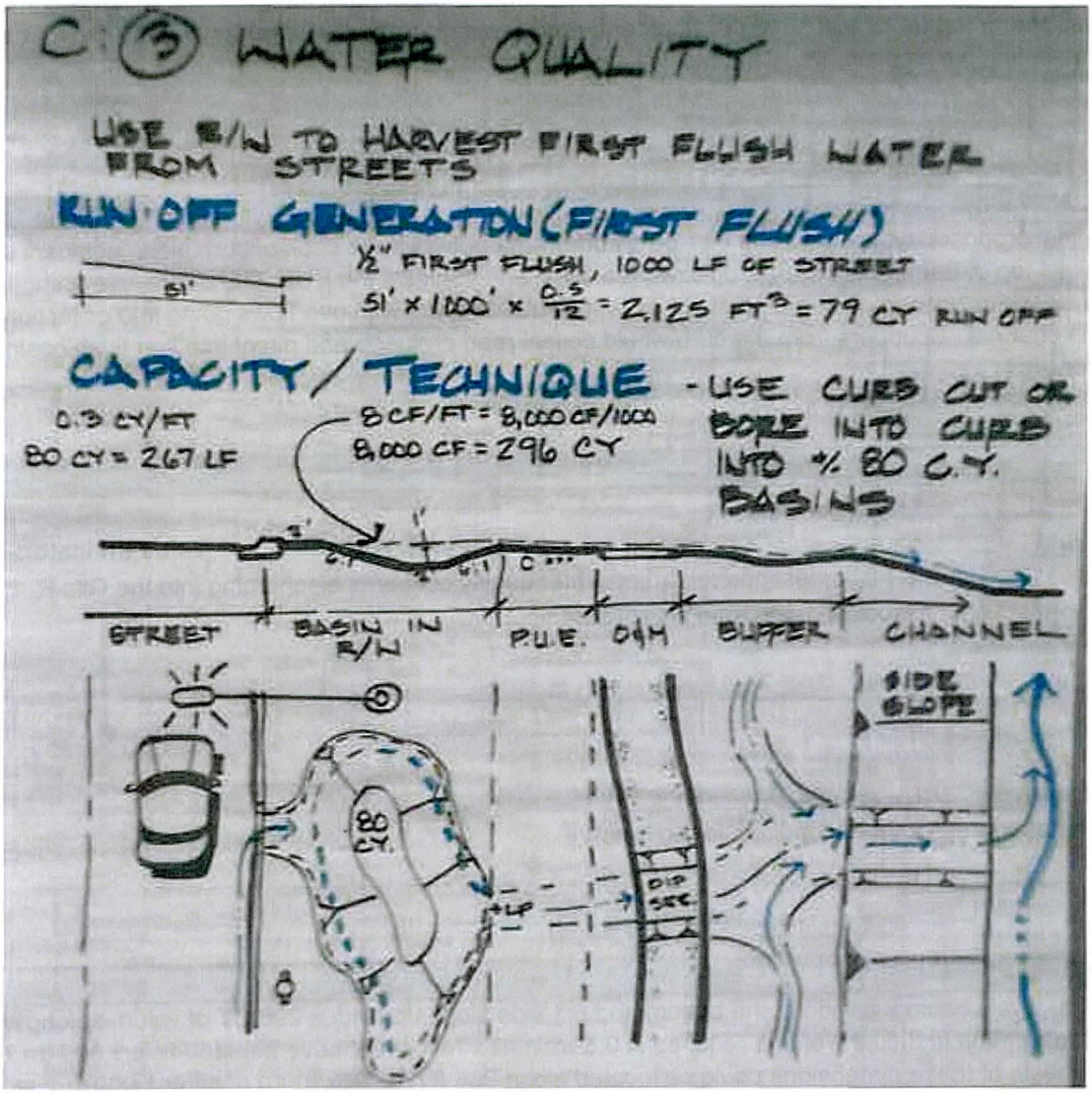
	Initial Cost	Life Cycle Cost
Original Design	0	0
Proposed Design	0	0
Potential Savings	0	0

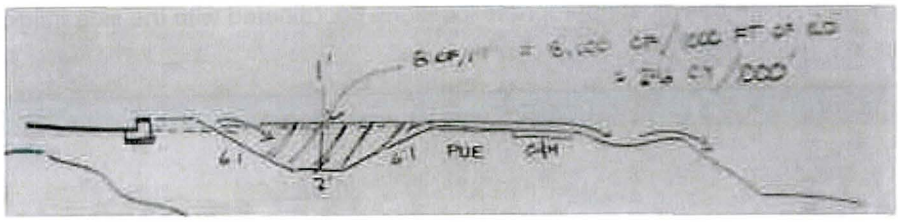
Sketch Worksheet

Project: **Watson Drainage System** | **VA No.**
Item: **Water Quality treatments** | **C-3**

Function (verb noun): ***reduce pollution***

■ Original Design ☐ Proposed Design





Cost Worksheet

Project: **Watson Drainage System**
Item: **Water Quality treatments**

VA No.
C-3

Function (verb noun): ***reduce pollution***

Original Design		Quantity	Unit	Unit Cost	Total
Subtotal					
Markup	(general requirements, design contingency)	35.0%			
				Total Cost	**0**

Proposed Design		Quantity	Unit	Unit Cost	Total
Subtotal					0
Markup	(general requirements, design contingency)	35.0%			0
				Total Cost	**0**

Potential Savings	
Potential Savings	**0**

First flush volume requ	2125 CF	79 CY
0.5 depth, inch		
51 width, ft half street		
1000 street length		
Swale/Basin volume	8000 CF	296 CY
1 depth, ft		
2 bottom width, ft		
6 side slopes H:V		

Watson Drainage System Alternate Outlet

Summary of Cost models.

We came up with four alternate concepts for the outflow section of the Watson drainage system.

Concept A: (alternate from original design concept that was developed in the meeting): was using the existing BWCDD channel with modifying the channel at the crossings to accommodate the peak flows for the entire system. See detail description below. This model appears to save 3 million dollars.

Concept A with an online basin: This model uses a basin to limit the CFS flow into the existing BWCDD channel to the current flow of 360 CFS. This would not require any upgrades to the existing channel. The issue with this option is it increases the cost due to landscaping, excavation roads, inlets and outlets to the basin. This basin will also constantly be wet so it will have to be designed as wet basin. One possible advantage is that it could be a cleaning system for the storm water pollution from the roadways. This would possibly allow the removal of oil separation devices from the upper sections of the Watson drainage range. One additional item is that the designer feels there is a depressed area in the topography in this region. The current design does not accommodate the water concentrated in this sub basin. The evidence of this basin is shown by and old wash that can be seen in the aerial view and it can be seen in the topos there appears to be a depression of about 10 ft in this sub basin. So the idea is that a new online basin in the design would mediate the concentrated flows in this region.

Concept B: This designer's original model was to route around the edge of the Cemex property inside the Cemex property lines instead of crossing the future pond it would skirt it. In this concept the channel is longer but does not require concrete boxes at the crossing which cost about 500k. But it does require that the mineral rights be purchased which is a cost of about 960k

Concept C: This is an existing designer's concept that was cost out with the properties but not the channel design costs we assumed the channel costs for our cost model. This concept was to route around the Cemex property outside of the property lines. This is a longer channel which will cost more but FCD does not have to pay for the mineral rights. One advantage is there is no crossing at the Cemex properties which saves the cost of the concrete boxes of about 500k

Detailed Description of the cost models

Concept A alternate: (without a inline basin) taking all 1100 peak CFS

This model saves $2,713,072.98 million dollars from original cost model for Concept A

The concept was to drain into the future pond created from the excavation of river run from the Cemex property (quarry) which will in the final condition be a large pond like the other ones in the area since the groundwater table is just a few feet below the surface next to the Gila River. In the alternate final

condition the mineral rights and the property would be turned over to from the BWCDD and Town of Buckeye Cemex in an agreement if they allow the channel to drain into Cemex's pond and then into the river.

The current design would have a strip of 300 foot wide land crossing the pond to outlet into the river where the water would balance back into the pond anyway.

One key element to making this work is to get the cooperation of Cemex's who benefits from the use of the 300 ft strip as quarried material and they do not have to try and accommodate a 300ft strip across their quarry with a trail roadway and canal conveying water. They will not have to maintain a crossing where pedestrians, maintenance vehicles and their heavy excavating equipment have to meet.

Another key element is to get BWCDD to maintain control of the canal and allow FCD to discharge into their existing system and allow us to improve the canal to accommodate the final flows without FCD taking ownership.

The City of Buckeye should have no concerns that we could determine since they will benefit from the final condition. A series of ponds near the river could be used for multiple development purposes from public recreation to private developments.

Key concepts:

1. Using the existing BWCDD canal as an intermediate drainage channel the following needs to happen in order for this to work.
    - Channel Capacity: The conveyance of the channel has to work for the final design. This was verified in our preliminary estimates by the designer. The final flow at peak was shown as 1100 with the existing configuration with the off line basins. The designer confirmed that the existing BWCDD channel configuration can pass the design peak flow with a capacity of near 1250 CFS. The existing culverts are an issue and are assumed to be too small to allow the peak flows to pass. Therefore in the intermediate stage the culverts will have to be removed.
    - Culverts since the culverts do not have adequate capacity we are assuming for this VA. They will have to be replaced. We considered using the original design of concrete box culverts with headwalls with a cost of almost 500k. We decided that since the culverts would be in place for a few years then tore out and since FCD will not be the owner that the current configuration using CMP culverts would be a far cheaper option with no head walls. We also decided that at the outlet end into the Gila River that we would use the current head cutting prevention of rip rap and grade control channels. We assumed they were concrete however there is no reason they could not be done in slurry. Since we did not have accurate prices for the new CMP we assumed that half of the original cost would be a realistic estimate. Also the current length of concrete box is shown at near 800 ft which we could not see the necessity for. Since the quarry would only need a 50 ft wide crossing like is currently in

place. With what we assumed would be rip rap protection upstream and down-stream of the culverts.

- In order to keep the channel at the current configuration with the side walls at a 1 ¼ to 1 side slope the channel cannot be owned by FCD. BWCCD needs to keep ownership of the canal until the time when CEMEX chooses to excavate the basin. This is a significant saving since the channel would not have to be widened and treated to FCD standards.

2. Another key concept that we discovered was that in the final condition the water table would be what we estimated from the topos given 4 feet below the invert of the channel that entered into the pond. This would have to be verified. But to capture a cost for this scenario we put into the design a head cut system at the inlet to the pond. We assumed that the current design will work. So we used the cost model from the current design to estimate this section. In effect installing two head cutting protections. This is an additional cost but is far off set by the savings in the other elements of the current design that will not have to be installed.
3. This model does not have a basin in online so that those costs are saved in exchange for the costs of upgrading the culverts with CMP. This we estimated is much less cost than maintaining and developing an additional 15 acre basin that is always wet.

Detailed Cost Model A alternate

See attached sheet cost model A alternate without basin and improvements to the Cemex crossing.

Concept A: (with an inline basin) reducing the peak flows to 360 CFS

This model saves dollars from original cost model for Concept A

This concept was essentially the same as the concept above but to limit the flows into the channel to the current condition. In order to do this we had to install a 15 acre basin that is approximately 8 ft deep into the system. This basin would be a wet system since the tail waters from the farms will still be fed through this drainage system.

Watson Drainage System Basin 6 Volume estimation:

According the Consultant, the 100-year 24-hour peak flow rate for design condition is 1100 cfs and for existing condition it is 360 cfs. The basin volume required to attenuate the flow rate from 1100 cfs to 360 cfs is calculated as follows based on an assumption that the design hydrograph flow rate exceeds 360 cfs for a period of 2.55 hours:

$V = (1100 - 360)\ ft^3/s * 2.55$ hours * 60 minutes / hour *60 seconds / minute = $6793200\ ft^3$, or

$= 6793200\ ft^3 / (43560\ ft^3/ac\text{-}ft) = 156$ ac-ft.

In fact, this volume was derived by the Consultant using the design hydrograph and targeted basin discharge flow rate (360 cfs).

Detailed Cost Model A with basin

See attached sheet cost model A with basin and no improvements to the Cemex crossing.

Concept B: Diverting the channel around the Cemex property completely.

This model was an existing alternate that was cost out at the level of property purchasing costs only. We have expanded it to capture the cost of the channel and the cost savings of not using the boxes in the crossing design and also saving the cost of the mineral purchase.

Detailed Cost Model B

See attached sheet cost model B

Concept C:

This concept was essentially the same as concept B with but moving the channel over to the edge of the Cemex property and buying the land from Cemex. The benefit is it removes the channel from crossing an open pond and it reduces the length of the channel from the Concept B and it saves the cost of the crossing the same as the concept B. The disadvantage is it increases the cost do to the necessity to buy the mineral rights from Cemex.

Detailed Cost Model C

See attached sheet cost model C

Conclusions

By comparison the costs are as follows for the different concepts from the original chosen concept A:

Concept A original – $3,606,204.00

Concept A alternate – $893,131.02 Saving **$2,713,072.98** from original

Concept A with inline basin - $3,208,996.92 Saving **$397,207.08** from original

Concept B - $6,656,379.64 Costing an additional $3,050,175.64

Concept C - $4,352,900.64 Costing an additional $1,206,542.08

Alignment A alternate can be seen to be the most cost effective system is to use Concept A alternate. However there are many items that have to be coordinated and are outside of FCD's control. This might not even be possible.

Alignment A with an inline basin is the next most cost effective version is to build the inline basin however our preliminary calculations with a 15 acre basin show it as being 12 foot deep which is deep. Also it would be the first basin that FCD has constructed that is constantly submerged since it will be below the water table and it will also have a constant flow of water in it. These were not analyzed in this version of the cost model. This may well make this an unreasonable solution.

Alignment B will be the most costly due to the length and property costs. This puts the alignment on the Cemex property.

Alignment C is the is a realistic option since it allows the channel to be out of the future pond and is near the same cost as the original alignment A but the advantage is it is completely in FCD's control and the Town of Buckeyes in the future and it has no construction traffic crossing which removes it from Cemex property.

We would suggest pursuing the alignment A alternate since it is the most cost effective. It is worth the effort to see if a deal can be struck between the interested parties. The next most logical alternate would be Alignment C since it allows separation and total control by FCD with marginal cost increase.

Watson Drainage System South of Beloat RD Alignment A					
Item Description	Unit	Quantity	Unit Price	Cost	
Removals and Relocations					
Clear and Grub	LS	1	$16,055.00	$16,055.00	
Misc. Removals	LS	1	$8,030.00	$8,030.00	
Remove and Replace Pavement per MAG 200-B		0			
Remove Pipe	LF	464	$21.00	$9,744.00	
Remove Concrete Ditch	LF	157	$30.00	$4,710.00	
Irrigation Pipe Relocation (30")	LF	310	$109.00	$33,790.00	
Subtotal				$72,329.00	
Channel and Basin Construction Items					
Excavation	CY	20843	$6.00	$125,058.00	
Channel Subgrade Preparation	SY	14788	$6.30	$93,164.40	
Dumped Riprap (D50 = 12")	LS	86000	$1.00	$86,000.00	
Dumped Riprap (D50 = 18")	LS	230000	$1.00	$230,000.00	
Channel invert (8" thick)	SY	1571	$99.00	$155,529.00	
Weep holes	EA	236	$10.00	$2,360.00	
Concrete Cutoff wall	CY	2600	$4.70	$12,220.00	
Vertical Drop Structure	EA	2	$31,000.00	$62,000.00	
Gila River Outfall CO Wall (3x15x200)	EA	2	$30,000.00	$60,000.00	
AC Maintenance Road **(consider chip seal?)**	SY	2082	$15.80	$32,895.60	
Subtotal				$859,227.00	
Storm Drain Construction Items					
CMP pipe (not 10 x 6 CBC)	LS	1	$67,000.00	$67,000.00	
CMP End Treatments (not 10 x 4 Concrete Wing Walls)	LS	1	$10,400.00	$10,400.00	
Subtotal				$77,400.00	
Landscaping construction Items					
Hydroseed	SY	30633	$0.34	$10,415.22	
Tree (24" Box)	EA	134	$184.00	$24,656.00	
Container Shrubs (5 gal)	EA	268	$22.00	$5,896.00	
Container Shrubs (1 gal)	EA	402	$10.90	$4,381.80	

Landscape Boulder (3.5x2.5x2)	EA	67	$119.00	$7,973.00	
Landscape Boulder4x3x2.5)	EA	40	$153.00	$6,120.00	
Subtotal				$59,442.02	
SUBTOTAL CONSTRUCTION				$1,068,398.02	
Right of Way Acquisition					
Low Density Residential Property	SF	528000	$1.50	$792,000.00	
Mineral Rights (Cemex) Savings	LS	1	$967,267.00		$967,267.00
Subtotal ROW				$792,000.00	
TOTAL CONSTRUCTION & RIGHT OF WAY COST -- A				$1,860,398.02	
CREDIT FOR MINERAL RIGHTS				$967,267.00	
TOTAL NET COST				**$893,131.02**	
ORIGINAL COST A (no contingency)				$3,606,204.00	
SAVINGS				$2,713,072.98	

Contingent upon reaching agreements with Cemex and BWCDD

Existing channel has capacity for entire Up-Stream flow

Watson Drainage System - RTWTR2, Alignment A with Basin					
ID	Item Description	Unit	Quantity	Unit Price	Cost
	Removals and Relocations				
201	Clear and Grub	LS	1	$16,055.00	$16,055.00
205	Misc. Removals	LS	1	$8,030.00	$8,030.00
207	Remove and Replace Pavement per MAG 200-B		0		
215	Remove Pipe	LF	464	$21.00	$9,744.00
220	Remove Concrete Ditch	LF	157	$30.00	$4,710.00
252	Irrigation Pipe Relocation (30")	LF	310	$109.00	$33,790.00
	Subtotal				$72,329.00
	Channel and Basin Construction Items				
301	Excavation	CY	77503	$6.00	$465,018.00
305	Channel Subgrade Preparation	SY	14788	$6.30	$93,164.40
317	Dumped Riprap (D50 = 12")	LS	1	106000	$106,000.00
319	Dumped Riprap (D50 = 18")	LS	1	275000	$275,000.00
331	Channel invert (8" thick)	SY	1571	$99.00	$155,529.00
339	Weep holes	EA	236	$10.00	$2,360.00
342	Concrete Cutoff wall	CY	2600	$4.70	$12,220.00
343	Vertical Drop Structure	EA	3	$31,000.00	$93,000.00
344	Gila River Outfall CO Wall (3x15x200)	EA	2	$30,000.00	$60,000.00
	Basin Weir Structure (includes inlet and outlet)	EA	1	$100,000.00	$100,000.00
351	AC Maintenance Road **(consider chip seal?)**	SY	10295	$15.80	$162,661.00
	Subtotal				$1,524,952.40
	Storm Drain Construction Items				
???	**CMP pipe** (not 10 x 6 CBC)	LS	2	$67,000.00	$134,000.00
???	**CMP End Treatments** (not 10 x 4 Concrete Wing Walls)	LS	2	$10,400.00	$20,800.00
	Subtotal				$154,800.00
	Landscaping construction Items				
602	Hydroseed	SY	30633	$0.34	$10,415.22
610	Tree (24" Box)	EA	134	$184.00	$24,656.00

613	Container Shrubs (5 gal)	EA	268	$22.00	$5,896.00
614	Container Shrubs (1 gal)	EA	402	$10.90	$4,381.80
630	Landscape Boulder (3.5x2.5x2)	EA	67	$119.00	$7,973.00
631	Landscape Boulder4x3x2.5)	EA	40	$153.00	$6,120.00
	Basin Landscaping	LS	1	$70,000.00	$70,000.00
	Subtotal				$129,442.02
	SUBTOTAL CONSTRUCTION				$1,881,523.42
	Right of Way Acquisition				
701	Low Density Residential Property	SF	1529827	$1.50	$2,294,740.50
	Mineral Rights (Cemex) (minus for savings, plus for cost)	LS	1	-$967,267.00	
	SUBTOTAL ROW				$2,294,740.50
	TOTAL CONSTRUCTION & RIGHT OF WAY COST				$4,176,263.92
	CREDIT FOR MINERAL RIGHTS				$967,267.00
	TOTAL NET COST				**$3,208,996.92**
	Original cost for design alignment A: 3606204.00				**$3,606,204.00**
	SAVINGS				**$397,207.08**

Contingent upon reaching agreements with Cemex and BWCDD

Existing channel has capacity for entire Up-Stream flow

	Watson Drainage System - RTWTR2, Alignment B					
ID	Item Description	Unit	Quantity	Unit Price	Cost	
	Removals and Relocations					
201	Clear and Grub	LS	1	$16,055.00	$16,055.00	
205	Misc. Removals	LS	1	$8,030.00	$8,030.00	
207	Remove and Replace Pavement per MAG 200-B		0			
215	Remove Pipe	LF	464	$21.00	$9,744.00	
220	Remove Concrete Ditch	LF	157	$30.00	$4,710.00	
252	Irrigation Pipe Relocation (30")	LF	310	$109.00	$33,790.00	
	Subtotal				$104,877.05	
	Channel and Basin Construction Items					
301	Excavation	CY	62531	$6.00	$375,186.00	
305	Channel Subgrade Preparation	SY	44364	$6.30	$279,493.20	
317	Dumped Riprap (D50 = 12")	LS	920.7	$52.00	$47,876.40	
319	Dumped Riprap (D50 = 18")	LS	2761	$46.00	$127,006.00	
331	Channel invert (8" thick)	SY	4713	$99.00	$466,587.00	
339	Weep holes	EA	706	$10.00	$7,060.00	
342	Concrete Cutoff wall	CY	7070	$4.70	$33,229.00	
343	Vertical Drop Structure	EA	114	$270.00	$30,780.00	
344	Gila River Outfall CO Wall (3x15x200)	EA	78.62069	$2,100.00	$165,103.45	
351	AC Maintenance Road **(consider chip seal?)**	SY	2082	$15.80	$32,895.60	
	Subtotal				$1,565,216.65	
	Storm Drain Construction Items					
???	**CMP pipe** (not 10 x 6 CBC)	LS	0	$67,000.00	$0.00	
???	**CMP End Treatments** (not 10 x 4 Concrete Wing Walls)	LS	0	$10,400.00	$0.00	
	Subtotal				$0.00	
	Landscaping construction Items					
602	Hydroseed	SY	91899	$0.34	$31,245.66	
610	Tree (24" Box)	EA	402	$184.00	$73,968.00	
613	Container Shrubs (5 gal)	EA	804	$22.00	$17,688.00	
614	Container Shrubs (1 gal)	EA	1206	$10.90	$13,145.40	

630	Landscape Boulder (3.5x2.5x2)	EA	201	$119.00	$23,919.00	
631	Landscape Boulder4x3x2.5)	EA	121	$153.00	$18,513.00	
701	Subtotal				$178,479.06	
	SUBTOTAL CONSTRUCTION				$2,236,773.04	
	Right of Way Acquisition					
	Low Density Residential Property	SF	1698404.4	$1.50	$2,547,606.60	
	Mineral Rights (Cemex)	LS	1	$1,872,000.00	$1,872,000.00	$0.00
	Subtotal ROW				$4,419,606.60	
	TOTAL CONSTRUCTION & RIGHT OF WAY COST				$6,656,379.64	
	COST FOR MINERAL RIGHTS (See above)				$0.00	
	TOTAL NET COST				**$6,656,379.64**	
	Original cost for design alignment A: 3606204.00				**$3,606,204.00**	
	SAVINGS				**-$3,050,175.64**	

Watson Drainage System - RTWTR2, Option C					
ID	Item Description	Unit	Quantity	Unit Price	Cost
	Removals and Relocations				
201	Clear and Grub	LS	1	$16,055.00	$16,055.00
205	Misc. Removals	LS	1	$8,030.00	$8,030.00
207	Remove and Replace Pavement per MAG 200-B		0		
215	Remove Pipe	LF	464	$21.00	$9,744.00
220	Remove Concrete Ditch	LF	157	$30.00	$4,710.00
252	Irrigation Pipe Relocation (30")	LF	310	$109.00	$33,790.00
	Subtotal		GW-why 1.45 factor?		$104,877.05
	Channel and Basin Construction Items				
301	Excavation	CY	62531	$6.00	$375,186.00
305	Channel Subgrade Preparation	SY	44364	$6.30	$279,493.20
317	Dumped Riprap (D50 = 12")	LS	920.7	$52.00	$47,876.40
319	Dumped Riprap (D50 = 18")	LS	2761	$46.00	$127,006.00
331	Channel invert (8" thick)	SY	4713	$99.00	$466,587.00
339	Weep holes	EA	706	$10.00	$7,060.00
342	Concrete Cutoff wall	CY	7070	$4.70	$33,229.00
343	Vertical Drop Structure	EA	114	$270.00	$30,780.00
344	Gila River Outfall CO Wall (3x15x200)	EA	78.6206897	$2,100.00	$165,103.45
351	AC Maintenance Road **(consider chip seal?)**	SY	2082	$15.80	$32,895.60
	Subtotal				$1,565,216.65
	Storm Drain Construction Items				
???	**CMP pipe** (not 10 x 6 CBC)	LS	0	$67,000.00	$0.00
???	**CMP End Treatments** (not 10 x 4 Concrete Wing Walls)	LS	0	$10,400.00	$0.00
	Subtotal				$0.00
	Landscaping construction Items				
602	Hydroseed	SY	91899	$0.34	$31,245.66
610	Tree (24" Box)	EA	402	$184.00	$73,968.00
613	Container Shrubs (5 gal)	EA	804	$22.00	$17,688.00
614	Container Shrubs (1 gal)	EA	1206	$10.90	$13,145.40

630	Landscape Boulder (3.5x2.5x2)	EA	201	$119.00	$23,919.00
631	Landscape Boulder4x3x2.5)	EA	121	$153.00	$18,513.00
701	Subtotal				$178,479.06
	SUBTOTAL CONSTRUCTION		GW-why 1.4 factor?		$2,588,001.86
	Right of Way Acquisition				
	Low Density Residential Property	SF	2055596.4	$1.50	$3,083,394.60
	Mineral Rights (Gila River Lake)	SF	$301,511.00	$1.13	$339,199.88
	Subtotal ROW	GW-CY instead of SF?			$3,422,594.48
	TOTAL CONSTRUCTION & RIGHT OF WAY COST				$6,010,596.34
	COST FOR MINERAL RIGHTS (See above)				
	TOTAL NET COST				**$6,010,596.34**
	Original cost for design alignment A: 3606204.00				**$3,606,204.00**
	SAVINGS				**-$2,404,392.34**

WATSON DRAINAGE SYSTEM SUMMARY 6/21/2013

211.05.30

OPTION

	A		B		C	
	AC	$	AC	$	AC	$
ROW	22.59	$ 1,476,240	38.99	$ 2,547,780	47.19	$ 3,083,460
MINERAL		$ 967,267		$ 1,872,000		$ 339,200
TOTAL		$ 2,443,507		$ 4,419,780		$ 3,422,660

WATSON DRAINAGE SYSTEM
211.05.30

OUTLET TO GILA RIVER
ALIGNMENT OPTION A

6/21/2013

OWNER	APN	CHANNEL WIDTH, FT	CHANNEL LENGTH, FT	AREA, SF	RIGHT-OF-WAY AREA, AC	RIGHT-OF-WAY UNIT PRICE 2	COST	MINERAL RIGHTS DEPTH	MINERAL RIGHTS VOLUME, CY	MINERAL RIGHTS UNIT PRICE 1	COST
LONGHENRY	400-43-007P	320	666	213,120	4.89	$ 1.50	$ 319,680				$ -
TERRELL	400-43-007R	220	314	69,080	1.59	$ 1.50	$ 103,620				$ -
VISS	400-43-007T	220	320	70,400	1.62	$ 1.50	$ 105,600				$ -
VISS	400-43-007W			-	-	$ 1.50	$ -				$ -
VISS	400-43-007U	60	320	19,200	0.44	$ 1.50	$ 28,800				$ -
WJW HINDMAN-2005	400-43-003F			-	-	$ 1.50	$ -				$ -
UNITED METRO MATE	400-43-001B	60	1319	79,140	1.82	$ 1.50	$ 118,710	40	117,244	$ 1.125	$ 131,900
UNITED METRO MATE	400-43-001A	160	1319	211,040	4.84	$ 1.50	$ 316,560	40	312,652	$ 1.125	$ 351,733
UNITED METRO MATE	400-45-017B	60	1319	79,140	1.82	$ 1.50	$ 118,710	40	117,244	$ 1.125	$ 131,900
UNITED METRO MATE	400-45-017A	160	1319	211,040	4.84	$ 1.50	$ 316,560	40	312,652	$ 1.125	$ 351,733
MKE FARM	400-43-006			-	-	$ 1.50	$ -				$ -
MKE FARM	400-45-018			-	-	$ 1.50	$ -				$ -
GILA RIVER LAKE, LLC	400-04-004			-	-	$ 1.50	$ -	40	-	$ 1.125	$ -
ARIZONA GAME & FISH	400-45-005			-	-	$ 1.50	$ -				$ -
ARIZONA GAME & FISH	400-45-007A	320	100	32,000	0.73	$ 1.50	$ 48,000				$ -
					22.59		$ 1,476,240				$ 967,267
										TOTAL	$ 2,443,507

NOTES

1 1 CY= 1.5 TONS, STATE LAND DEPARTMENT ROYALTY RATE =$0.75/TON =$1.125/CY

2 $2.50/SF INDUSTRIAL LAND WITHOUT IMPROVEMENTS
$1.50/SF RESIDENTIAL LAND WITHOUT IMPROVEMENTS

WATSON DRAINAGE SYSTEM
211.05.30

OUTLET TO GILA RIVER
ALIGNMENT OPTION B

6/21/2013

OWNER	APN	CHANNEL WIDTH, FT	CHANNEL LENGTH, FT	AREA, SF	RIGHT-OF-WAY AREA, AC	RIGHT-OF-WAY UNIT PRICE 2	COST	DEPTH	MINERAL RIGHTS VOLUME, CY	MINERAL RIGHTS UNIT PRICE 1	COST
LONGHENRY	400-43-007P	320	666	213,120	4.89	$ 1.50	$ 319,680				$ -
TERRELL	400-43-007R	220	314	69,080	1.59	$ 1.50	$ 103,620				$ -
VISS	400-43-007T	220	320	70,400	1.62	$ 1.50	$ 105,600				$ -
VISS	400-43-007W			-	-	$ 1.50	$ -				$ -
VISS	400-43-007U	60	320	19,200	0.44	$ 1.50	$ 28,800				$ -
WJW HINDMAN-2005	400-43-003F			-	-	$ 1.50	$ -				$ -
UNITED METRO MATE	400-43-001B	60	320	19,200	0.44	$ 1.50	$ 28,800	40	28,444	$ 1.125	$ 32,000
UNITED METRO MATE	400-43-001A	320	2131	681,920	15.65	$ 1.50	$ 1,022,880	40	1,010,252	$ 1.125	$ 1,136,533
UNITED METRO MATE	400-45-017B	0		-	-	$ 1.50	$ -	40	-	$ 1.125	$ -
UNITED METRO MATE	400-45-017A	320	1319	422,080	9.69	$ 1.50	$ 633,120	40	625,304	$ 1.125	$ 703,467
MKE FARM	400-43-006			-	-	$ 1.50	$ -				$ -
MKE FARM	400-45-018			-	-	$ 1.50	$ -				$ -
GILA RIVER LAKE, LLC	400-04-004			-	-	$ 1.50	$ -	40	-	$ 1.125	$ -
ARIZONA GAME & FISH	400-45-005	320	636	203,520	4.67	$ 1.50	$ 305,280				$ -
ARIZONA GAME & FISH	400-45-007A			-	-	$ 1.50	$ -				$ -
					38.99		$ 2,547,780				$ 1,872,000
										TOTAL	$ 4,419,780

NOTES

1 1 CY= 1.5 TONS, STATE LAND DEPARTMENT ROYALTY RATE =$0.75/TON =$1.125/CY
2 $2.50/SF INDUSTRIAL LAND WITHOUT IMPROVEMENTS
$1.50/SF RESIDENTIAL LAND WITHOUT IMPROVEMENTS

WATSON DRAINAGE SYSTEM
211.05.30

OUTLET TO GILA RIVER
ALIGNMENT OPTION C

6/21/2013

OWNER	APN	CHANNEL WIDTH, FT	CHANNEL LENGTH, FT	AREA, SF	RIGHT-OF-WAY AREA, AC	RIGHT-OF-WAY UNIT PRICE 2	COST	MINERAL RIGHTS DEPTH	MINERAL RIGHTS VOLUME, CY	MINERAL RIGHTS UNIT PRICE 1	COST
LONGHENRY	400-43-007P	320	666	213,120	4.89	$ 1.50	$ 319,680				$ -
TERRELL	400-43-007R	220	314	69,080	1.59	$ 1.50	$ 103,620				$ -
VISS	400-43-007T	320	569	182,080	4.18	$ 1.50	$ 273,120				$ -
VISS	400-43-007W	320	667	213,440	4.90	$ 1.50	$ 320,160				$ -
VISS	400-43-007U	60	320	19,200	0.44	$ 1.50	$ 28,800				$ -
WJW HINDMAN-2005	400-43-003F	320	320	102,400	2.35	$ 1.50	$ 153,600				$ -
UNITED METRO MATE	400-43-001B			-	-	$ 1.50	$ -	40	-	$ 1.125	$ -
UNITED METRO MATE	400-43-001A			-	-	$ 1.50	$ -	40	-	$ 1.125	$ -
UNITED METRO MATE	400-45-017B			-	-	$ 1.50	$ -	40	-	$ 1.125	$ -
UNITED METRO MATE	400-45-017A			-	-	$ 1.50	$ -	40	-	$ 1.125	$ -
MKE FARM	400-43-006	320	1338	428,160	9.83	$ 1.50	$ 642,240				$ -
MKE FARM	400-45-018	320	1316	421,120	9.67	$ 1.50	$ 631,680				$ -
GILA RIVER LAKE, LLC	400-04-004	320	636	203,520	4.67	$ 1.50	$ 305,280	40	301,511	$ 1.125	$ 339,200
ARIZONA GAME & FISH	400-45-005	320	636	203,520	4.67	$ 1.50	$ 305,280				$ -
ARIZONA GAME & FISH	400-45-007A			-	-	$ 1.50	$ -				$ -
					47.19		$ 3,083,460				$ 339,200
										TOTAL	$ 3,422,660

NOTES

1 1 CY= 1.5 TONS, STATE LAND DEPARTMENT ROYALTY RATE =$0.75/TON =$1.125/CY

2 $2.50/SF INDUSTRIAL LAND WITHOUT IMPROVEMENTS
$1.50/SF RESIDENTIAL LAND WITHOUT IMPROVEMENTS

Watson Drainage System
Preliminary Cost Estimate - RTWTR2, Alternative ~~A~~ C
Milestone: Alternatives Analysis

ID	Construction Item Description	Unit	Quantity	Unit Price	Total Cost
200	*REMOVALS AND RELOCATIONS*				
201	Clear and Grub	LS	1	49,400.00	49,400.00
205	Miscellaneous Removals	LS	1	24,700.00	24,700.00
207	Sawcut, Remove and Replace Pavement per MAG 200-B	SF	959	9.40	9,014.60
215	Remove Pipe	LF	464	21.00	9,744.00
220	Remove Concrete Ditch	LF	157	30.00	4,710.00
252	Irrigation Pipe Relocation (30")	LF	310	109.00	33,790.00
				Sub-Total	***131,358.60***
300	*CHANNEL & BASIN CONSTRUCTION ITEMS*				
301	Excavation	CY	62,531	6.00	375,184.51
305	Channel Subgrade Preparation	SY	44,364	6.30	279,494.78
317	Dumped Riprap (D50 = 12")	CY	837	52.00	43,506.67
319	Dumped Riprap (D50 = 18")	CY	2,510	46.00	115,460.00
331	Channel Invert CRCP (8" Thick, 0.8% Steel)	SY	4,713	99.00	466,620.00
339	Weep Holes	EA	706	10.00	7,060.00
342	Concrete Cutoff Wall	LF	7,070	4.70	33,229.00
343	Vertical Drop Structure	LF	114	270.00	30,780.00
344	Gila River Outfall Cutoff Wall	LF	114	2,100.00	239,400.00
351	AC Maintenance Road (2" AC on 6" AB)	SY	6,246	15.80	98,679.78
				Sub-Total	***1,689,414.73***
400	*STORM DRAIN CONSTRUCTION ITEMS*				
428	10' x 6' Concrete Box Culvert	LF	720	670.00	482,400.00
458	10' x 4' Concrete Box Culvert Wing Walls	EA	3	6,800.00	20,400.00
				Sub-Total	***502,800.00***
600	*LANDSCAPING CONSTRUCTION ITEMS*				
602	Hydroseed	SY	91,899	0.34	31,245.66
610	Tree (24" Box)	EA	402	184.00	73,968.00
613	Container Shrubs (5 gallon)	EA	804	22.00	17,688.00
614	Container Shrubs (1 gallon)	EA	1,206	10.90	13,145.40
630	Landscape Boulder (3.5' x 2.5' x 2')	EA	201	119.00	23,919.00
631	Landscape Boulder (4' x 3' x 2.5')	EA	121	153.00	18,513.00
				Sub-Total	***178,479.06***
700	*RIGHT-OF-WAY ACQUISITION*				
701	Low Density Residential Property	SF	788,680	1.40	1,104,152.00
				Sub-Total	***1,104,152.00***
				Sub-Total	3,606,204.39
				Contingency	1,081,861.32
				Reach Total	4,688,065.70

(3273 + 250 + 1325) = 5598 / 4000 1.40
− 250 + 1000
4848 =

4000'

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT WATSON VA PAGE ____ OF ____

DETAIL ____ COMPUTED ____ DATE ____

CHECKED BY ____ DATE ____

	TOTAL ALTA	OUTFALL	SAVINGS
PROJECT COST W/O CONTING.	58,495,281	28,481,930	
C&I UPPR CHL LINING			
ALTA	8" PCC, 4:1 SS	5,723,960	
VA C1A	6" PCC 4:1 SS	4,272,000	$1,500,000 OR
VA C1B	6" PCC 2:1 SS + FENCE REDUCED R/W	3,425,000	2,300,000
C2 INTERIM CONDITION IMPROVEMENTS			
ALTA	$1,291,221 2.58 mi (95,000 /1000 FT CHL)		
VA C2A	CLSM + ROCK WALL H 1.76 $\frac{54,000}{1000} + \frac{30,000}{1000} = \frac{84,000}{1000} \times 2.58$ mi = $1,144,282		147,439 OR
VA C2B	GABIONS + RW/HYD = 69,200/1000 = $942,642		399,018 OR
VA C2C	ROCK IN TRENCH/HYD/RW $57,200/1000 = $779,178		512,542 OR
VA C2D	HYDSD/WATTLES/DOWNDRAIN/CLSM 58,000/1000 = 790,076		501,695 OR
VA C2E	" /GABIONS 43,200/1000 = 588,470.4		703,250 OR
VA C2F	" /ROCK IN TR 31,200/1000 = 425,006		866,714

6910-153 R08-03

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT WABONA PAGE 3 OF

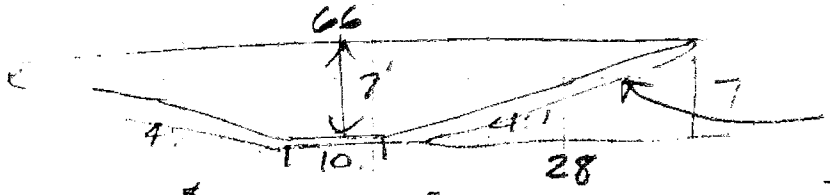
DETAIL COMPUTED DATE

CHECKED BY DATE

LIPAR

S= .0005

(1)

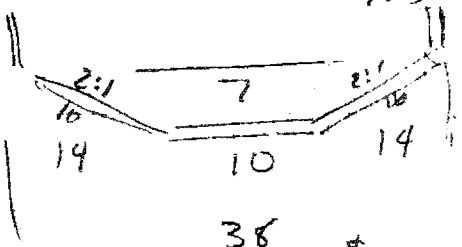


29
29
10
68/9 = 7.5 SY/LF
$75
$562.50/LF

ext	8"	$99/SY	$5,723,960
PROP	6" PPC		4,292,917

1.5' Save

(2)



16 42LF/FT /9 = 4.7 SY/LF
×$75
$352.5/LF

ROW/ 38/28 × $2.50 SF $70/LF

Δ = $210/LF
+ 70/LF R/W
$280/LF
− $60 LF
Δ = $220/LF
× 10,000 LF = $2.2M
SAVINGS

C.L. FENCE/RAIL $16/LF

25-35 $30/LF × 2 = SAVINGS

3,525,000
600 000
4,125,000
700,000
COST 3,425,000

Watson Drainage System
Preliminary Cost Estimate - **RTURR1, Alternative A**
Milestone: Alternatives Analysis

ID	Construction Item Description	Unit	Quantity	Unit Price	Total Cost
200	***REMOVALS AND RELOCATIONS***				
201	Clear and Grub	LS	1	62,100.00	62,100.00
205	Miscellaneous Removals	LS	1	31,100.00	31,100.00
207	Sawcut, Remove and Replace Pavement per MAG 200-B	SF	894	9.40	8,403.60
220	Remove Concrete Ditch	LF	15	30.00	450.00
251	Irrigation Pipe Relocation (24")	LF	15	102.00	1,530.00
259	Earth-Lined Irrigation Ditch Relocation	LF	2,714	16.30	44,238.20
294	Railroad Spur Replacement	LF	44	175.00	7,700.00
				Sub-Total	***155,521.80***
300	***CHANNEL & BASIN CONSTRUCTION ITEMS***				
301	Excavation	CY	31,678	6.00	190,070.83
305	Channel Subgrade Preparation	SY	15,579	6.30	98,147.81
331	Channel Invert CRCP (8" Thick, 0.8% Steel)	SY	15,579	99.00	1,542,322.65
335	Granular Drainage Layer (4" Thick)	SY	1,731	6.90	11,943.90
339	Weep Holes	EA	880	10.00	8,800.00
342	Concrete Cutoff Wall	LF	11,611	4.70	54,571.89
351	AC Maintenance Road (2" AC on 6" AB)	SY	9,042	15.80	142,870.62
				Sub-Total	***2,048,727.70***
400	***STORM DRAIN CONSTRUCTION ITEMS***				
420	6' x 4' Concrete Box Culvert	LF	1,408	370.00	520,960.00
450	6' x 4' Concrete Box Culvert Wing Walls	EA	1	4,900.00	4,900.00
				Sub-Total	***525,860.00***
600	***LANDSCAPING CONSTRUCTION ITEMS***				
603	Decomposed Granite	SY	43,119	4.00	172,476.00
610	Tree (24" Box)	EA	582	184.00	107,088.00
613	Container Shrubs (5 gallon)	EA	1,164	22.00	25,608.00
614	Container Shrubs (1 gallon)	EA	1,746	10.90	19,031.40
621	Drip Irrigation System	SY	43,119	3.10	133,668.90
630	Landscape Boulder (3.5' x 2.5' x 2')	EA	291	119.00	34,629.00
631	Landscape Boulder (4' x 3' x 2.5')	EA	175	153.00	26,775.00
				Sub-Total	***519,276.30***
700	***RIGHT-OF-WAY ACQUISITION***				
705	Industrial Property	SF	512,629	2.50	1,281,573.50
				Sub-Total	***1,281,573.50***
				Sub-Total	4,530,959.30
				Contingency	1,359,287.79
				Reach Total	5,890,247.09

Watson Drainage System
Preliminary Cost Estimate - RTURR2, Alternative A
Milestone: Alternatives Analysis

ID	Construction Item Description	Unit	Quantity	Unit Price	Total Cost
200	***REMOVALS AND RELOCATIONS***				
201	Clear and Grub	LS	1	55,100.00	55,100.00
205	Miscellaneous Removals	LS	1	27,500.00	27,500.00
215	Remove Pipe	LF	56	21.00	1,176.00
220	Remove Concrete Ditch	LF	15	30.00	450.00
251	Irrigation Pipe Relocation (24")	LF	15	102.00	1,530.00
259	Earth-Lined Irrigation Ditch Relocation	LF	2,606	16.30	42,477.80
				Sub-Total	***128,233.80***
300	***CHANNEL & BASIN CONSTRUCTION ITEMS***				
301	Excavation	CY	34,804	6.00	208,826.80
305	Channel Subgrade Preparation	SY	19,891	6.30	125,315.93
331	Channel Invert CRCP (8" Thick, 0.8% Steel)	SY	19,891	99.00	1,969,250.25
335	Granular Drainage Layer (4" Thick)	SY	2,210	6.90	15,250.10
339	Weep Holes	EA	738	10.00	7,380.00
342	Concrete Cutoff Wall	LF	10,927	4.70	51,356.20
351	AC Maintenance Road (2" AC on 6" AB)	SY	5,833	15.80	92,166.67
				Sub-Total	***2,469,545.94***
400	***STORM DRAIN CONSTRUCTION ITEMS***				
420	6' x 4' Concrete Box Culvert	LF	220	370.00	81,400.00
450	6' x 4' Concrete Box Culvert Wing Walls	EA	1	4,900.00	4,900.00
				Sub-Total	***86,300.00***
600	***LANDSCAPING CONSTRUCTION ITEMS***				
603	Decomposed Granite	SY	21,142	4.00	84,568.00
610	Tree (24" Box)	EA	375	184.00	69,000.00
613	Container Shrubs (5 gallon)	EA	750	22.00	16,500.00
614	Container Shrubs (1 gallon)	EA	1,125	10.90	12,262.50
621	Drip Irrigation System	SY	21,142	3.10	65,540.20
630	Landscape Boulder (3.5' x 2.5' x 2')	EA	188	119.00	22,372.00
631	Landscape Boulder (4' x 3' x 2.5')	EA	113	153.00	17,289.00
				Sub-Total	***287,531.70***
700	***RIGHT-OF-WAY ACQUISITION***				
705	Industrial Property	SF	418,529	2.50	1,046,321.50
				Sub-Total	***1,046,321.50***
				Sub-Total	4,017,932.94
				Contingency	1,205,379.88
				Reach Total	5,223,312.82

Watson Drainage System
Preliminary Cost Estimate - **RTURR3, Alternative A**
Milestone: Alternatives Analysis

ID	Construction Item Description	Unit	Quantity	Unit Price	Total Cost
200	***REMOVALS AND RELOCATIONS***				
201	Clear and Grub	LS	1	20,400.00	20,400.00
205	Miscellaneous Removals	LS	1	10,200.00	10,200.00
				Sub-Total	***30,600.00***
300	***CHANNEL & BASIN CONSTRUCTION ITEMS***				
301	Excavation	CY	12,863	6.00	77,176.87
305	Channel Subgrade Preparation	SY	6,984	6.30	44,001.66
331	Channel Invert CRCP (8" Thick, 0.8% Steel)	SY	6,984	99.00	691,454.61
335	Granular Drainage Layer (4" Thick)	SY	776	6.90	5,354.68
339	Weep Holes	EA	330	10.00	3,300.00
342	Concrete Cutoff Wall	LF	4,568	4.70	21,471.34
351	AC Maintenance Road (2" AC on 6" AB)	SY	2,581	15.80	40,774.53
				Sub-Total	***883,533.68***
600	***LANDSCAPING CONSTRUCTION ITEMS***				
603	Decomposed Granite	SY	10,151	4.00	40,604.00
610	Tree (24" Box)	EA	166	184.00	30,544.00
613	Container Shrubs (5 gallon)	EA	332	22.00	7,304.00
614	Container Shrubs (1 gallon)	EA	498	10.90	5,428.20
621	Drip Irrigation System	SY	10,151	3.10	31,468.10
630	Landscape Boulder (3.5' x 2.5' x 2')	EA	83	119.00	9,877.00
631	Landscape Boulder (4' x 3' x 2.5')	EA	50	153.00	7,650.00
				Sub-Total	***132,875.30***
700	***RIGHT-OF-WAY ACQUISITION***				
705	Industrial Property	SF	177,447	2.50	443,616.60
				Sub-Total	***443,616.60***
				Sub-Total	1,490,625.58
				Contingency	447,187.68
				Reach Total	1,937,813.26

Worksheet for Trapezoidal Channel - 1 2:1

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00050	ft/ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	433.00	ft^3/s

Results

Normal Depth	4.47	ft
Flow Area	84.77	ft^2
Wetted Perimeter	30.01	ft
Hydraulic Radius	2.83	ft
Top Width	27.90	ft
Critical Depth	3.13	ft
Critical Slope	0.00204	ft/ft
Velocity	5.11	ft/s
Velocity Head	0.41	ft
Specific Energy	4.88	ft
Froude Number	0.52	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	4.47	ft
Critical Depth	3.13	ft
Channel Slope	0.00050	ft/ft

Worksheet for Trapezoidal Channel - 1 4:1

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00050	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	10.00	ft
Discharge	433.00	ft^3/s

Results

Normal Depth	3.82	ft
Flow Area	96.50	ft^2
Wetted Perimeter	41.49	ft
Hydraulic Radius	2.33	ft
Top Width	40.55	ft
Critical Depth	2.73	ft
Critical Slope	0.00208	ft/ft
Velocity	4.49	ft/s
Velocity Head	0.31	ft
Specific Energy	4.13	ft
Froude Number	0.51	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.82	ft
Critical Depth	2.73	ft
Channel Slope	0.00050	ft/ft

Worksheet for Box Pipe - 1

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00050	ft/ft
Height	8.00	ft
Bottom Width	10.00	ft
Discharge	430.00	ft^3/s

Results

Normal Depth	7.96	ft
Flow Area	79.63	ft^2
Wetted Perimeter	25.93	ft
Hydraulic Radius	3.07	ft
Top Width	10.00	ft
Critical Depth	3.86	ft
Percent Full	99.5	%
Critical Slope	0.00337	ft/ft
Velocity	5.40	ft/s
Velocity Head	0.45	ft
Specific Energy	8.42	ft
Froude Number	0.34	
Discharge Full	348.19	ft^3/s
Slope Full	0.00033	ft/ft
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%
Normal Depth Over Rise	99.53	%
Downstream Velocity	Infinity	ft/s

Worksheet for Circular Pipe - 1

Project Description

Friction Method	Manning Formula
Solve For	Full Flow Capacity

Input Data

Roughness Coefficient	0.013	
Channel Slope	0.00050	ft/ft
Normal Depth	4.00	ft
Diameter	4.00	ft
Discharge	32.12	ft^3/s

Results

Discharge	32.12	ft^3/s
Normal Depth	4.00	ft
Flow Area	12.57	ft^2
Wetted Perimeter	12.57	ft
Hydraulic Radius	1.00	ft
Top Width	0.00	ft
Critical Depth	1.68	ft
Percent Full	100.0	%
Critical Slope	0.00366	ft/ft
Velocity	2.56	ft/s
Velocity Head	0.10	ft
Specific Energy	4.10	ft
Froude Number	0.00	
Maximum Discharge	34.55	ft^3/s
Discharge Full	32.12	ft^3/s
Slope Full	0.00050	ft/ft
Flow Type	SubCritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Average End Depth Over Rise	0.00	%

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT WATSON UP PAGE 2 OF ____

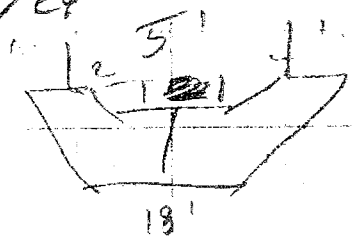
DETAIL ____ COMPUTED ____ DATE ____

____ CHECKED BY ____ DATE ____

INTERIM
~~SIDE~~ SLOPES

28,000/1000FT HYDROSEED, W/WATER, LS SWALES TOP OF BANK
GROUTED RIP RAP DOWNDRAINS @

GROUTED RIP RAP $150/CY



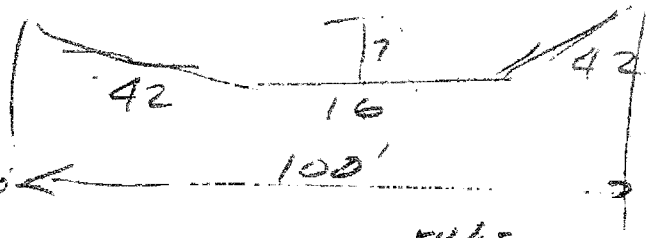
8 x 1.5 = 12

20 CY x 150 = $3000

45
12
96
45
540 FT

1 DOWN/300'
$9000/1000 FT
x 2
18000/1000 FT

HYDROSEED @ $0.10
100 x .10 x 1000 = $10,000/1000



56
6

15 CY/LF
$90

ROCK MULCH

84' x 1000' = 84000/9 = 9333 SY x 3.90 = 36,400
+ 18,000
$ 54,400 /1000'

54
36
10
154 LF

ALTA

TURF	118,331 SY	@ $5.40/SY	= 639,987
SYRES	37,528	2.00	75,056
TURF IRRG	154,859	3.70	576,678
			$1,291,721

/ 3.0 miles = $81.55/LF

81,548/1000FT

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT WATSON VA PAGE 1 OF ____

DETAIL ____ COMPUTED ____ DATE ____

____ CHECKED BY ____ DATE ____

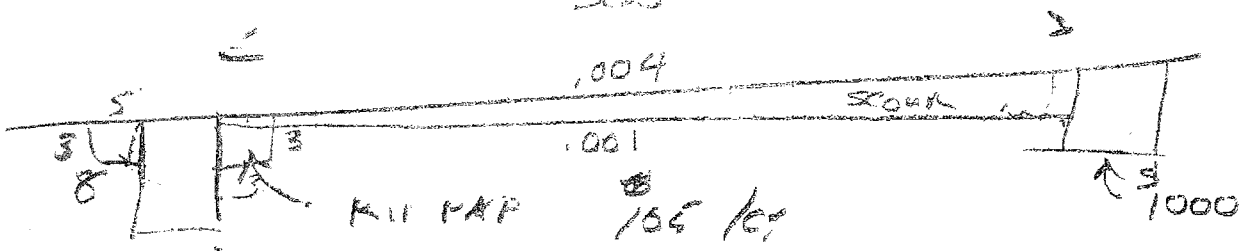
GROUP C

INTERIM CONDITION GRADE

CLSM @ 3,000 LF 3,000'

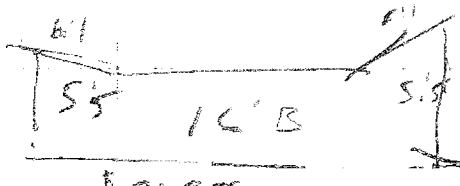
max 1' 1½ on 3

300'

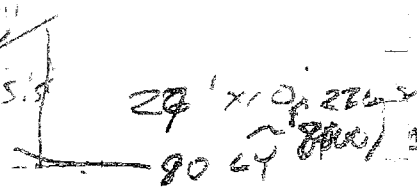


10' $52/(cu yd)/(lift)

3x3x27
5x3x27 - 24 CY x 2
1248



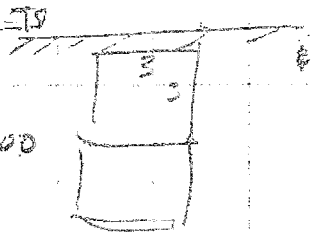
$9,698



29' x 10' x 2 = 580
90 CY

$30,000/1000'

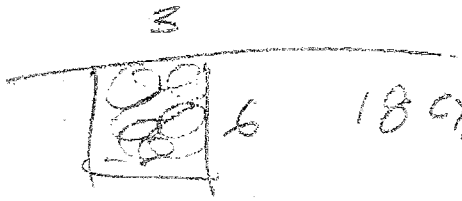
GABION BASKETS



$300/CY x 18 = $5400 ea

$18,200/1000

ROCK IN TRENCH



18 CY x 52 = 936/EA
100
1056 EA

$3200/100

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

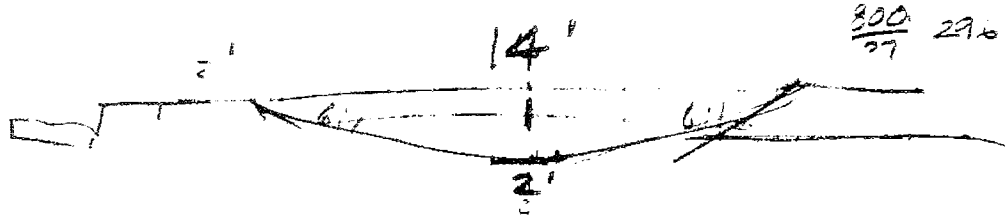
PROJECT WATSON PAGE 4 OF

DETAIL COMPUTED DATE

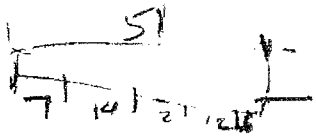
CHECKED BY DATE

WATER QUALITY

AG RUNOFF
NEW DEV – MIN WQ
STREETS IN –

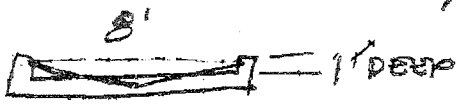


800/27 29.6



51' x 1000' x 0.5/12 = 2,125 FT³ 79 CY / 1,000'

LOW FLOW – CONC FOR INTERIM
IRRIG TAILWATER Keep out or



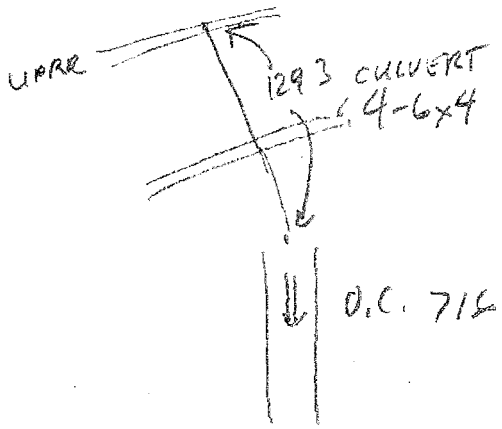
$\frac{18 \times 0.5}{27}$ 0.18 CY/FT ~ 8 75/LF
+ RIPRAP 1 CY/LF ~ 52/LF
127 LF

RAIN REDUCTION

N of UPRR
S of MC85

Watson Drainage System
Preliminary Cost Estimate - RTSPT2, Alternative A
Milestone: Alternatives Analysis

ID	Construction Item Description	Unit	Quantity	Unit Price	Total Cost
200	***REMOVALS AND RELOCATIONS***				
201	Clear and Grub	LS	1	68,200.00	68,200.00
205	Miscellaneous Removals	LS	1	34,100.00	34,100.00
207	Sawcut, Remove and Replace Pavement per MAG 200-B	SF	1,724	9.40	16,205.60
220	Remove Concrete Ditch	LF	30	30.00	900.00
250	Irrigation Pipe Relocation (18")	LF	30	96.00	2,880.00
290	Kinder-Morgan 20" Gas Pipeline Crossing	LS	1	960,000.00	960,000.00
291	ANPP 96" Reclaimed Water Pipeline Crossing	LS	1	380,000.00	380,000.00
293	BWCDD Canal Crossing	LS	1	450,000.00	450,000.00
295	Railroad Crossing	LS	1	240,000.00	240,000.00
296	Fiber Optic Line Relocation	LS	4	30,000.00	120,000.00
				Sub-Total	***2,272,285.60***
300	***CHANNEL & BASIN CONSTRUCTION ITEMS***				
301	Excavation	CY	6,945	6.00	41,670.15
305	Channel Subgrade Preparation	SY	4,728	6.30	29,783.32
351	AC Maintenance Road (2" AC on 6" AB)	SY	3,069	15.80	48,491.96
				Sub-Total	***119,945.42***
400	***STORM DRAIN CONSTRUCTION ITEMS***				
420	6' x 4' Concrete Box Culvert	LF	5,172	370.00	1,913,640.00
450	6' x 4' Concrete Box Culvert Wing Walls	EA	1	4,900.00	4,900.00
				Sub-Total	***1,918,540.00***
600	***LANDSCAPING CONSTRUCTION ITEMS***				
603	Decomposed Granite	SY	29,041	4.00	116,164.00
606	Turf (Sod)	SY	4,728	5.40	25,528.56
610	Tree (24" Box)	EA	198	184.00	36,432.00
613	Container Shrubs (5 gallon)	EA	396	22.00	8,712.00
614	Container Shrubs (1 gallon)	EA	594	10.90	6,474.60
621	Drip Irrigation System	SY	29,041	3.10	90,027.10
622	Turf Irrigation System	SY	4,728	3.70	17,491.79
630	Landscape Boulder (3.5' x 2.5' x 2')	EA	99	119.00	11,781.00
631	Landscape Boulder (4' x 3' x 2.5')	EA	60	153.00	9,180.00
				Sub-Total	***321,791.05***
700	***RIGHT-OF-WAY ACQUISITION***				
705	Industrial Property	SF	184,019	2.50	460,048.00
				Sub-Total	***460,048.00***
				Sub-Total	5,092,610.07
				Contingency	1,527,783.02
				Reach Total	6,620,393.10



1293 BR to DAYLIGHT

Dibble Engineering

CALC _____ DATE _____ JOB _____

CHKD _____ DATE _____ SHT ____ OF ____

TITLE _____

1- IF UTILITIES (K-M) (F.O.) IN UPRR HAVE 4' COVER, THEN ~~CAN~~ MAY BE ABLE TO GO OVER WITHOUT RELOCATIONS

SAVINGS = $2M ±

• NEED TO POTHOLE

2- KEEPING DRAINAGE SYSTEM SEPARATE FROM IRRIGATION SYSTEM @ UPRR ALLOWS TAILWATER TO CONTINUE IN WASTEWAY / DOWNSTREAM DELIVERY DITCH.

SAVINGS = $?

3- LOCATE UPRR CROSSING IN PROXIMITY OF EXISTING CULVERT

→ EXISTING UTILITIES ON D/S SIDE OF UPRR (3F.O. & K-M) MAY HAVE DIPPED FOR CULVERT CROSSING, & ∴ HAVE BETTER CHANCE OF GETTING OVER TOP OF UTILITIES W/O RELOCATION COSTS

4- TEMPORARY DIVERSION CHANNEL FOR BNCDD WOULD SAVE COST OF PERMANENT ROW FOR CANAL RELOCATION. HOWEVER, CANAL SECTION (250'±) WOULD STILL NEED TO BE REINFORCED (@ $60/SY)

(900'± × 150'± = 135,000 SF @ $1.50 = $202,520)

50' × 250' = 12,500 SF = 1,388 SY @ $60 = $83,340

5- OPEN CHANNEL VS BOX CULVERT FROM BNCDD SOUTH TO MC-85 ?

($1,500-$2,000 PER LF FOR BOX CULVERT)

(500 PER LF FOR CHAN)

1,200' ±

BOX = $2.4M + ROW (30' × 1200' × $2.50) = $90K ($2.49M)

CHAN = $600K + ROW (250' × 1200' × $2.5) = 750K = $1.35M

WHOLE PARCEL = 1,107,731 SF @ 2.5 = $2.77M + 600K = $3.37M

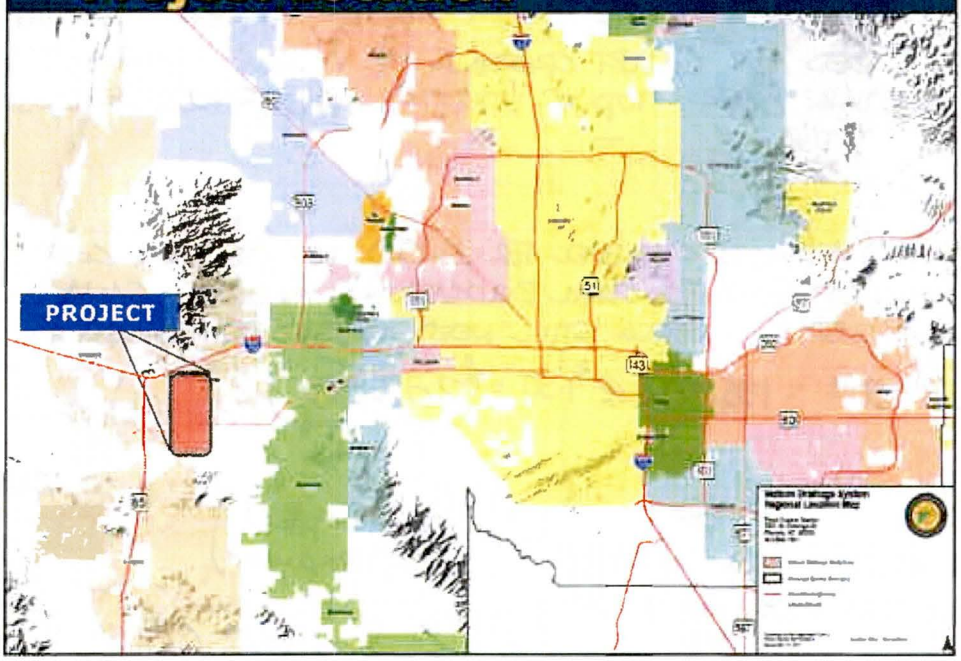
6. CONVEYANCE CHANNEL ON NORTH SIDE OF UPRR THROUGH WALMART, OPEN CHANNEL VS. BOX, DEPENDING ON ROW ENCROACHMENT INTO WALMART BASIN

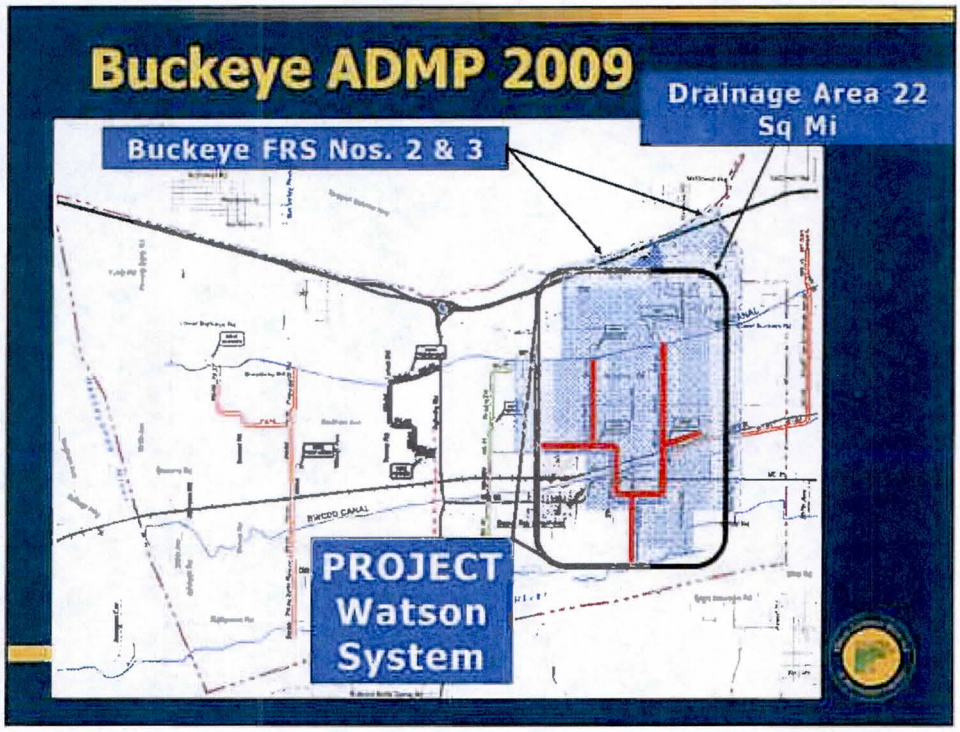
Value Analysis
June 17-18, 2013

WATSON DRAINAGE SYSTEM Pre-Design

Flood Control District
Gary Wesch, P.E.
Project Manager

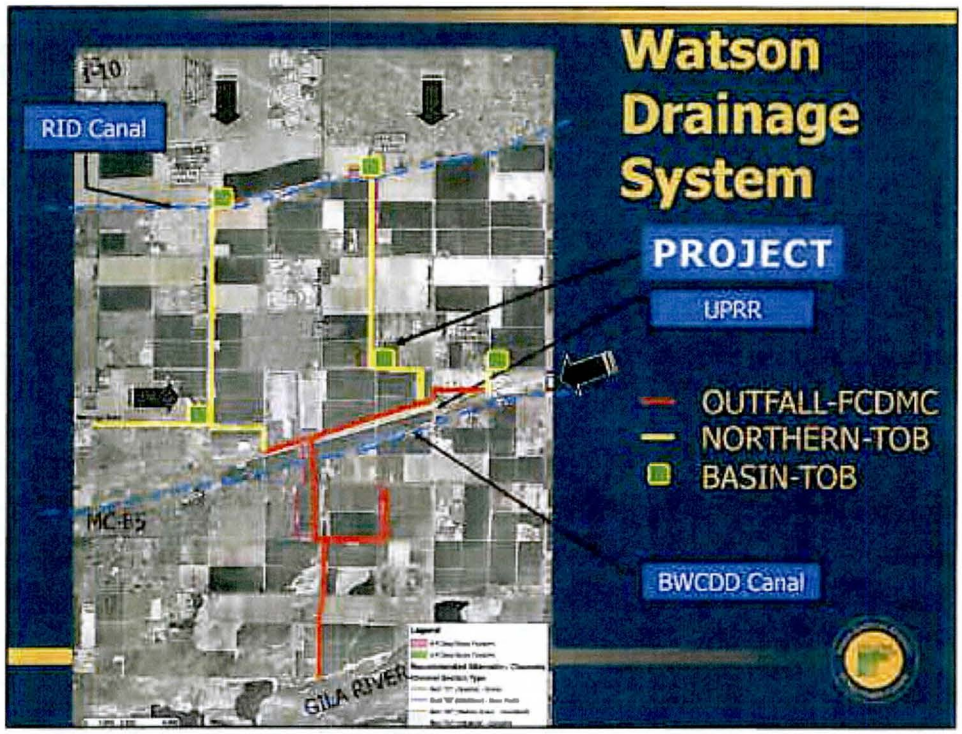
Project Location





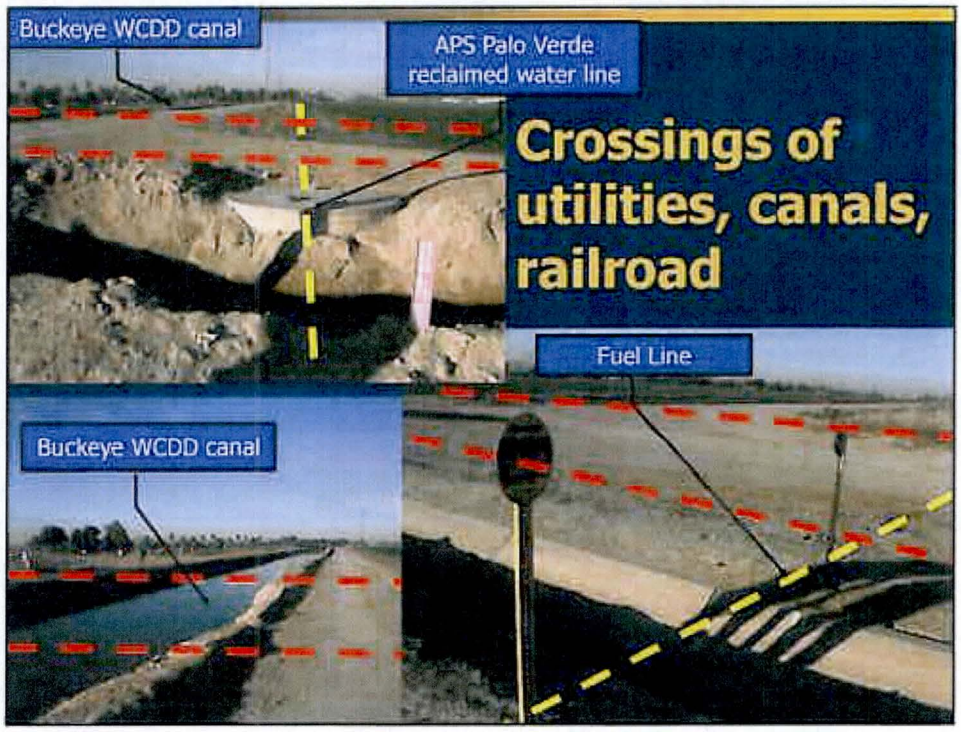
Pre-Design Process

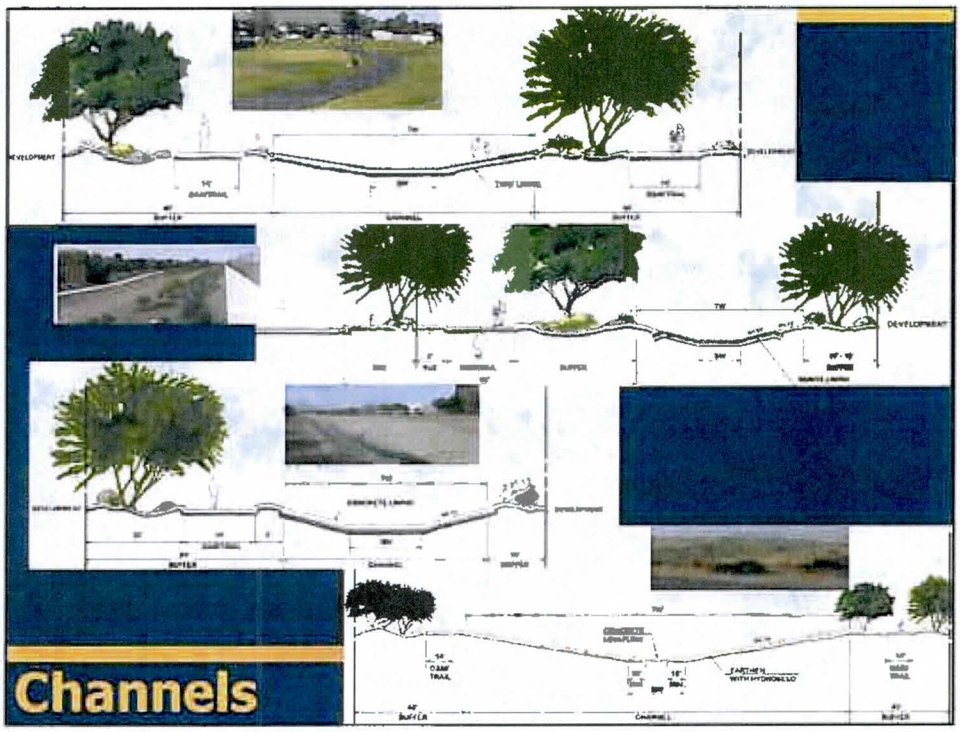
- Hydrology updated
- 3 Alternatives to ADMP identified
- Evaluation criteria (from ADMP)
- ADMP "Base" and 3 Alternatives evaluated
- Alternative "A" selected as recommended plan



Project Features

- 22 sq. miles drainage area, eastern part of ADMP
- 10+ miles of open channel and culverts
- 5 detention basins
- Design Flows range from 50 cfs to 1,100 cfs
- Crossings of UPRR, RID & BWCDD canals, APS Palo Verde pipeline, Kinder Morgan pipeline
- $76 Million Estimated Project Cost (incl. 30% contingencies)
  - $52 Million estimated Construction/Utility relocation for 10+ miles
  - $24 Million estimated ROW for 221 ac

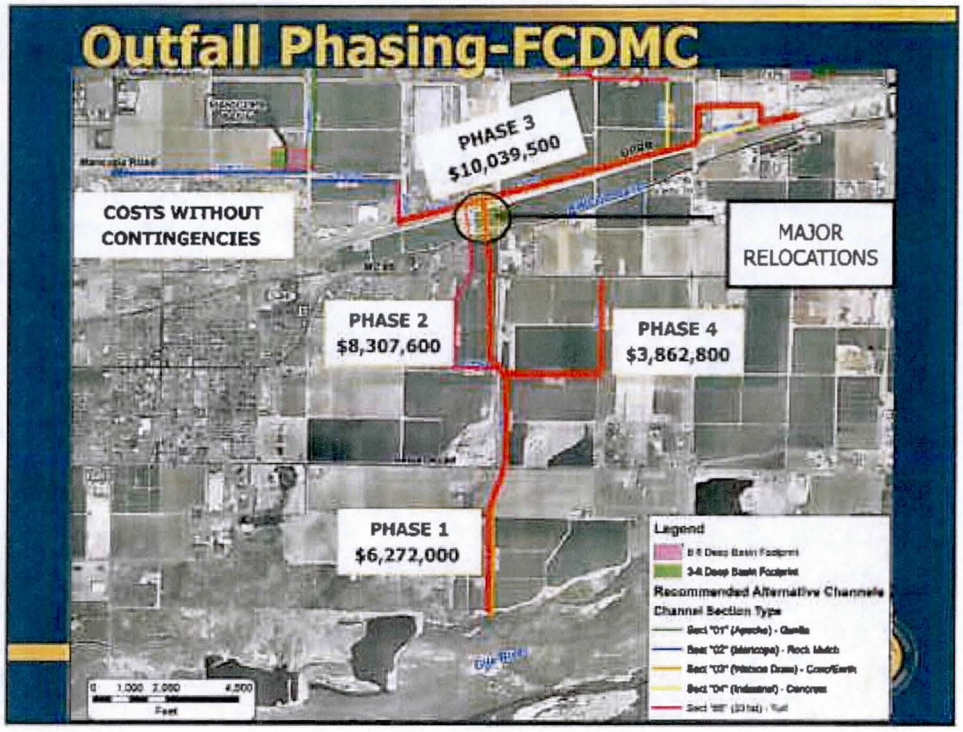

Buckeye WCDD canal
APS Palo Verde reclaimed water line
Crossings of utilities, canals, railroad
Fuel Line
Buckeye WCDD canal

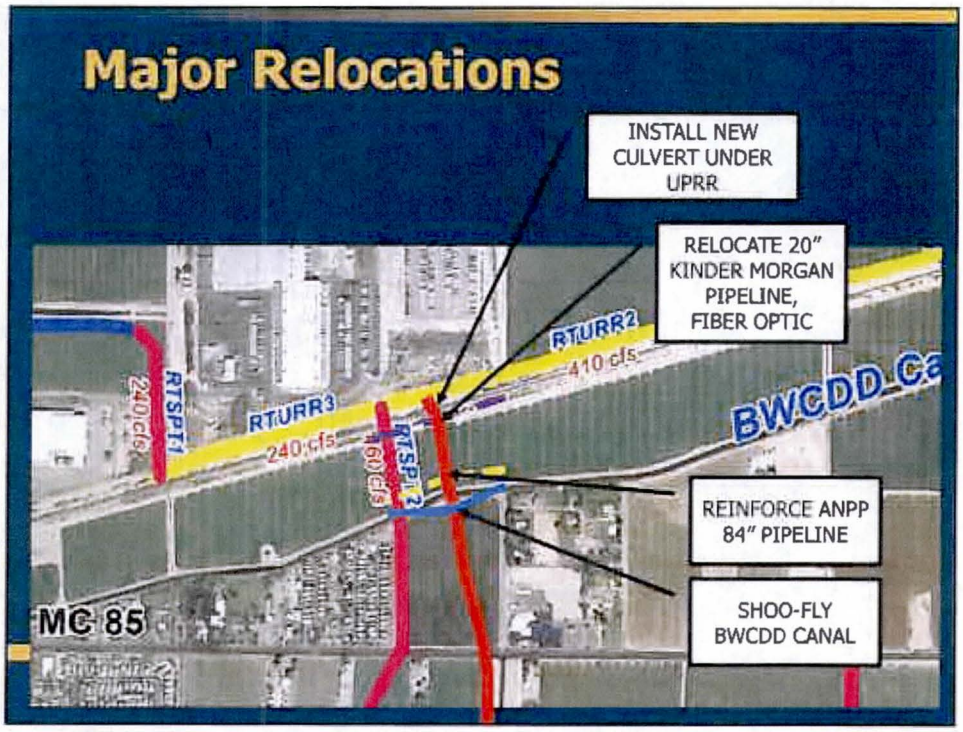

Channels

Basins

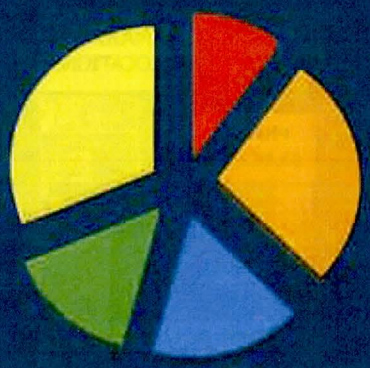
Implementation Steps

- 2010 Buckeye prioritization request included in 2012 CIP endorsed by FCAB
- 2012-2013 Pre-Design
  - Alternative Selected
  - Determine specifics of FCD/Buckeye responsibilities
- FCD : final design & construction from UPRR south to Gila River
  - 2014 Design
  - 2015 ROW & utility relocations
  - 2016 begin construction
- Buckeye : implement upstream of UPRR with future development & capital projects


Outfall Phasing-FCDMC
PHASE 3
$10,039,500
COSTS WITHOUT CONTINGENCIES
MAJOR RELOCATIONS
PHASE 2
$8,307,600
PHASE 4
$3,862,800
PHASE 1
$6,272,000
Legend
Recommended Alternative Channels
Channel Section Type


Major Relocations
INSTALL NEW CULVERT UNDER UPRR
RELOCATE 20" KINDER MORGAN PIPELINE, FIBER OPTIC
RTURR2
410 cfs
RTURR3
240 cfs
RTSPT1
240 cfs
RTSPT2
160 cfs
BWCDD Ca
REINFORCE ANPP 84" PIPELINE
SHOO-FLY BWCDD CANAL
MC 85

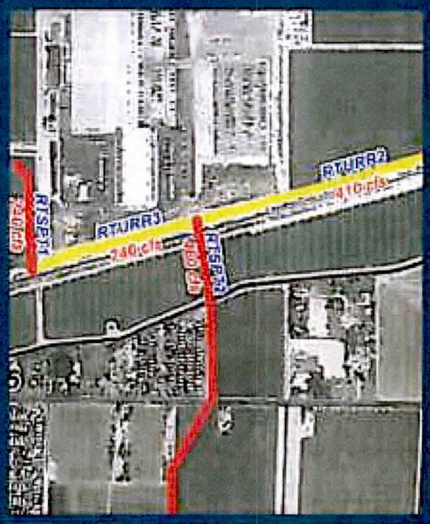
Project Costs-Alt A



- REMOVALS AND RELOCATIONS
- CHANNEL & BASIN CONSTRUCTION
- STORM DRAIN CONSTRUCTION
- LANDSCAPING CONSTRUCTION
- RIGHT-OF-WAY ACQUISITION

COSTS WITHOUT CONTINGENCIES		
$	5,886,863	10%
$	15,882,243	27%
$	9,994,926	17%
$	8,432,296	14%
$	18,298,954	31%
$	58,495,281	TOTAL

UPRR/BWCDD Crossing



UPRR/BWCDD Crossing

Potential Cost-Saving/Value-Adding Measures

1. **Design UPPR crossing to go OVER the existing utility facilities in the corridor**
   - Kinder-Morgan Petroleum
   - (5) Fiber Optic Lines
   - Preliminary system layout indicates potential
   - Contingent upon results of potholing
   - Recommend potholing at 2 locations
     - Near existing UPRR culvert
     - 100'-200' east of existing UPRR culvert

POTENTIAL COST SAVINGS = $2M

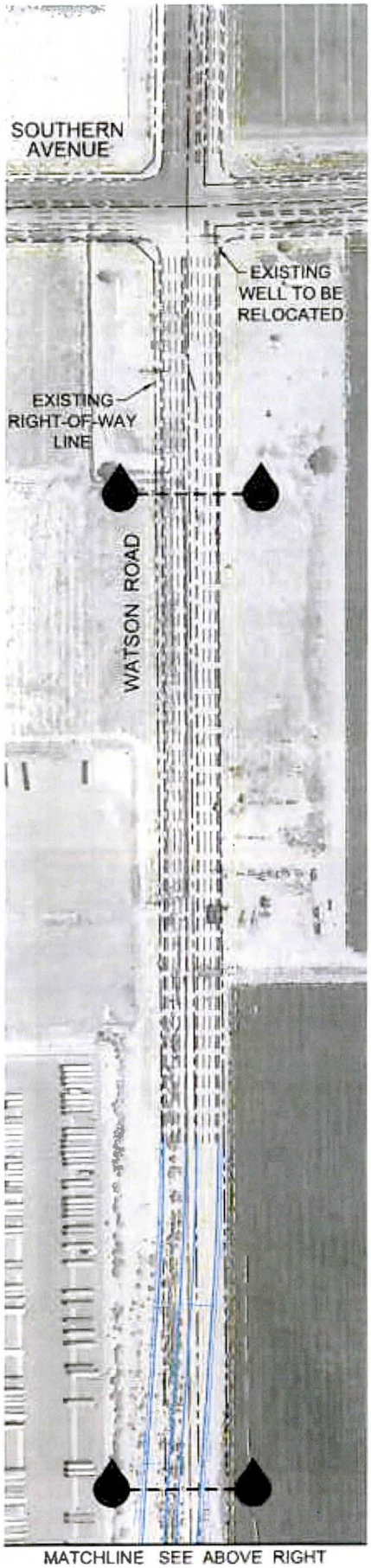
UPRR/BWCDD Crossing

Potential Cost-Saving/Value-Adding Measures

2. **Keep irrigation system separate from drainage system (tailwater recapture)**
   - Avoid the need for a pump station/system to return the tailwater to "elevated" downstream facilities

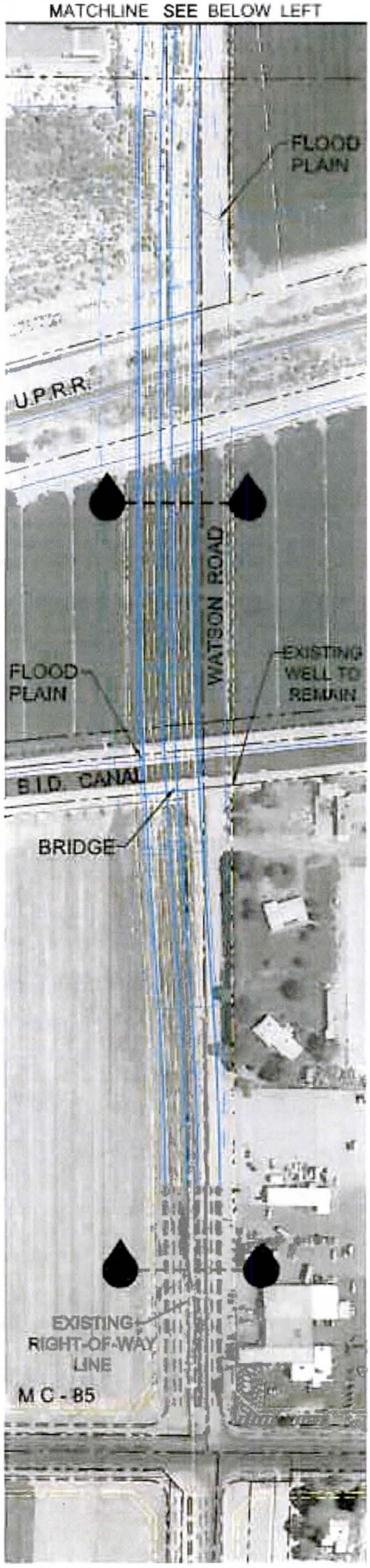
POTENTIAL COST SAVINGS = $??

BRIDGE / OVERPASS GRADE SEPARATED ROADWAY



MATCHLINE SEE ABOVE RIGHT

MATCHLINE SEE BELOW LEFT



NORTH

SCALE : 1" = 200'

WATSON ROAD	EXHIBIT	TOWN OF BUCKEYE

WATSON VALUE ENGINEERING ANALYSIS

6·17·2013

GARY WESCH
ART GLOVER
RICHARD WISNIEWSKI
SCOTT ZUPPKA
MIKE DUNCAN
SHIMIN LI
MARK LEWIS
JOHN GRIFFIN
KEVIN ROBERTS
JEFF RUDDLE

AREAS TO FOCUS ON / CANDIDATE AREAS FOR IMPROVEMENT:

- UPRR CROSSING
- BNCDD REALIGNMENT
- GILA RIVER OUTFALL
- "INTERIM" CONDITIONS

FOCUS AREAS:

- UPRR
- BNCDD
  - SHOO FLY
  - PRECAST BRK DURING DRY UP (SEE RID/RAINBOW RD)
  - OVERSHOOT — IS THIS APPROVABLE?
  - CONTINUOUS TRAIL
- INTERIM CONDITIONS
- ↳ ULTIMATE = TURF
  - ↳ INTERIM - RIPRAP CHECK DAMS?
- GILA RIVER OUTFALL
  - DIAGONAL TO LAKE (?)
  - ←
  - WATER QUALITY
    - RUNOFF - AG
    - FIRST FLUSH
      - DEVELOPMENTS (100 YR 2HR RETENTION)
      - ROADS
        - FIRST FLUSH FACILITIES
- · SKIRT COMEX PROPERTY?
- · COMEX DIGS HOLE / GRANT EASEMENT?

* FINAL REPORT (?) SHOULD HAVE A SECTION REGARDING FIRST FLUSH CRITERIA FOR ADJACENT DEVELOPMENT - REQUESTED BY SCOTT ZUPPKA

- UPRR CHANNEL - INDUSTRIAL
  - CONCRETE CHANNEL
    - STEEPER SIDESLOPES
    - PIPES (CIPP?)

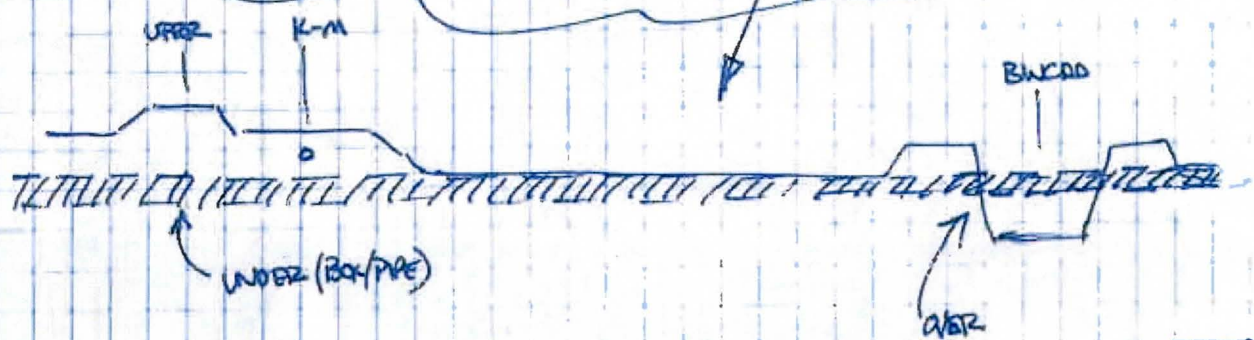
FCD DOESN'T DO SHOTCRETE/GUNITE

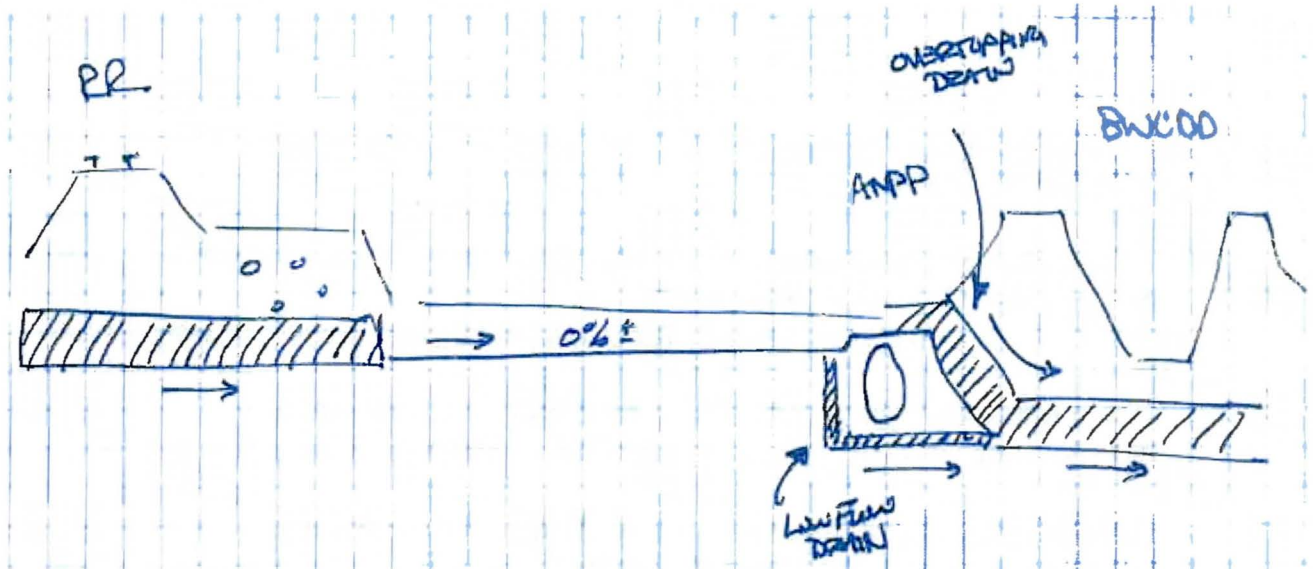
- COMBINE FLOWS INTO BWCOD CANAL?
- RID CROSSINGS
  - DIRECTIONAL BORE?

- WHAT IS EXISTING CAPACITY OF EXISTING WATSON DRAIN BETWEEN BELOAT RD & RIVER?
  - CAN WE GET AGREEMENT W/ CONOCO FOR THEM TO DIG CHANNEL & DEDICATE DRAINAGE EASEMENT?
    - AVOID PAYING FOR MINERAL RIGHTS, COST TO CURE, ETC.
  - COULD LOCATE BASIN @ SWC OF BELOAT/WATSON TO ATTENUATE FLOWS, ~~TO~~ TO MAINTAIN EXISTING FLOWS?
  - REPLACE EXISTING PIPES. USE EXIST. DRAIN UNTIL CONOCO EXCAVATES PIT THAT BECOMES OUTFALL.
  - TEMP BASIN @ SWC BELOAT/WATSON DRAIN
  - TRAIL ON CONOCO BERM
  - WATSON DRAIN UPGRADES

A.1. ?

- BNCDD OVERSHOOT VS. UNDER CROSSING
  - LINING REQ. 100' BEYOND PROPOSED IMPACTS
    - 4"-6" CONCRETE W/ WWF REINFORCEMENT
- KINDER MORGAN
  - 100' SEGMENT HORIZONTAL REPLACEMENT (LOP 303 PROJECT) $930K
  - CAN WE GO UNDER
- * CAN WE GO UNDER UPRR & K-M, BUT OVER BNCDD?
  - DEVELOP PROFILE FOR THIS





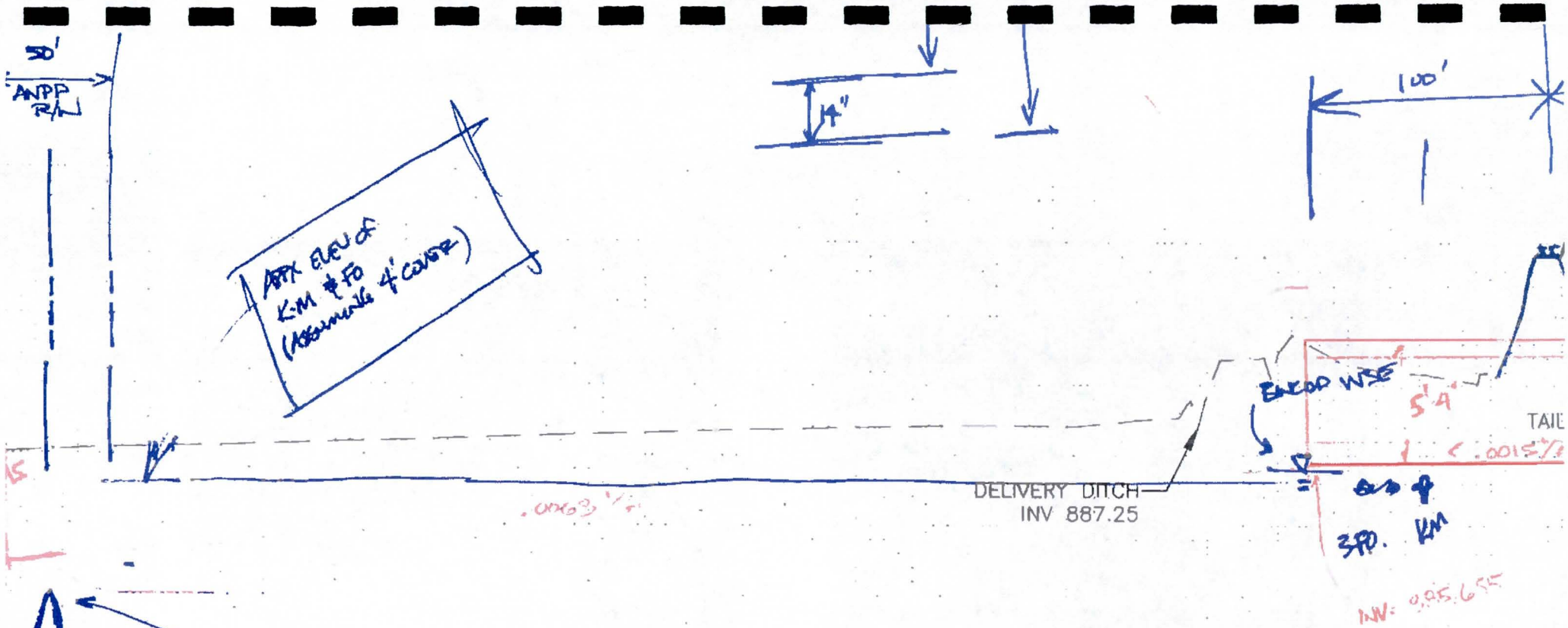
* SHOULD WE CONSIDER STEEPER SIDE SLOPES FOR THE CONCRETE/GUNITE SECTIONS?
  - WOULD NEED TO ADD FENCE OR RAILING
  - FCD WOULD ALLOW 2:1 OR MAYBE 1.5:1

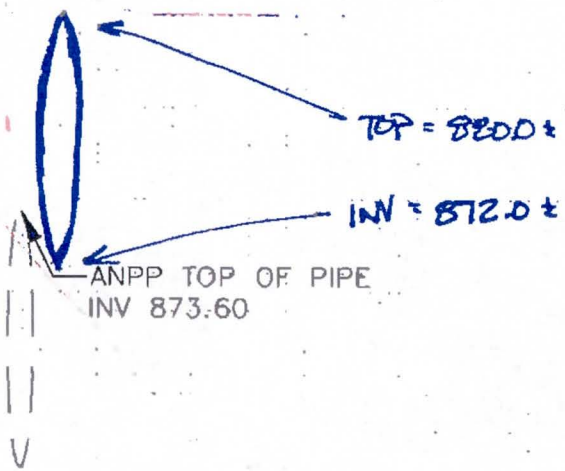
IDEA GROUPS:

(A) OUTFALL @ GILA — SHUMAN, ART GLABER, MARK LOMAS

(B) UPRR/BNCDD
KINDER MORGAN & F.O. — KOW, SCOTT, MIKE D

(C) INTERIM CONDITIONS
WATER QUALITY
UPRR/INDUSTRIAL CHANNEL — GARY, JOHN G, JEFF R, RICARDO





871.0±

16.95' V / 24' H 2.2 : 1 (H) (V)

CRITICAL ?'s:

- WHERE ARE UTILITIES IN UPRR?
- WHERE IS ANPP LINE HORIZONTALLY?
- TRASH RACKS / ACCESS BARRIERS?
- HOW DEEP IS COLLECTION CHANNEL @ UPSTREAM SIDE OF UPRR?
-

OTHER:

THEN DROP COULD BE

OTHER:

UPRR/BWCDD Crossing

Potential Cost-Saving/Value-Adding Measures

3. **Temporary diversion channel for BWCDD crossing construction in lieu of permanent realignment**
   - Avoid the cost of permanent ROW for the realigned canal
   - BWCDD canal lining costs remain the same
   - Only effective IF whole parcel is NOT taken (no impact if whole parcel take)

POTENTIAL COST SAVINGS = $166K

UPRR/BWCDD Crossing

Potential Cost-Saving/Value-Adding Measures

4. **Conveyance system from BWCDD to MC85: Box Culvert vs. Open Channel?**
   - Box culvert
     - May only require 30' of ROW
     - Cost of box = $2.4M
     - Cost of 30' strip of ROW = $90K
     - Total cost = $2.49M

UPRR/BWCDD Crossing

Potential Cost-Saving/Value-Adding Measures

4. **Conveyance system from BWCDD to MC85: Box Culvert vs. Open Channel?**
   - Open Channel (STRIP OF ROW)
     - Could require 250' of ROW
     - Cost of channel = $600K
     - Cost of 250' strip of ROW = $750K
     - Total cost = $1.35M

UPRR/BWCDD Crossing

Potential Cost-Saving/Value-Adding Measures

4. **Conveyance system from BWCDD to MC85: Box Culvert vs. Open Channel?**
   - Open Channel (FULL PARCEL TAKE)
     - Cost of channel = $600K
     - Cost of full parcel = $2.77M
     - Total cost = $3.37M

POTENTIAL COST SAVINGS (Channel)= $1.14M
POTENTIAL COST SAVINGS (Box vs Parcel)= $880K

A - OUTFALL - GILA

- AGREEMENT w/CEMEX TO
  FCD NOT PAY FOR MINERAL RIGHTS
  MINE AREA OF CHANNEL, MAINTAIN
  HYDRAULICS OF OUTFALL
  ACCEPT RUNOFF FROM CHL

ART, SHIMIN, MARK

- REPLACE EX. PIPES IN WATSON DRAIN
  USE EX. DRAIN UNTIL CEMEX
  EXCAVATES PIT THAT BECOMES OUTFALL

- TEMP BASIN - VISS/LONGHENRY/TERRER,
  USE EX WATSON DRAIN

- TRAIL ON CEMEX BERM

- WATSON DRAIN UPGRADES

FOCUS AREAS

CROSSINGS

B UPRR - BOX ORCHL
DOUBLE TRACK
SPAN ENTIRE 200' RW

BWCDD

KEVIN, SCOTT MIKE

SHOO FLY

PRECAST BOX DURING DRY-UP
└ RID/RAINBOW

OVERSHOOT - APPROVABLE

C INTERIM CONDITIONS

RICHARD, JOHN JEFF GARY

CONTINUOUS TRAIL — DRY UP 100' EACH SIDE
LINER - 4" THK WWF SHOTCRETE

└ ULT-TURF

RIPRAP - DROPS/CHECK DAMS

A GILA RIVER OUTFALL

· DIAGONAL TO LAKE

· SKIRT CEMEX PROPERTY

- CEMEX DIGS HOLE/GRANTESMT

NON STRUCTURAL SOL'N

COMPENSATE FOR INCREASED FLOWS

13

KINDER MORGAN

1/4 30' 100' SEGMENT (303) RELOCATE IN PLACE

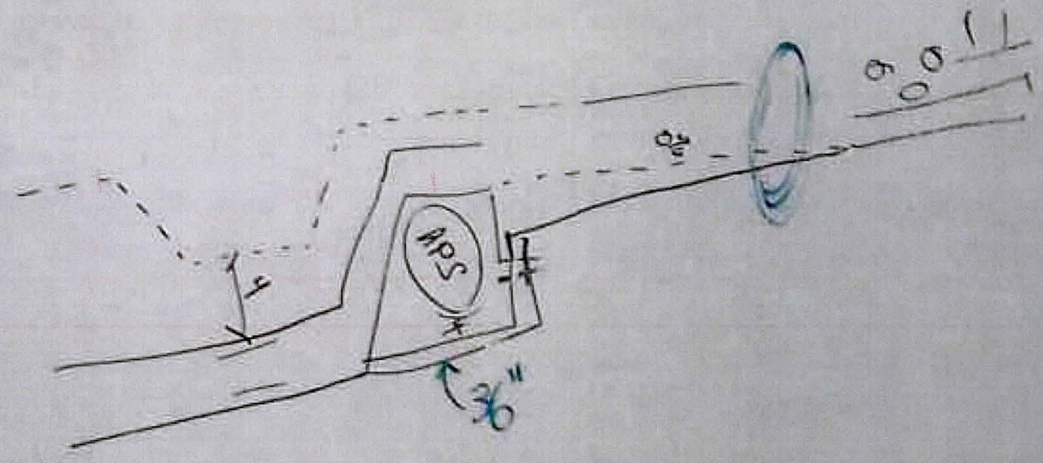
HORIZ. RELOCATION

UNDER KM (NORTHERN PKWY, ~~AVE~~)

WIDER/SHALLOW

COST SHARE/WATSON PKWY

OVER/UNDER ANPP + UNDER KM



ROBS
FENCE

WATER QUALITY

- RUNOFF - AG
- FIRST FLUSH
  - DEVELOP 100/2H RETEN
  - ROADS
    - FIRST FLUSH

UPRR CHANNEL - INDUSTRIAL

- CONCRETE CHL / GUNITE - SHOTCRETE
  6" - #4" ROR
  - SS - STEEPER
  - PIPES (CIPP)

FCD DOESN'T DO, QC PROBS

STEEPER S:S, HANDRAIL/FENCE

2:1 STEEPEST.

COMBINE FLOWS INTO BWCDD CANAL

RID CROSSINGS

- DIRECTIONAL BORE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

PROJECT _____ PAGE ____ OF ____

DETAIL _____ COMPUTED _____ DATE ____

CHECKED BY _____ DATE ____

SAVINGS

B UPRR/BWCOD

1. OVER EXIST FACILITIES W/O RELOCATING — $2,000,000

2. KEEP IRRIG SYS. SEP FROM DRAINAGE AVOID PUMP STATION — ?

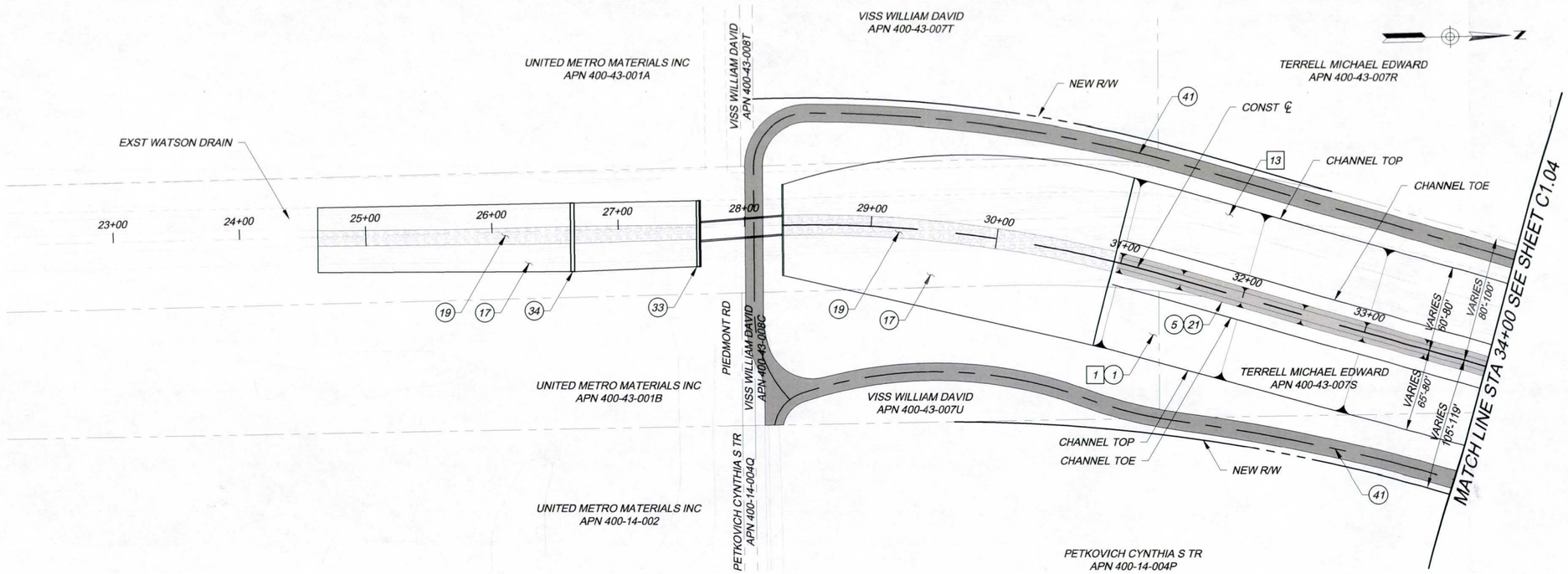
3. BWCOD TEMP DIVERSION CHL CROSSING CONST PERM REM COST IF WHOLE PARCEL NOT TAKEN — 0.166 M

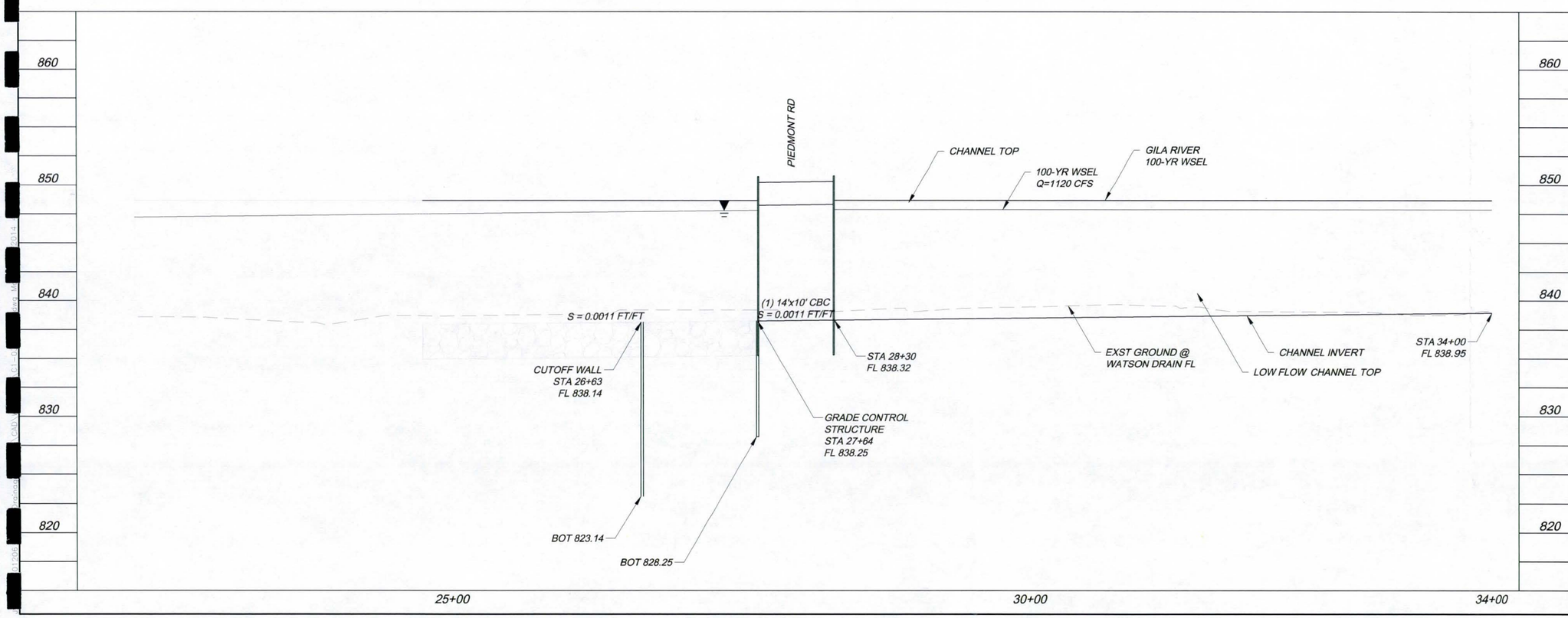
4. BWCOD TO MC85 1600 FT
- BOX CULVERT / 30' ROW — $2.49 M
- 2-8x4 — $1.35 M
- OPEN CHL 250' STRIP — $3.37 M
- IF ENTIRE PARCEL ACQ — $2.77 M
- ALT'A assumed BOX

$1.14 M

0.88 M

TOT. $3.2 M





REMOVAL NOTES

1 CLEAR & GRUB
13 REMOVE RIPRAP
51 REMOVE IRRIGATION PIPE

CONSTRUCTION NOTES

1 CHANNEL EXCAVATION
5 CHANNEL SUBGRADE PREPARATION
17 DUMPED RIPRAP (D50=12")
19 DUMPED RIPRAP (D50=18")
21 REINFORCED CONCRETE CHANNEL LINING STR SEC 3, DWG G1.04
33 VERTICAL DROP STRUCTURE DTL 11, DWG D1.03
34 GILA RIVER OUTFALL CUTOFF WALL DTL 6, DWG D1.01
41 AC MULTI-USE PATH STR SEC 1, DWG G1.04
59 (1) 12'X10' BOX CULVERT
62 CONCRETE BOX CULVERT WING WALLS
80 24" IRRIGATION PIPE
83 IRRIGATION HEADWALL MAG STD DTL 501-1

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

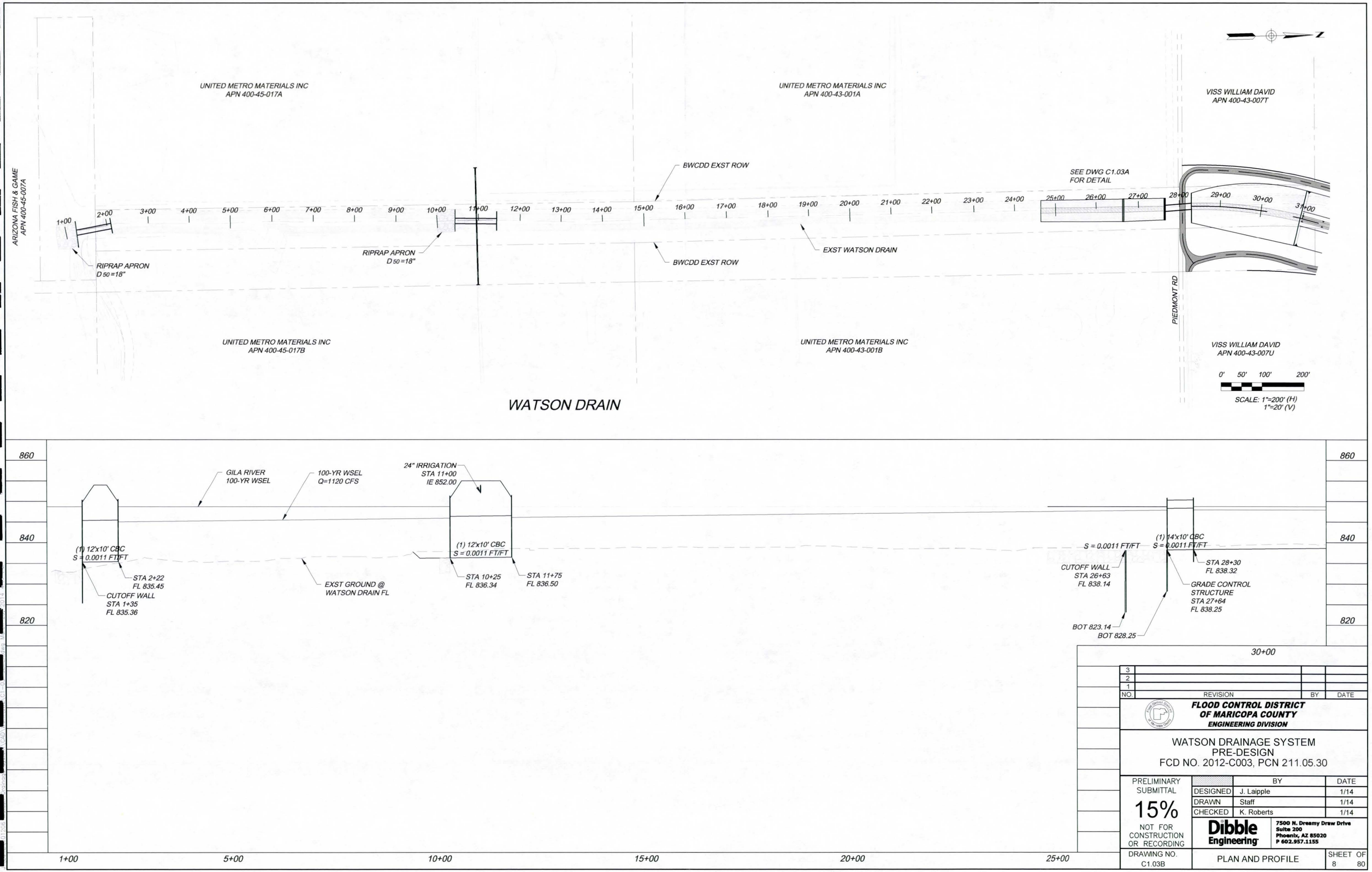
WATSON DRAINAGE SYSTEM
PRE-DESIGN
FCD NO. 2012-C003, PCN 211.05.30

PRELIMINARY SUBMITTAL
15%
NOT FOR CONSTRUCTION OR RECORDING

	BY	DATE
DESIGNED	J. Laipple	1/14
DRAWN	Staff	1/14
CHECKED	K. Roberts	1/14

Dibble Engineering
7500 N. Dreamy Draw Drive
Suite 200
Phoenix, AZ 85020
P 602.957.1155

DRAWING NO. C1.03A
PLAN AND PROFILE
SHEET 8 OF 80



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3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

WATSON DRAINAGE SYSTEM
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Dibble Engineering
7500 N. Dreamy Draw Drive
Suite 200
Phoenix, AZ 85020
P 602.957.1155

DRAWING NO. C1.03B

PLAN AND PROFILE

SHEET 8 OF 80

GEOTECHNICAL EVALUATION
WATSON DRAINAGE SYSTEM PRE-DESIGN
WATSON ROAD, MILLER ROAD TO RAINBOW ROAD
BUCKEYE, ARIZONA

PREPARED FOR:
Dibble Engineering
7500 North Dreamy Draw Drive, Suite 200
Phoenix, Arizona 85020

PREPARED BY:
Ninyo & Moore
Geotechnical and Environmental Sciences Consultants
3202 East Harbour Drive
Phoenix, Arizona 85034

December 3, 2013
Project No. 603770001

December 3, 2013
Project No. 603770001

Mr. Kevin Roberts, PE
Dibble Engineering
7500 North Dreamy Draw Drive, Suite 200
Phoenix, Arizona 85020

Subject: Geotechnical Evaluation
Watson Drainage System Pre-Design
Watson Road, Miller Road to Rainbow Road
Buckeye, Arizona

Dear Mr. Roberts:

In accordance with our proposal dated July 25, 2012, and your authorization, Ninyo & Moore has performed a geotechnical evaluation for the above-referenced site. The attached report describes our evaluation methodology and presents our findings, conclusions, and recommendations regarding the geotechnical conditions at the project site.

We appreciate the opportunity to be of service to you during this phase of the project.

Sincerely,
NINYO & MOORE

Jeff S. Rodgers, PG
Project Geologist

Steven D. Nowaczyk, PE
Principal Engineer

Registered Professional Engineer (Civil)
CERTIFICATE NO. 34866
STEVEN D. NOWACZYK
Date Signed 12-3-13
ARIZONA U.S.A.
EXPIRES 06/30/2015

JSR/KLP/SDN/clj

Distribution: (1) Addressee (Electronic Copy)

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Appendix A – Boring Logs
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1. INTRODUCTION

In accordance with our proposal dated July 25, 2012, and your authorization, we have performed a geotechnical evaluation for the Watson Drainage System Pre-Design project in Buckeye, Arizona. The purpose of our evaluation was to assess the subsurface conditions at the project site in order to formulate geotechnical recommendations for design. This report presents the results of our evaluation along with our geotechnical conclusions and recommendations regarding the proposed construction.

2. SCOPE OF SERVICES

The scope of our services for the project generally included:

- Conducting a visual geologic reconnaissance of the area and reviewing background information including geologic maps and aerial photographs.
- Conducting a site visit to select and mark out the boring locations and notifying Arizona Blue Stake of the locations prior to drilling.
- Drilling, logging, and sampling six small-diameter exploratory borings to approximately 10 feet below ground surface (bgs). The boring logs are presented in Appendix A.
- Performing laboratory tests on selected samples obtained from our borings to evaluate the in-situ moisture content and dry density, gradation analysis, Atterberg limits, consolidation (response-to-wetting), and corrosivity characteristics (including pH, minimum electrical resistivity, and soluble sulfate and chloride contents). The results of the laboratory testing are presented on the boring logs and/or in Appendix B.
- Preparing this report presenting our findings, conclusions, and recommendations regarding the design and construction of the project.

Environmental sampling and testing is a part of our scope of services for this project; however, Ninyo & Moore was requested not to perform these services at this time.

3. SITE DESCRIPTION

The project site is located in Sections 21, 22, 27, 28, 32, 33, and 34 in Township 1 North, Range 3 West, and in Sections 3 and 4 in Township 1 South, Range 3 West in Buckeye, Arizona. The

approximate location of the site is depicted on Figure 1. At the time of our evaluation, the project site was generally surrounded by agricultural land with scattered structures and roads. The White Tank Mountains were situated approximately 3 miles to the north, and the Estrella Mountains were situated approximately 5 miles to the south. The Gila River traversed in a northeast-southwest direction at the southern limits of the site. The Roosevelt Irrigation District (RID) Canal was situated near the northern limits of the site. The Buckeye Canal and the Union Pacific Railroad dissects the alignment near the middle of the site. An unlined irrigation ditch traversed along Apache Road from the RID Canal south to Maricopa Road. Another irrigation ditch traversed along Watson Road from Monroe Avenue to the Gila River.

According to the *Valencia and Buckeye, Arizona, 7.5-Minute United States Geological Survey (USGS) Topographic Quadrangle Maps (2011),* the elevation at the project site is approximately 1,000 feet relative to mean sea level (MSL) near the northern limits and at approximately 860 feet MSL at the southern limits. Based on information from these quadrangle maps, the regional topography at the site slopes from the north down to the south towards the Gila River.

Several aerial photographs from the Flood Control District of Maricopa County were reviewed for this project. Aerial photographs from 1949 depict the site as being used for agricultural land. Scattered small structures were observed along the project alignment. The RID and Buckeye Canals and the Union Pacific Railroad were observed in this photograph. Aerial photographs from 1997, 2003, and 2009 depicted the site as being similar to its current condition, with residential structures constructed to the south of Maricopa Road and west of Apache Road. A commercial structure was depicted in this photograph near the northeast corner of 239th Avenue and Maricopa Road.

4. PROPOSED CONSTRUCTION

The project consists of the design and construction of a new drainage system to be constructed along Apache Road from just north of the RID Canal to Maricopa Road, and along Maricopa Road from approximately 600 feet east of Miller Road to 239th Avenue. The system extends

along 239th Avenue from Maricopa Road to Monroe Road, and west along Monroe Road to 231st Avenue. Another project alignment may start north of the RID Canal to Monroe Avenue along 231st Avenue. The alignment may also extend along Watson Road from Monroe Avenue to the Gila River. New basins may be constructed to the north of the RID Canal and near the northeast corner of Apache Road and Maricopa Road, and one situated to the north of the Buckeye Canal. At the time of our evaluation, the design of the new drainage system was not yet completed; however, we assume that the design will consist of unlined open cut channels and concrete box culverts.

5. FIELD EXPLORATION AND LABORATORY TESTING

On February 13, 2013, Ninyo & Moore conducted a subsurface evaluation at the project site in order to evaluate the existing subsurface conditions and to collect soil samples for laboratory testing. Our evaluation consisted of drilling, logging, and sampling six small-diameter borings denoted as B-1 through B-6. The borings were advanced using a CME-55 truck-mounted drill rig equipped with hollow-stem augers and extended to approximately 10 feet bgs. Bulk and relatively undisturbed soil samples were collected at selected intervals. Detailed descriptions of the soils encountered are presented on the boring logs in Appendix A. The general locations of the borings are depicted on Figure 2.

Ninyo & Moore personnel logged the borings in general accordance with the Unified Soil Classification System (USCS) and American Society for Testing and Materials (ASTM) D 2488 by observing cuttings and drive samples. Collected ring samples were trimmed in the field, wrapped in plastic bags, and placed in cylindrical plastic containers to retain in-place moisture conditions. Similarly, the Standard Penetration Test (SPT) and bulk samples were sealed in plastic bags to retain their approximate in-place moisture.

The soil samples collected from our drilling activities were transported to the Ninyo & Moore laboratory in Phoenix, Arizona, for geotechnical laboratory testing. The testing included in-situ moisture content and dry density, gradation analyses, Atterberg limits, consolidation (response-

to-wetting) and corrosivity characteristics (including pH, minimum electrical resistivity, and soluble sulfate and chloride contents). The results of the in-situ moisture content and dry density tests are presented on the boring logs in Appendix A. A description of each laboratory test method and the remainder of the test results are presented in Appendix B.

6. GEOLOGY AND SUBSURFACE CONDITIONS

The following sections describe the geologic and subsurface conditions at the site.

6.1. Geologic Setting

The project site is situated along the boundary of the Sonoran Desert Section of the Basin and Range Physiographic Province and the Transition Zone (also referred to as the Central Highlands), which is typified by broad alluvial valleys separated by steep, discontinuous, subparallel mountain ranges. The mountain ranges generally trend north-south and northwest-southeast. The basin floors consist of alluvium with thickness extending to several thousands of feet.

The basins and surrounding mountains were formed approximately 10 to 18 million years ago during the mid- to late-Tertiary age. Extensional tectonics resulted in the formation of horsts (mountains) and grabens (basins) with vertical displacement along high-angle normal faults. Intermittent volcanic activity also occurred during this time. The surrounding basins filled with alluvium from the erosion of the surrounding mountains, as well as from river deposition. Coarser-grained alluvial material was deposited at the margins of the basins near the mountains.

The surficial geology of the site is described as Holocene-age (less than 10,000 years) and Middle to Late Pleistocene-age (10,000 to 790,000 years) alluvial fan and river deposits. The site soils are generally described as deposits of silt, sand, and gravel with varying amounts of clay layers. Stage I to II (scattered specks to partial grain coating) calcic horizons were

described in the Holocene-age soils, while Stage II to IV (cemented layer) calcic horizons were described in the Pleistocene-age material.

6.2. Subsurface Conditions

Our knowledge of the subsurface conditions at the project site is based on the results of our field exploration, laboratory testing, and our understanding of the general geology of the area. The following sections provide a generalized description of the materials encountered in our borings. More detailed descriptions are presented on the boring logs in Appendix A.

While not encountered at our boring locations during our field exploration, tilled alluvium could be encountered at the surface along the project alignment during construction. This material is generally loose and can extend to several feet thick.

6.2.1. Fill

Man-placed fill was encountered at the surface of borings B-4 through B-6 and ranged in thickness from approximately 1 to 5 feet. The fill generally consisted of silty sand and clayey sand in our borings.

6.2.2. Alluvium

Alluvium was encountered at the surface of borings B-1 through B-3, and underlying the fill in the remaining borings. The alluvium extended to the total explored depths. The alluvium generally consisted of clay, clayey sand, and silty sand in our borings. Varying amounts of gravel and scattered caliche nodules were observed in our borings.

6.3. Groundwater

Groundwater was not encountered in our borings. Based on well data provided by the Arizona Department of Water Resources (ADWR, 2013), the depth to the regional groundwater table, as measured in wells situated near the site, has been estimated to be on the order of 100 feet bgs near the northern project limits and on the order of 10 feet bgs near

the southern project limits near the Gila River. Groundwater levels may fluctuate due to the close proximity to the Gila River, adjacent ditches and canals, seasonal variations, irrigation, groundwater withdrawal or injection, and other factors.

7. GEOLOGIC HAZARDS

The following sections describe potential geologic hazards at the site such as land subsidence and earth fissures, faulting, and liquefaction.

7.1. Land Subsidence and Earth Fissures

Groundwater depletion, due to groundwater pumping, has caused land subsidence and earth fissures in numerous alluvial basins in Arizona. It has been estimated that subsidence has affected more than 3,000 square miles and has caused damage to a variety of engineered structures and agricultural land (Schumann and Genualdi, 1986). From 1948 to 1983, excessive groundwater withdrawal has been documented in several alluvial valleys where groundwater levels have been reportedly lowered by up to 500 feet. With such large depletions of groundwater, the alluvium has undergone consolidation resulting in large areas of land subsidence.

In Arizona, earth fissures are associated with land subsidence and pose an on-going geologic hazard. Earth fissures generally form near the margins of geomorphic basins where significant amounts of groundwater depletion have occurred. Reportedly, earth fissures have also formed due to tensional stress caused by differential subsidence of the unconsolidated alluvial materials over buried bedrock ridges and irregular bedrock surfaces (Schumann and Genualdi, 1986).

Based on our field reconnaissance and review of the referenced material, there are no known earth-fissures underlying the project site. Based on our research, the closest documented earth fissure is located approximately 10 miles to the north of the site. Continued groundwater withdrawal in the area may result in subsidence and the formation of new fissures or the

extension of existing fissures. While the future occurrence of land subsidence and earth fissures cannot accurately be predicted, these phenomena are not expected to be a constraint to the construction of this project.

7.2. Faulting

The site lies within the Sonoran zone, which is a relatively stable tectonic region located in southwestern Arizona, southeastern California, southern Nevada, and northern Mexico (Euge et al., 1992). This zone is characterized by sparse seismicity and few Quaternary faults. Based on our field observations, review of pertinent geologic data, and analysis of aerial photographs, faults are not located on or adjacent to the property. The closest fault to the site is the Sand Tank Fault, situated approximately 35 miles to the south of the site (Pearthree, 1998). The Sand Tank Fault is situated along the western piedmont of the Sand Tank Mountains, to the southeast of Gila Bend. The fault is a northeast striking normal fault that dips to the northwest. The most recent movement along this fault was as recent as approximately 70,000 years ago during the Late Pleistocene epoch. The slip-rate category of this fault is less than 0.2 millimeters per year (Pearthree, 1998).Seismic design considerations are presented in Section 9.2.

7.3. Liquefaction Potential

Based on the relatively low seismic ground motion hazard (relatively low ground accelerations), the likelihood or potential for liquefaction is considered to be negligible and is therefore not a design consideration.

8. CONCLUSIONS

Based on the results of our subsurface evaluation, laboratory testing, and data analysis, it is our opinion that the proposed construction is feasible from a geotechnical standpoint, provided that the recommendations of this report are incorporated into design and construction of the proposed project, as appropriate. Geotechnical considerations include the following:

- The on-site surface soils should generally be excavatable to the anticipated earthwork depths with heavy-duty earth moving construction equipment in good working condition.
- We estimate an earthwork (shrinkage) factor of 10 to 20 percent if the on-site soils are re-used as engineered fill.
- New box culverts and wing walls should be founded on a zone of engineered fill as described in Section 9.1.6.
- Imported soils and soils generated from on-site excavation activities that exhibit a relatively low plasticity and very low to low expansion potential can generally be used as engineered fill.
- Groundwater was not observed in our borings. The regional groundwater table has been encountered on the order of 100 feet near the northern limits of the site to 10 feet bgs near the southern limits of the site, based on the nearby well data.
- No known geologic hazards are situated immediately adjacent to or below the surface at the site.
- Corrosivity test results indicate that subgrade soils at the site are generally considered to be corrosive to ferrous materials, and the sulfate content of the soils present a moderate sulfate exposure to concrete.

9. RECOMMENDATIONS

The following sections present our geotechnical recommendations for the proposed construction. An additional geotechnical evaluation including additional explorations and laboratory testing should be conducted to support the final design when the details for the proposed construction are available.

9.1 Earthwork

In general, the specifications contained in the latest revisions to Maricopa Association of Governments (MAG) and any Town of Buckeye amendments are expected to apply, except as noted in the following sections.

9.1.1. Excavations

Our evaluation of the excavation characteristics of the on-site materials is based on the results of our exploratory borings, site observations, and our experience with similar materials. In our opinion, the excavation of near-surface on-site materials can generally be accomplished with heavy-duty earthmoving or excavation equipment in good operating condition. It should be noted that due to the wide spacing of our soil borings, excavation conditions different from what was encountered in our borings may be encountered during construction.

Excavations that are 20 feet deep or less could be constructed using a sloped excavation in accordance with Occupational Safety and Health Administration (OSHA) Standards, based on the soil types encountered. We recommend that the OSHA soil "*Type C*" be used for the soils along the alignment. Based on OSHA standards, this corresponds to a temporary side slope of 1.5:1 Horizontal:Vertical (H:V), or flatter, in sloped excavations that are less than 20 feet. Slope stability for trenches deeper than 20 feet, though not anticipated, should be designed by the contractor's engineer based on alignment-specific soil properties and settlement-sensitive features.

9.1.2. Temporary Shoring

Due to the adjacent structures, roadways and underground utilities, temporary earth retention systems may be needed for this project. Temporary earth retention systems may include braced systems, such as trench boxes or shields with internal supports or cantilever systems (e.g., soldier piles and lagging); however, the risk of excessive lateral deflection may render the cantilever shoring system inappropriate for the project.

The contractor should retain a qualified and experienced engineer to design the shoring system. We recommend that the contractor take appropriate measures to protect the workers. OSHA requirements pertaining to workers' safety should be observed. Ninyo & Moore should evaluate the soil parameters used by the shoring engineer for appropriateness.

9.1.3. Permanent Cut Slopes

Permanent cut slopes that are protected from erosion (by soil cement, riprap, shotcrete, gabions, etc.) for this project can be sloped at an inclination of 3:1 (H:V) for excavations less than 10 feet below adjacent grade. Sloughing of the side slopes should be anticipated if the slopes are not protected from erosion. Regular maintenance should be anticipated for the slopes.

9.1.4. Bottom Stability

Trench bottom stability problems during construction should be anticipated where the alignment is near the Gila River or shallow groundwater is encountered. In addition, if excavations are located near drainage ditches, or near washes, arroyos, or drainage areas that are open during a heavy rain event, or near any leaking utilities, the trench material(s) might become saturated and unstable and a dewatering system may be needed for these conditions. Should this occur, remedial measures will be needed.

9.1.5. Construction Dewatering

Stream flow, surface run-off, and perched groundwater will vary seasonally depending on rainfall in the site vicinity. Excavations that do encounter surface run-off (if any) could be dewatered by pumping the water out from the bottom and away from the excavation. However, heavily saturated units or perched groundwater zones, if encountered, may call for more aggressive means of dewatering and consultation with a qualified expert. Discharge of water from the excavations to natural drainage channels may entail securing a special permit.

9.1.6. Grading, Fill Placement, and Compaction

Vegetation and debris from the clearing operation and demolition debris should be removed from the site and disposed of at a legal dumpsite. Obstructions that extend below finish grade, if present, should be removed and the resulting holes filled with compacted soil.

The geotechnical consultant should carefully evaluate any areas of soft or wet soils prior to placement of grade-raise fill or other construction. Drying or overexcavation of some materials may be appropriate.

On-site soils and imported soils that are suitable for re-use as engineered fill should not consist of potentially expansive material as evaluated by the ASTM D 4318 of having a Plasticity Index (PI) more than 20, and/or Expansion Index (EI) more than 50, as evaluated by ASTM D 4829. Our Atterberg Limits tests on selected samples indicated that the plasticity indices ranged from 0 (non-plastic) to 29. As such, it is our opinion that some of the on-site soils are not suitable for re-use as engineered fill during construction unless suitably processed. Additional evaluation should be conducted prior to and/or during construction to better delineate these areas of unacceptable soils. Due to the clayey nature of some of the site soils, compaction of clay soils may be difficult to accomplish during construction.

In addition, suitable fill material should not include organic material (more than 4 percent organic content), construction debris, or other non-soil fill materials. Clay lumps or rock particles should not be larger than 4 inches in dimension.

We recommend that new box culverts and wing wall foundations be supported on 6 to 12 inches, or more, of moisture-conditioned and compacted engineered fill. This zone can either be improved by overexcavation or scarification. The fill thickness should be measured from the bottom of the box culvert or wing wall base and should be compacted by appropriate mechanical methods to 95 percent or more relative compaction, in accordance with ASTM D 698 at a moisture content slightly above its optimum. The improved zone should extend laterally 1 or more feet horizontally beyond the culvert or wing wall footprint.

Following the overexcavation as described above, and prior to the placement of new fill, the resulting exposed surface should be carefully evaluated by Ninyo & Moore. Based on this evaluation, additional remediation may be needed. This could include

scarification of the exposed surface. This additional remediation, if needed, should be addressed by Ninyo & Moore during the earthwork operations. An earthwork (shrinkage) factor ranging from 10 to 20 percent for the on-site soils is estimated for this project.

9.1.7. Imported Fill Material

Imported fill, if utilized, should consist of granular material with a very low or low expansion potential. Import material in contact with ferrous materials should preferably have low corrosion potential (minimum resistivity more than 2,000 ohm-cm, chloride content less than 25 parts per million [ppm]). Import material in contact with concrete should have a soluble sulfate content preferably less than 0.1 percent. Ninyo & Moore should evaluate such materials and details of their placement prior to importation.

9.2. Seismic Design Considerations

Based on a Probabilistic Seismic Hazard Assessment for the conterminous United States, issued by the USGS (2002 data), the site is located in a zone where the peak ground accelerations having 10, 5, and 2 percent probability of being exceeded in 50 years are 0.04g, 0.05g, and 0.07g, respectively. These ground motion values are calculated for "firm rock" sites, which correspond to a shear-wave velocity of approximately 2,500 feet per second in approximately the top 100 feet bgs. Different soil or rock types may amplify or de-amplify these values. The proposed improvements should be designed in accordance with the requirements of governing jurisdictions and applicable building codes. Table 1 presents the seismic design parameters for the site in accordance with International Building Code (ICC, 2009) guidelines and mapped spectral acceleration parameters (USGS, 2011).

Table 1 – 2009 International Building Code Seismic Design Criteria

Seismic Design Factors	Value
Site Class	D
Site Coefficient, F_a	1.6

Table 1 – 2009 International Building Code Seismic Design Criteria

Seismic Design Factors	Value
Site Coefficient, F_v	2.4
Mapped Spectral Acceleration at 0.2-second Period, S_s	0.165 g
Mapped Spectral Acceleration at 1.0-second Period, S_1	0.059 g
Spectral Acceleration at 0.2-second Period Adjusted for Site Class, S_{MS}	0.265 g
Spectral Acceleration at 1.0-second Period Adjusted for Site Class, S_{M1}	0.141 g
Design Spectral Response Acceleration at 0.2-second Period, S_{DS}	0.176 g
Design Spectral Response Acceleration at 1.0-second Period, S_{D1}	0.094 g

9.3. Box Culverts/ Wing Wall Foundations

Box culverts and wing wall foundations should be supported on 6 to 12 inches of engineered fill, as described in Section 9.1.6. Foundations may be designed using an allowable bearing pressure of 2,000 to 3,000 pounds per square foot (psf) for static conditions. Total and differential settlements are estimated to be on the order of 1-inch and 1/2-inch, respectively.

The "at-rest" earth pressure against box culvert and wing walls that are restrained at the top or braced so that they cannot yield, and with level backfill with no water present, may be taken as equivalent to the pressure exerted by a fluid weighing 55 pounds per cubic foot (pcf). For undrained conditions, an equivalent fluid pressure of 91 pcf may be used. Restrained retaining walls should also be designed to resist a horizontal earth pressure of 0.5q. The value for "q" represents the vertical surcharge pressure induced by adjacent light loads, slab, or traffic loads.

Box culvert and wing walls that are not restrained from movement at the top (such as a "U"-shaped box with no roof) and have a level backfill behind the wall may be designed using an "active" equivalent fluid unit weight of 35 pcf for drained conditions, and 80 pcf for undrained conditions. This value assumes compaction within about 5 feet of the wall will be accomplished with relatively light compaction equipment, and that very low to low expansive backfill will be placed behind the wall. For any wing walls with sloping backfill behind them, Ninyo & Moore should be contacted for the recommended "active" equivalent

fluid pressure based on the actual slope configuration. Retaining walls should also be designed to resist a horizontal earth pressure of 0.3q. The value for "q" represents the vertical surcharge pressure induced by adjacent light loads, slab, or traffic loads.

9.4. Corrosion

The corrosion potential of the on-site materials was analyzed to evaluate its potential effect on the concrete. Corrosion potential was evaluated using the results of laboratory testing of one sample obtained during our subsurface evaluation that was considered representative of soils at the subject site.

Laboratory testing consisted of pH, minimum electrical resistivity, and chloride and soluble sulfate contents. The pH and minimum electrical resistivity tests were performed in general accordance with Arizona Test 236b, while sulfate and chloride tests were performed in accordance with Arizona Test 733 and 736, respectively. The results of the corrosivity tests are presented in Appendix B.

The soil pH value of the samples tested ranged from 7.8 to 8.1, which is considered to be alkaline. The minimum electrical resistivity measured in the laboratory ranged from 1,204 ohm-cm to 1,642 ohm-cm, which is considered to be corrosive to ferrous materials. The chloride content of the samples tested ranged from 145 ppm to 2,286 ppm, which is also considered to be corrosive to ferrous materials. The soluble sulfate content of the soil samples ranged from 0.012 to 0.116 percent by weight, representing a moderate sulfate exposure for concrete.

The results of the laboratory testing indicate that the on-site materials are considered to be corrosive to ferrous materials. Therefore, special consideration may be given to the use of heavy-gauge, corrosion-protected, underground steel pipe or culverts. As an alternative, wrapped/plastic pipe or reinforced concrete pipe may be considered. A corrosion specialist should be consulted for further recommendations.

9.5. Concrete

Laboratory chemical tests performed on an on-site soil sample indicated a sulfate content up to 0.116 percent by weight. Based on the following American Concrete Institute (ACI) table, the on-site soils are generally considered to have a moderate sulfate exposure to concrete.

Table 2 – ACI Requirements for Concrete Exposed to Sulfate-Containing Soil

Sulfate Exposure	Water-Soluble Sulfate (SO_4) in Soil, Percentage by Weight	Cement Type	Water-Cementitious Materials Ratio, by Weight, Normal-Weight Aggregate Concrete[1]	f'_c, Normal-Weight and Lightweight Aggregate Concrete, psi x 0.00689 for MPa
Negligible	0.00 - 0.10	--	--	--
Moderate[2]	0.10 - 0.20	II, IP(MS), IS (MS)	0.50 or less	4,000 or more
Severe	0.20 - 2.00	V	0.45 or less	4,500 or more
Very severe	Over 2.00	V plus pozzolan[3]	0.45 or less	4,500 or more

Notes:
[1] A lower water-cementitious materials ratio or higher strength may be call for low permeability or for protection against corrosion of embedded items or freezing and thawing (ACI Table 4.2.2).
[2] Seawater.
[3] Pozzolan that has been evaluated by test or service record to improve sulfate resistance when used in concrete containing Type V cement.

Notwithstanding, the sulfate test results and due to the limited number of chemical tests performed, as well as our experience with similar soil conditions and local practice, we recommend the use of "Type II" cement for construction of concrete structures at this site.

The concrete should have a water-cementitious materials ratio of no more than 0.50 by weight for normal weight aggregate concrete. The structural engineer should ultimately select the concrete design strength based on the project specific loading conditions. However, higher strength concrete may be selected for increased durability, resistance to slab curling and shrinkage cracking.

9.6. Site Drainage

Surface drainage should be provided to divert water away from the paved surfaces and structures. Surface water should not be permitted to pond on or adjacent to pavement areas. To deter accumulation of water below the new pavement sections, the subgrade soils below the new pavement sections should be sloped away from the center toward the edges of the roadway.

9.7. Pre-Construction Conference

We recommend that a pre-construction conference be held. Representatives of the owner, the civil engineer, Ninyo & Moore, and the contractor should be in attendance to discuss the project plans and schedule. Our office should be notified if the project description included herein is incorrect, or if the project characteristics are significantly changed.

10. LIMITATIONS

The field evaluation, laboratory testing, and geotechnical analyses presented in this geotechnical report have been conducted in general accordance with current practice and the standard of care exercised by geotechnical consultants performing similar tasks in the project area. No warranty, expressed or implied, is made regarding the conclusions, recommendations, and opinions presented in this report. There is no evaluation detailed enough to reveal every subsurface condition. Variations may exist and conditions not observed or described in this report may be encountered during construction. Uncertainties relative to subsurface conditions can be reduced through additional subsurface exploration. Additional subsurface evaluation will be performed upon request. Please also note that our evaluation was limited to assessment of the geotechnical aspects of the project, and did not include evaluation of structural issues, environmental concerns, or the presence of hazardous materials.

This document is intended to be used only in its entirety. No portion of the document, by itself, is designed to completely represent any aspect of the project described herein. Ninyo & Moore

should be contacted if the reader requires additional information or has questions regarding the content, interpretations presented, or completeness of this document.

This report is intended for design purposes only. It does not provide sufficient data to prepare an accurate bid by contractors. It is suggested that the bidders and their geotechnical consultant perform an independent evaluation of the subsurface conditions in the project areas. The independent evaluations may include, but not be limited to, review of other geotechnical reports prepared for the adjacent areas, site reconnaissance, and additional exploration and laboratory testing.

Our conclusions, recommendations, and opinions are based on an analysis of the observed site conditions. If geotechnical conditions different from those described in this report are encountered, our office should be notified and additional recommendations, if warranted, will be provided upon request. It should be understood that the conditions of a site could change with time as a result of natural processes or the activities of man at the subject site or nearby sites. In addition, changes to the applicable laws, regulations, codes, and standards of practice may occur due to government action or the broadening of knowledge. The findings of this report may, therefore, be invalidated over time, in part or in whole, by changes over which Ninyo & Moore has no control.

This report is intended exclusively for use by the client. Any use or reuse of the findings, conclusions, and/or recommendations of this report by parties other than the client is undertaken at said parties' sole risk.

11. SELECTED REFERENCES

American Concrete Institute, 2005, Building Code Requirements for Structural Concrete (ACI 318-05) and Commentary (ACI 318R-05).

American Society for Testing and Materials (ASTM), Annual Book of ASTM Standards.

Arizona Department of Water Resources (ADWR), 2013, "GWSI Groundwater Maps" https://gisweb.azwater.gov/waterresourcedata/, Accessed March, 2013.

Demsey, 1989, Geologic Map of Quaternary and Upper Tertiary Alluvium in the Phoenix South 30' X 60' Quadrangle, AZ: Arizona Geological Survey, Open-File Report Series OFR 89-7, Scale 1:100,000.

Euge, K.M., et al., 1992, Development of Seismic Acceleration Contour Maps for Arizona: Arizona Department of Transportation Report No. AZ 92-344: dated September.

International Code Council, 2009, International Building Code.

Maricopa Association of Governments, 2012, Uniform Standard Specifications and Details for Public Works Construction.

Ninyo & Moore, In-house proprietary information.

Occupational Safety and Health Administration (OSHA), Title 29 of the Code of Federal Regulations (CFR), Part No. 1926 - Safety and Health Regulations for Construction, Subpart P - Excavations.

Pearthree, P.A., 1998, Quaternary Fault Data and Map for Arizona: Arizona Geological Survey, Open-File Report 98-24.

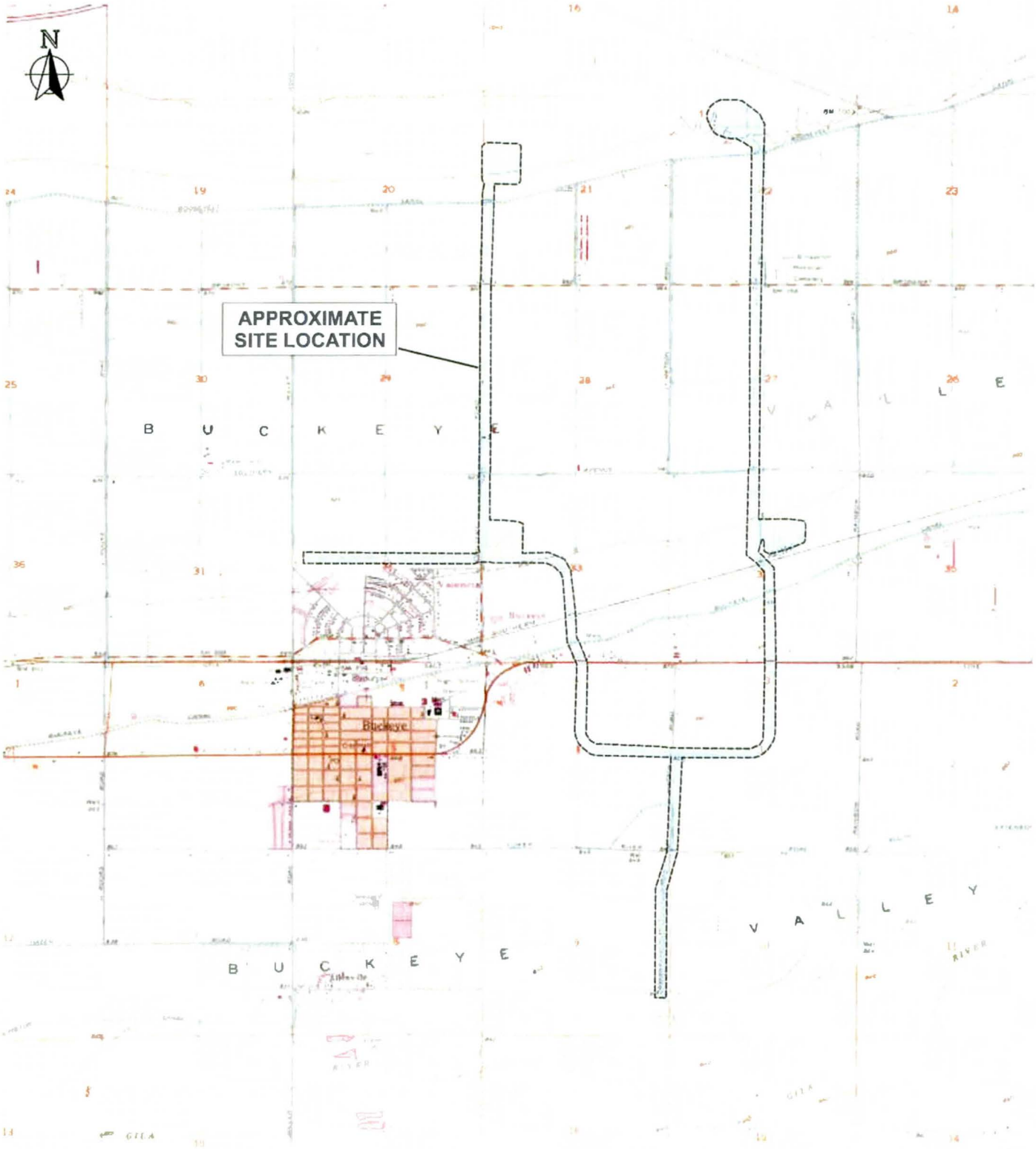
United States Geological Survey, 2009, National Seismic Hazard Mapping Project, World Wide Web, http://geohazards.cr.usgs.gov/eq.

United States Geological Survey, 2011, Buckeye, Arizona, 7.5-Minute Series (Topographic): Scale 1 = 24,000.

United States Geological Survey, 2011, Valencia, Arizona, 7.5-Minute Series (Topographic): Scale 1 = 24,000.

AERIAL PHOTOGRAPHS

Source	Date
Flood Control District of Maricopa County	1949, 1997, 2003, 2009



Source: US Geological Survey 7.5-minute topographic map, Valencia, Arizona, 1978, rev. 1982.

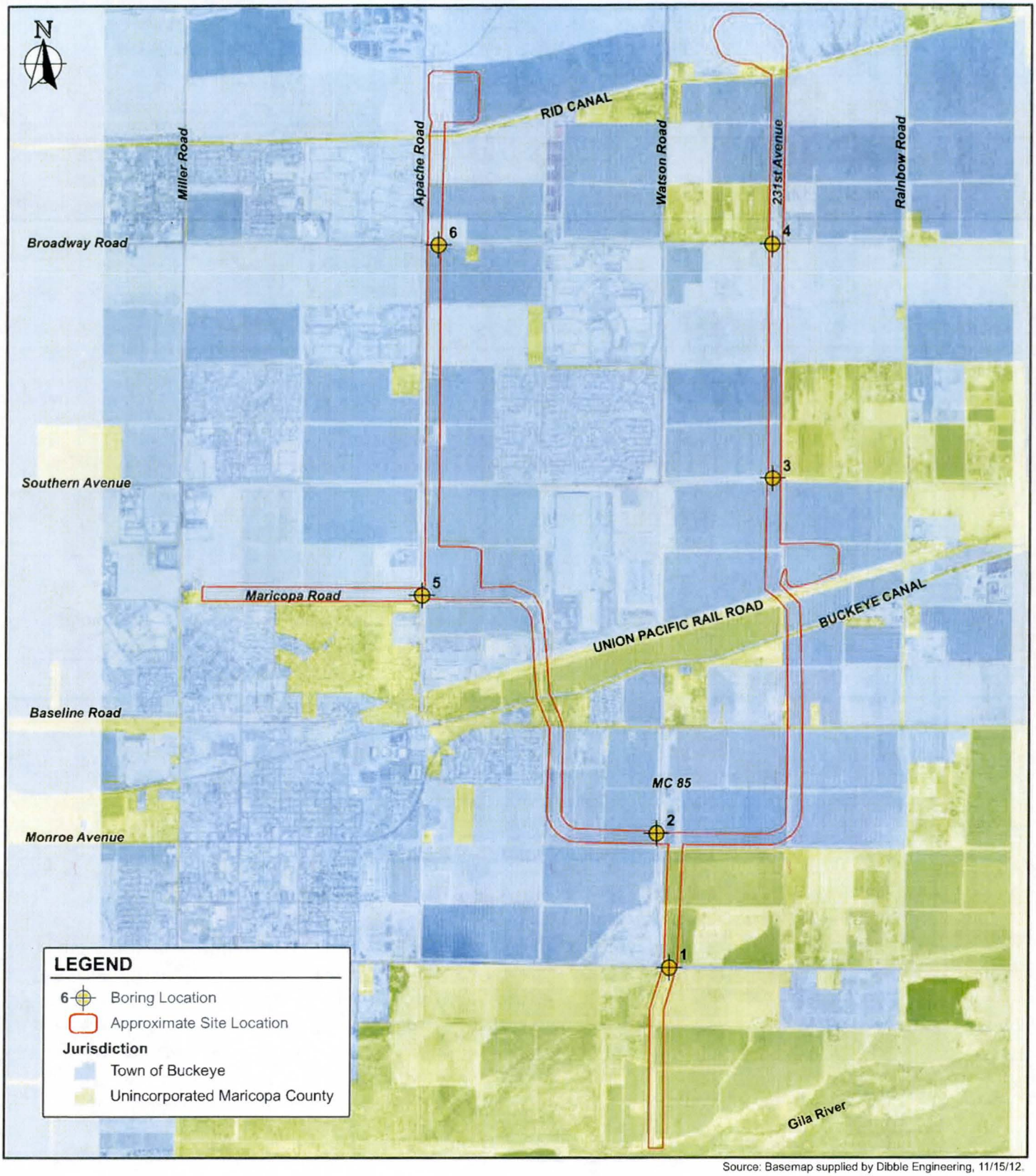
0 4000

Approximate Scale:
1 inch = 4000 feet

Note: Dimensions, directions, and locations are approximate.

Ninyo & Moore	SITE LOCATION	FIGURE
PROJECT NO: 603770001 / DATE: 12/13	WATSON DRAINAGE SYSTEM PRE-DESIGN BUCKEYE, ARIZONA	1

file no: 3770vmap0313



Source: Basemap supplied by Dibble Engineering, 11/15/12.

0 3000

Approximate Scale:
1 inch = 3000 feet

Note: Dimensions, directions, and locations are approximate.

Ninyo & Moore	BORING LOCATIONS	FIGURE
PROJECT NO: 603770001 / DATE: 12/13	WATSON DRAINAGE SYSTEM PRE-DESIGN BUCKEYE, ARIZONA	2

file no: 3770blm0313

APPENDIX A

BORING LOGS

Field Procedure for the Collection of Disturbed Samples

Disturbed soil samples were obtained in the field using the following methods.

Bulk Samples

Bulk samples of representative earth materials were obtained from the exploratory borings. The samples were bagged and transported to the laboratory for testing.

The Standard Penetration Test Spoon

Disturbed drive samples of earth materials were obtained by means of a Standard Penetration Test sampler. The sampler is composed of a split barrel with an external diameter of 2 inches and an unlined internal diameter of 1-3/8 inches. The sampler was driven into the ground 12 to 18 inches with a 140-pound hammer free-falling from a height of 30 inches in general accordance with ASTM D 1586. The blow counts were recorded for every 6 inches of penetration; the blow counts reported on the logs are those for the last 12 inches of penetration. Soil samples were observed and removed from the sampler, bagged, sealed and transported to the laboratory for testing.

Field Procedure for the Collection of Relatively Undisturbed Samples

Relatively undisturbed soil samples were obtained in the field using the following methods.

The Modified Split-Barrel Drive Sampler

The sampler, with an external diameter of 3.0 inches, was lined with 1-inch long, thin brass rings with inside diameters of approximately 2.4 inches. The sample barrel was driven into the ground with the weight of a hammer or the kelly bar of the drill rig in general accordance with ASTM D 3550. The driving weight was permitted to fall freely. The approximate length of the fall, the weight of the hammer or bar, and the number of blows per foot of driving are presented on the boring logs as an index to the relative resistance of the materials sampled. The samples were removed from the sample barrel in the brass rings, sealed, and transported to the laboratory for testing.

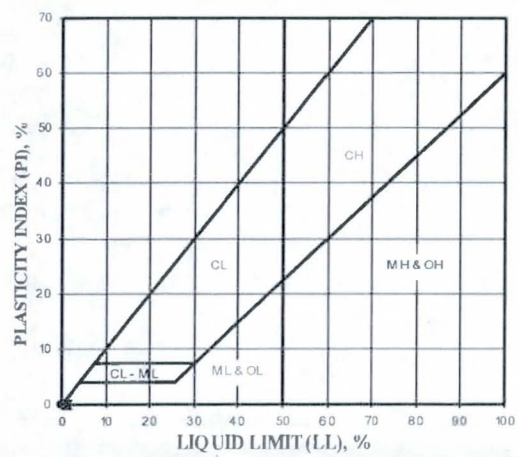
U.S.C.S. METHOD OF SOIL CLASSIFICATION

MAJOR DIVISIONS		SYMBOL	TYPICAL NAMES
COARSE-GRAINED SOILS (More than 1/2 of soil > No. 200 Sieve Size)	GRAVELS (More than 1/2 of coarse fraction > No. 4 sieve size	GW	Well graded gravels or gravel-sand mixtures, little or no fines
		GP	Poorly graded gravels or gravel-sand mixtures, little or no fines
		GM	Silty gravels, gravel-sand-silt mixtures
		GC	Clayey gravels, gravel-sand-clay mixtures
	SANDS (More than 1/2 of coarse fraction < No. 4 sieve size	SW	Well graded sands or gravelly sands, little or no fines
		SP	Poorly graded sands or gravelly sands, little or no fines
		SM	Silty sands, sand-silt mixtures
		SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (More than 1/2 of soil < No. 200 sieve size)	SILTS & CLAYS Liquid Limit <50	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
		OL	Organic silts and organic silty clays of low plasticity
	SILTS & CLAYS Liquid Limit >50	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
		CH	Inorganic clays of high plasticity, fat clays
		OH	Organic clays of medium to high plasticity, organic silty clays, organic silts
HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils

GRAIN SIZE CHART

CLASSIFICATION	RANGE OF GRAIN	
	U.S. Standard Sieve Size	Grain Size in Millimeters
BOULDERS	Above 12"	Above 305
COBBLES	12" to 3"	306 to 76.2
GRAVEL	3" to No. 4	76.2 to 4.76
Coarse	3" to 3/4"	76.2 to 19.1
Fine	3/4" to No. 4	19.1 to 4.76
SAND	No. 4 to No. 200	4.76 to 0.075
Coarse	No. 4 to No. 10	4.76 to 2.00
Medium	No. 10 to No. 40	2.00 to 0.420
Fine	No. 40 to No. 200	0.420 to 0.075
SILT & CLAY	Below No. 200	Below 0.075

PLASTICITY CHART



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U.S.C.S. METHOD OF SOIL CLASSIFICATION

Updated Nov 2011

BORING LOG EXPLANATION SHEET

DEPTH (feet)	SAMPLES: Bulk	SAMPLES: Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	
0	■							Bulk sample.
		■						Modified split-barrel drive sampler.
		╳						No recovery with modified split-barrel drive sampler.
		▬						Sample retained by others.
		▼						Standard Penetration Test (SPT).
5		╱						No recovery with a SPT.
		▯	XX/XX					Shelby tube sample. Distance pushed in inches/length of sample recovered in inches.
		◺						No recovery with Shelby tube sampler.
		▤						Continuous Push Sample.
				♀				Seepage.
10				▽				Groundwater encountered during drilling.
				▼				Groundwater measured after drilling.
						▩	SM	MAJOR MATERIAL TYPE (SOIL): Solid line denotes unit change.
						▨	CL	Dashed line denotes material change.
15						▨		Attitudes: Strike/Dip b: Bedding c: Contact j: Joint f: Fracture F: Fault cs: Clay Seam s: Shear bss: Basal Slide Surface sf: Shear Fracture sz: Shear Zone sbs: Shear Bedding Surface
20								The total depth line is a solid line that is drawn at the bottom of the boring.

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BORING LOG

Explanation of Boring Log Symbols

PROJECT NO.	DATE	FIGURE

Updated Nov. 2011

DATE DRILLED 2/13/13 BORING NO. B-1

GROUND ELEVATION -- SHEET 1 OF 1

METHOD OF DRILLING CME-55, 8" Diameter Hollow-Stem Auger (D&S Drilling)

DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY JSR

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0						CL	ALLUVIUM: Brown, damp to moist, stiff, CLAY; few sand.
		8					
		13	26.7	92.8			Very stiff.
5						SM	Brown, moist, medium dense, silty SAND.
		12					
		7					Loose.
10							Total Depth = 10 feet. Groundwater not encountered during drilling. Backfilled on 2/13/13 promptly after completion of drilling.
							Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.
15							
20							

Ninyo & Moore

BORING LOG

WATSON DRAINAGE SYSTEM PRE-DESIGN
BUCKEYE, ARIZONA

PROJECT NO.	DATE	FIGURE
603770001	12/13	A-1

DATE DRILLED 2/13/13 BORING NO. B-2

GROUND ELEVATION -- SHEET 1 OF 1

METHOD OF DRILLING CME-55, 8" Diameter Hollow-Stem Auger (D&S Drilling)

DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY JSR

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							SM	ALLUVIUM: Brown, moist, loose, silty SAND.
			7	6.3	108.1			
							CL	Brown, moist, soft to firm, CLAY with sand.
			3					
5								
			3					
			7					Stiff.
10								Total Depth = 10 feet. Groundwater not encountered during drilling. Backfilled on 2/13/13 promptly after completion of drilling.
								Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.
15								
20								

Ninyo & Moore

BORING LOG

WATSON DRAINAGE SYSTEM PRE-DESIGN
BUCKEYE, ARIZONA

PROJECT NO.	DATE	FIGURE
603770001	12/13	A-2

DATE DRILLED 2/13/13 BORING NO. B-3

GROUND ELEVATION -- SHEET 1 OF 1

METHOD OF DRILLING CME-55, 8" Diameter Hollow-Stem Auger (D&S Drilling)

DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY JSR

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0						SM	ALLUVIUM: Brown, moist, loose to medium dense, silty SAND.
		7					
		15	12.0	98.3		SC	Brown, damp, medium dense, clayey SAND; scattered caliche nodules.
5							
		25					Dense.
		45					
10							Total Depth = 10 feet. Groundwater not encountered during drilling. Backfilled on 2/13/13 promptly after completion of drilling. Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.
15							
20							

Ninyo & Moore

BORING LOG

WATSON DRAINAGE SYSTEM PRE-DESIGN
BUCKEYE, ARIZONA

PROJECT NO.	DATE	FIGURE
603770001	12/13	A-3

DATE DRILLED 2/13/13 BORING NO. B-4

GROUND ELEVATION -- SHEET 1 OF 1

METHOD OF DRILLING CME-55, 8" Diameter Hollow-Stem Auger (D&S Drilling)

DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY JSR

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							SM	FILL: Brown, damp, medium dense, silty SAND; trace gravel.
			15				SM	ALLUVIUM: Brown, damp, medium dense, silty SAND; trace gravel.
			5					Loose.
5			12	6.3	115.4			
			16				SC	Brown, damp, medium dense, clayey SAND; scattered caliche nodules.
10								Total Depth = 10 feet. Groundwater not encountered during drilling. Backfilled on 2/13/13 promptly after completion of drilling.
								Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.
15								
20								

Ninyo & Moore

BORING LOG

WATSON DRAINAGE SYSTEM PRE-DESIGN
BUCKEYE, ARIZONA

PROJECT NO.	DATE	FIGURE
603770001	12/13	A-4

DATE DRILLED 2/13/13 BORING NO. B-5

GROUND ELEVATION -- SHEET 1 OF 1

METHOD OF DRILLING CME-55, 8" Diameter Hollow-Stem Auger (D&S Drilling)

DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY JSR

DEPTH (feet)	SAMPLES (Bulk / Driven)	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0						SC	FILL: Brown, damp, medium dense, clayey SAND; few to little gravel; scattered caliche nodules.
		10					
		30					
5						SC	ALLUVIUM: Brown, damp, medium dense, clayey SAND.
		16					
		15	10.3	110.5			
10							Total Depth = 10 feet. Groundwater not encountered during drilling. Backfilled on 2/13/13 promptly after completion of drilling.
							Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.
15							
20							

Ninyo & Moore

BORING LOG

WATSON DRAINAGE SYSTEM PRE-DESIGN
BUCKEYE, ARIZONA

PROJECT NO.	DATE	FIGURE
603770001	12/13	A-5

DATE DRILLED 2/13/13 BORING NO. B-6

GROUND ELEVATION -- SHEET 1 OF 1

METHOD OF DRILLING CME-55, 8" Diameter Hollow-Stem Auger (D&S Drilling)

DRIVE WEIGHT 140 lbs. (Automatic) DROP 30"

SAMPLED BY DM LOGGED BY DM REVIEWED BY JSR

DEPTH (feet)	SAMPLES Bulk	SAMPLES Driven	BLOWS/FOOT	MOISTURE (%)	DRY DENSITY (PCF)	SYMBOL	CLASSIFICATION U.S.C.S.	DESCRIPTION/INTERPRETATION
0							SM	FILL: Brown, damp, loose, silty SAND.
			13				SM	ALLUVIUM: Brown, damp, loose, silty SAND.
			7					Loose to medium dense.
5								
			82/11"	7.8	107.8		CL	ALLUVIUM: Brown, damp, hard, sandy CLAY; trace gravel; scattered caliche nodules.
			30					
10								Total Depth = 10 feet. Groundwater not encountered during drilling. Backfilled on 2/13/13 promptly after completion of drilling.
								Note: Groundwater, though not encountered at the time of drilling, may rise to a higher level due to seasonal variations in precipitation and several other factors as discussed in the report.
15								
20								

Ninyo & Moore

BORING LOG

WATSON DRAINAGE SYSTEM PRE-DESIGN
BUCKEYE, ARIZONA

PROJECT NO.	DATE	FIGURE
603770001	12/13	A-6

APPENDIX B

LABORATORY TESTING

Classification

Soils were visually and texturally classified in accordance with the USCS in general accordance with ASTM D 2488. Soil classifications are indicated on the logs of the exploratory borings in Appendix A.

In-situ Moisture and Density Tests

The moisture content and dry density of relatively undisturbed samples obtained from the exploratory borings were evaluated in general accordance with ASTM D 2937. The test results are presented on the logs of the exploratory borings in Appendix A.

Gradation Analysis

Gradation analysis tests were performed on selected representative soil samples in general accordance with ASTM D 422. The grain-size distribution curves are shown on Figures B-1 through B-5. These test results were utilized in evaluating the soil classifications in accordance with the USCS.

Atterberg Limits

Tests were performed on selected representative fine-grained soil samples to evaluate the liquid limit, plastic limit, and plasticity index in general accordance with ASTM D 4318. These test results were utilized to evaluate the soil classification in accordance with the Unified Soil Classification System. The test results and classifications are shown on Figure B-6.

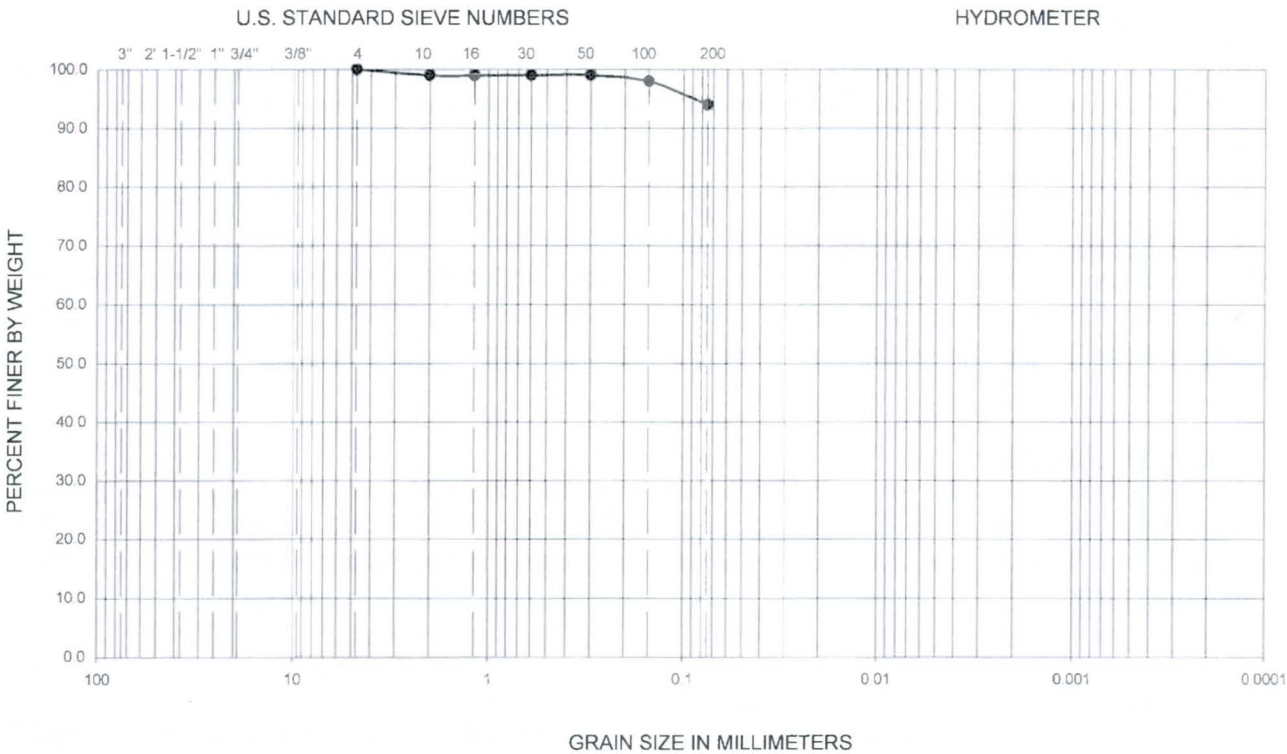
Consolidation Tests

Consolidation tests were performed on selected relatively undisturbed soil samples in general accordance with ASTM D 2435. The samples were inundated during testing to represent adverse field conditions. The percent of consolidation for each load cycle was recorded as a ratio of the amount of vertical compression to the original height of the sample. The results of the tests are summarized on Figures B-7 through B-9.

Soil Corrosivity Tests

Soil pH and resistivity tests were performed on representative samples in general accordance with Arizona Test ARIZ 236b. The chloride content of these selected samples was evaluated in general accordance with ARIZ 736. The sulfate content of these selected samples was evaluated in general accordance with ARIZ 733. The test results are presented on Figure B-10.

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

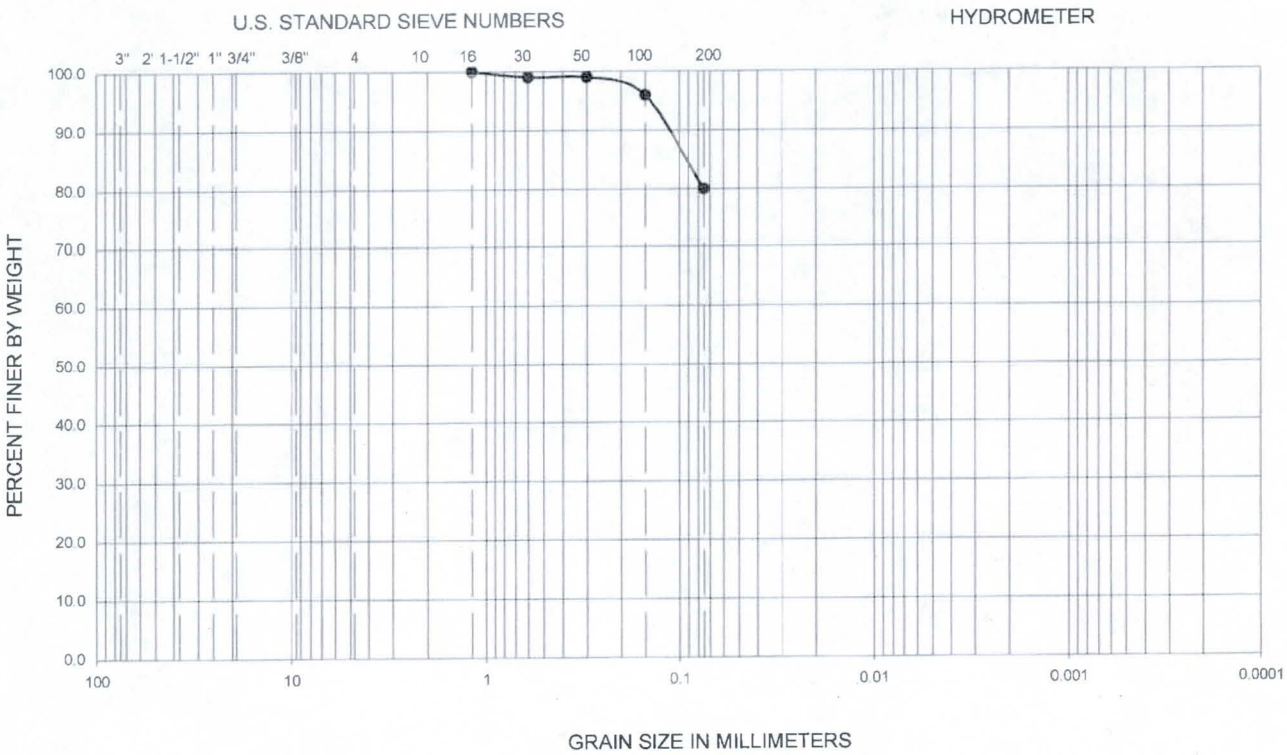


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-1	3.5-5	33	18	15	--	--	--	--	--	94	CL

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. 603770001 / DATE 12/13	WATSON DRAINAGE SYSTEM PRE-DESIGN BUCKEYE, ARIZONA	B-1

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

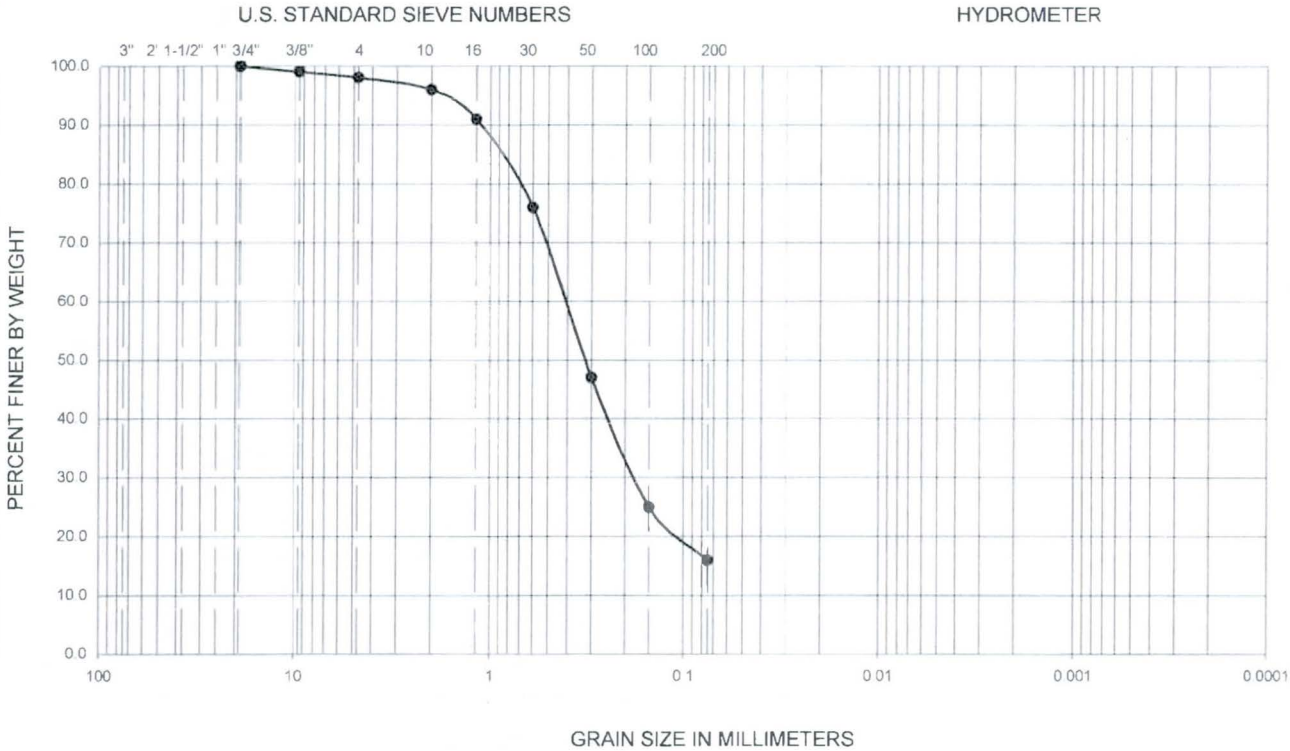


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-2	6-7.5	30	17	13	--	--	--	--	--	80	CL

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. 603770001 / DATE 12/13	WATSON DRAINAGE SYSTEM PRE-DESIGN BUCKEYE, ARIZONA	B-2

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



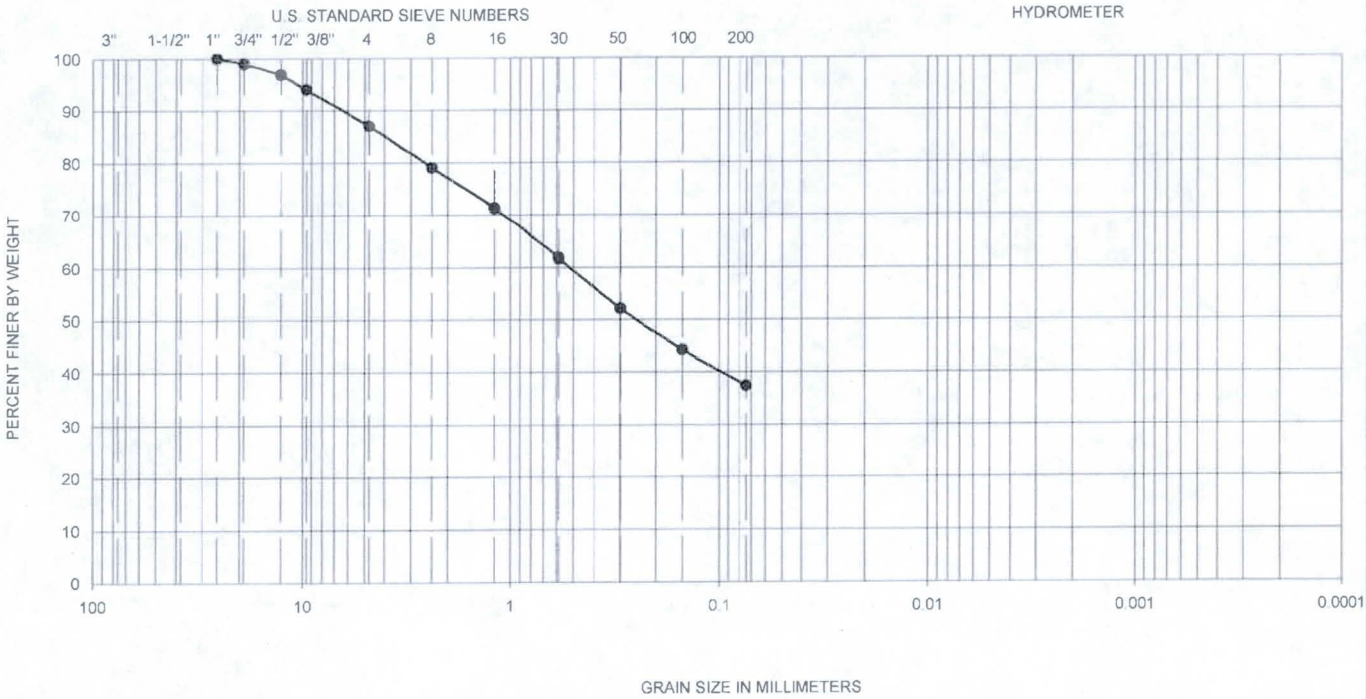
Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-4	6-7.5	--	--	NP	--	--	--	--	--	16	SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

NP - INDICATES NON-PLASTIC

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. 603770001 / DATE 12/13	WATSON DRAINAGE SYSTEM PRE-DESIGN BUCKEYE, ARIZONA	B-3

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	Silt	Clay

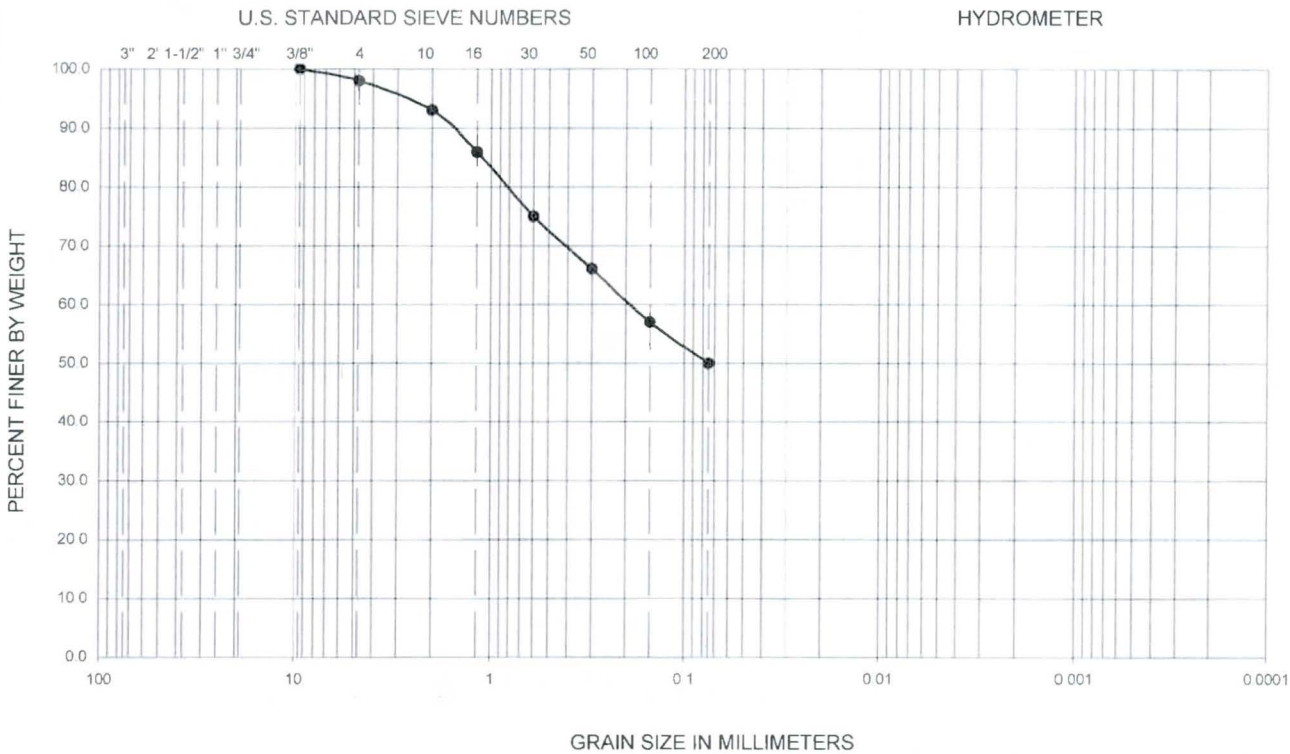


Symbol	Hole No.	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	U.S.C.S
●	B-5	0-5	50	21	29	--	--	--	--	--	37	SC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	WATSON DRAINAGE SYSTEM PRE-DESIGN BUCKEYE, ARIZONA	B-4
603770001 / 12/13		

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY



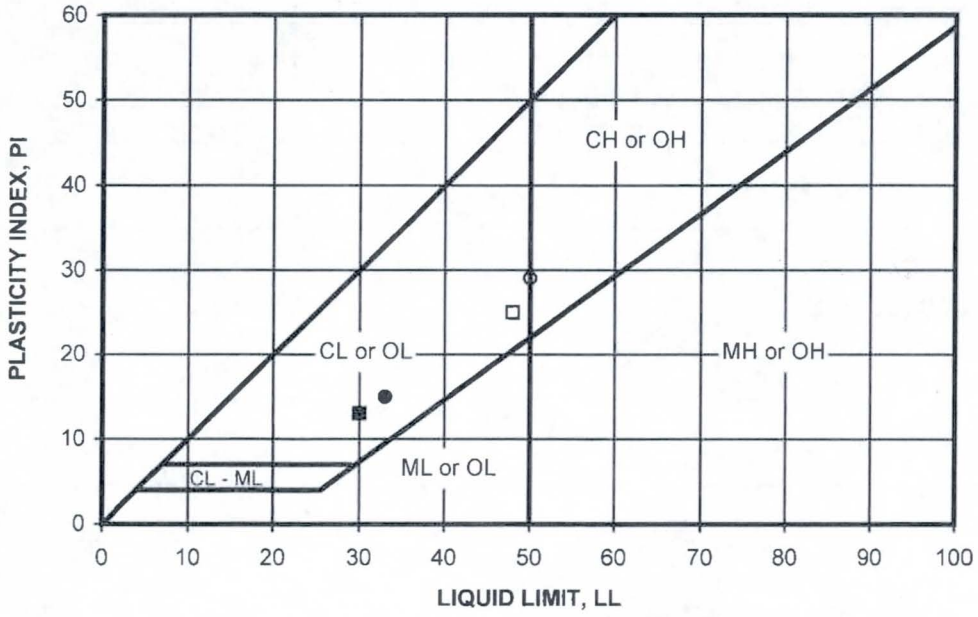
Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{60}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-6	6-7.9	48	23	25	--	--	--	--	--	50	CL

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	WATSON DRAINAGE SYSTEM PRE-DESIGN BUCKEYE, ARIZONA	B-5
603770001 / 12/13		

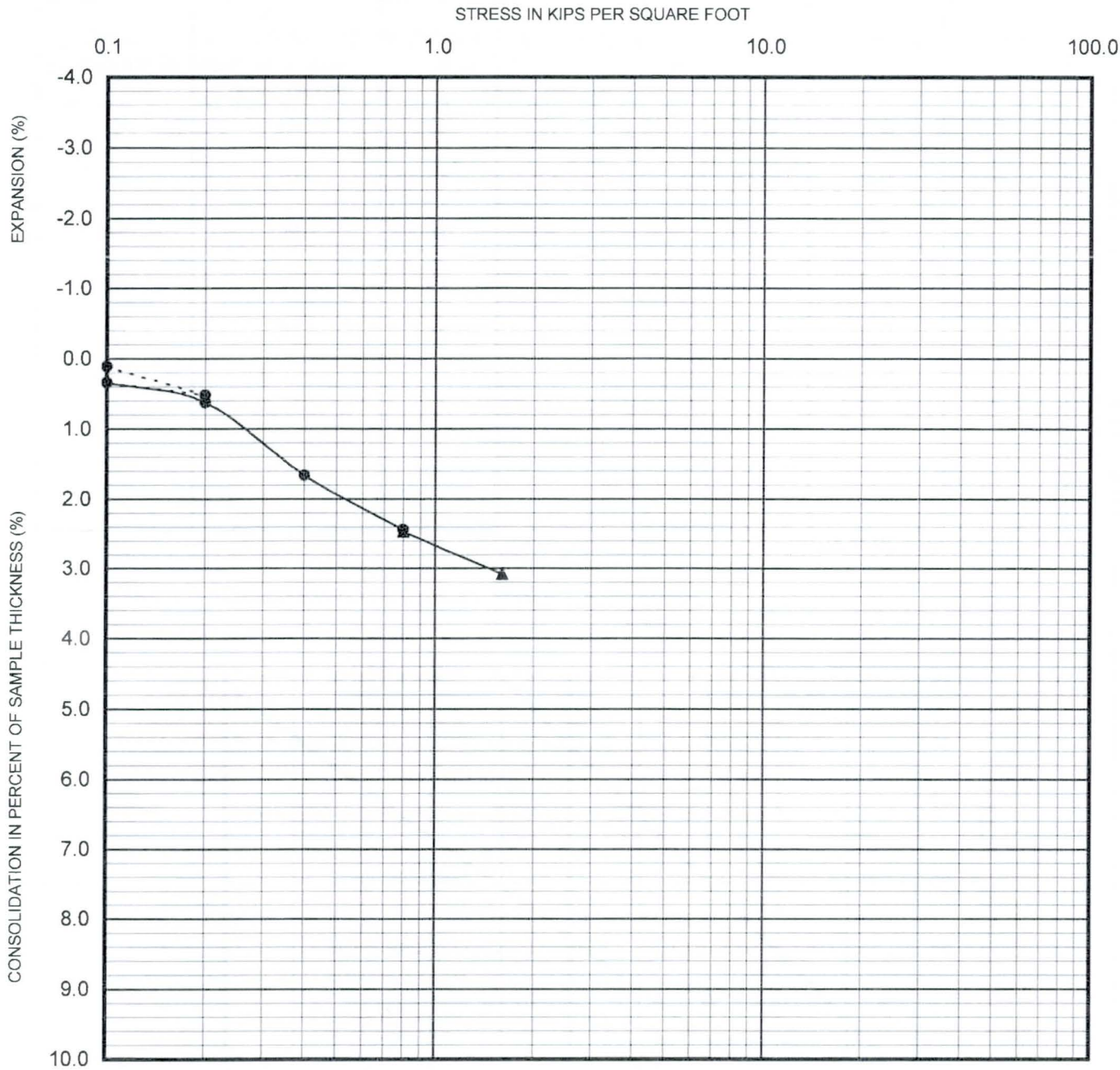
SYMBOL	LOCATION	DEPTH (FT)	LIQUID LIMIT, LL	PLASTIC LIMIT, PL	PLASTICITY INDEX, PI	USCS CLASSIFICATION (Fraction Finer Than No. 40 Sieve)	USCS (Entire Sample)
●	B-1	3.5-5	33	18	15	CL	CL
■	B-2	6-7.5	30	17	13	CL	CL
	B-4	6-7.5	--	--	NP	ML	SM
○	B-5	0-5	50	21	29	CH	SC
□	B-6	6-7.9	48	23	25	CL	CL

NP - INDICATES NON-PLASTIC



PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 4318

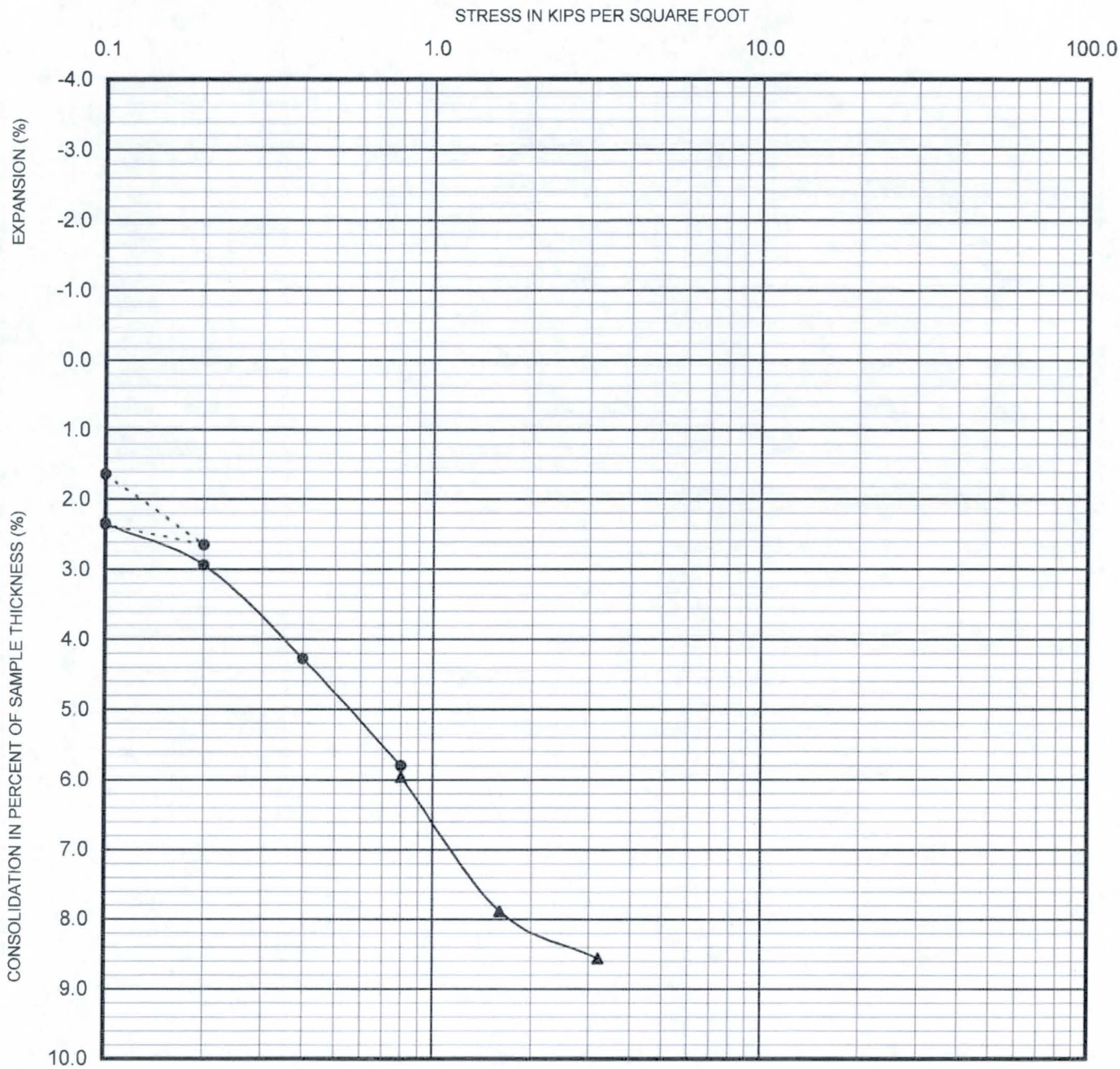
Ninyo & Moore	ATTERBERG LIMITS TEST RESULTS	FIGURE
PROJECT NO. 603770001 / DATE 12/13	WATSON DRAINAGE SYSTEM PRE-DESIGN BUCKEYE, ARIZONA	B-6



Sample Location	B-1
Depth (ft.)	3.5-5
Soil Type	CL

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

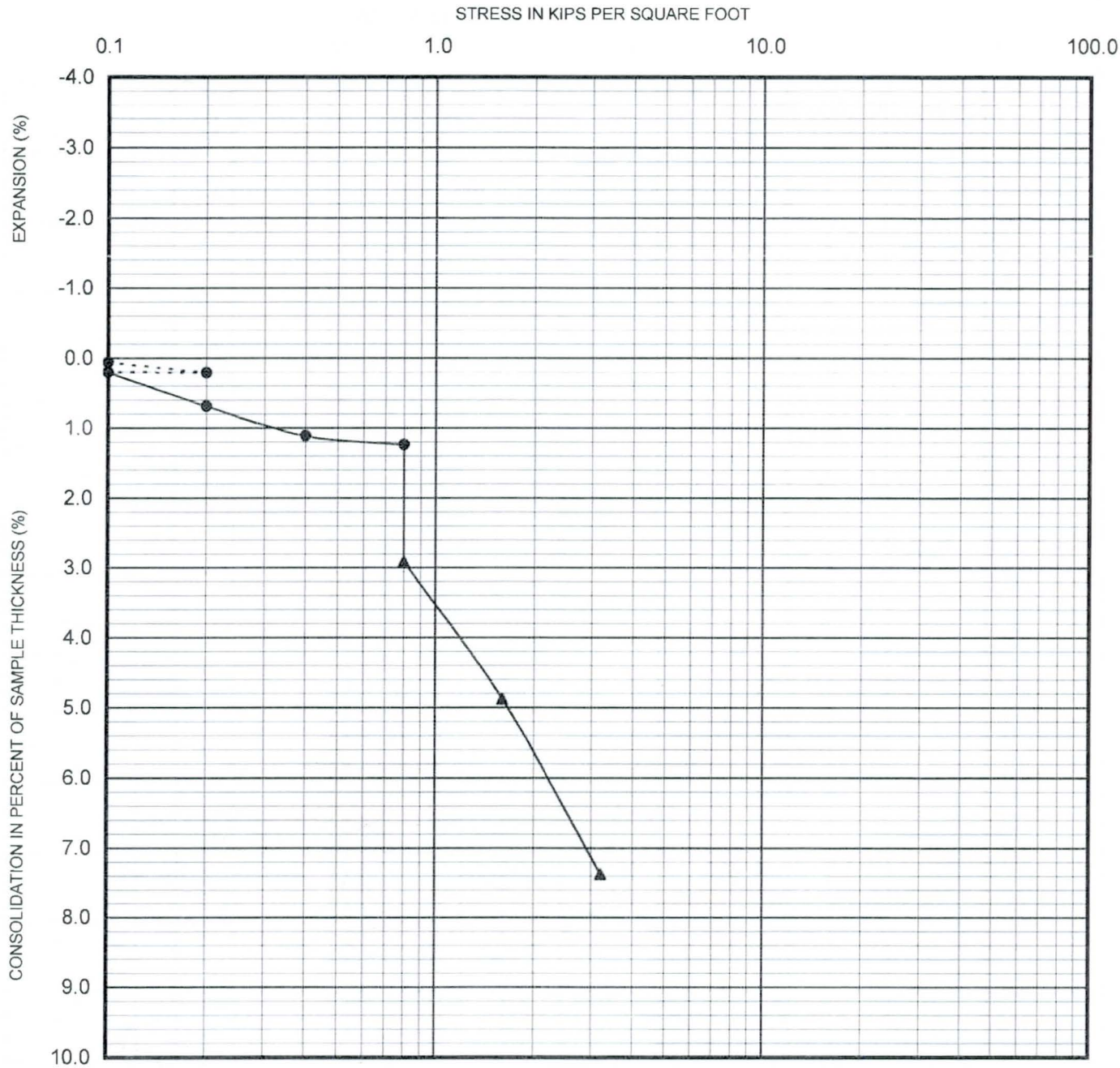
Ninyo & Moore	CONSOLIDATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	WATSON DRAINAGE SYSTEM PRE-DESIGN BUCKEYE, ARIZONA	B-7
603770001 / 12/13		



Sample Location	B-2
Depth (ft.)	6-7.5
Soil Type	CL

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

Ninyo & Moore	CONSOLIDATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	WATSON DRAINAGE SYSTEM PRE-DESIGN BUCKEYE, ARIZONA	B-8
603770001 / 12/13		



PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 2435

Ninyo & Moore		CONSOLIDATION TEST RESULTS	FIGURE
PROJECT NO.	DATE	WATSON DRAINAGE SYSTEM PRE-DESIGN BUCKEYE, ARIZONA	B-9
603770001	12/13		

SAMPLE LOCATION	SAMPLE DEPTH (FT)	pH [1]	RESISTIVITY [1] (Ohm-cm)	SULFATE CONTENT [2]		CHLORIDE CONTENT [3] (ppm)
				(ppm)	(%)	
B-1	0-5	7.8	1,532	1159	0.116	2286
B-2	0-5	8.0	1,211	434	0.043	571
B-3	0-5	8.1	759	186	0.019	234
B-4	0-5	8.0	1,204	119	0.012	232
B-5	0-5	8.0	1,286	160	0.016	145
B-6	0-5	7.8	1,642	218	0.022	385

[1] PERFORMED IN GENERAL ACCORDANCE WITH ARIZONA TEST METHOD 236b
[2] PERFORMED IN GENERAL ACCORDANCE WITH ARIZONA TEST METHOD 733
[3] PERFORMED IN GENERAL ACCORDANCE WITH ARIZONA TEST METHOD 736

Appendix B

Project, PAAC & Stakeholder Meeting Minutes

Project Coordination Meeting #2 (July 16, 2012)

Dibble Engineering

7500 North Dreamy Draw Drive, Suite 200
Phoenix, Arizona 85020
Tel. (602) 957-1157
Fax (602) 957-2838

MEETING MINUTES

Project: Watson Drainage System Pre-Design
Date: July 16, 2012 – 9:00 AM
Re: Coordination Meeting #2
Contract: FCD 2012C003
Dibble Project: 101206

1) MEETING ATTENDEES

Gary Wesch	FCDMC
Scott Zipprich	TOB
Kevin Roberts	DIBBLE
Justin Beeler	DIBBLE
Amir Motamedi	FCDMC
Shimin Li	FCDMC
Rob Sachs	FCDMC

John Holmes	FCDMC
Bob Stevens	FCDMC
Harry Cooper	FCDMC
Gary Shapiro	FCDMC
Gary Maiers	FCDMC
Brian Fry	JE FULLER
John Griffin	EPG

2) INTRODUCTIONS

3) REVIEW OF MEETING MINUTES / ACTION ITEMS

- Kevin comments on policy for meeting minutes and the Action item list to be reviewed at the following meeting.

4) PROJECT SCHEDULE REVIEW AND STATUS

a. Data Collection

i. Utility Information

- Gary M comments that no new utility information has come in.
- Scott Z – A new waterline will be in the same alignment as one of the 2 sewer lines along the railroad.
- Gary W – Suggested getting the details (horiz/vert details) for the culvert crossings between Apache and Rainbow from Olsson.

ii. Development Reports

iii. Hydrology Model (FCDMC Revisions)

- John – The only purpose of the memo is to summarize the updates from the ADMP model.

b. Existing Conditions Base Maps

- Some utilities are missing. May need note to identify missing utilities on map.
- A legend to identify the utility lines will need to be included with the maps.

c. Geotechnical Optional Task

- Kevin – Will complete the letter requesting the authorization soon.
- A map identifying the proposed locations should be included
- Bob S – Requests a CAD file to show boring locations, boring pit type and access routes. Annexation/jurisdictional boundaries should also be shown along with impacted APN's.

d. Potential Alternatives Elements
   i. Relocate Railroad Basin due to Industrial Park Development
   ii. Utilize planned Industrial Park north/south conveyance corridor
   iii. Consolidate BWCDD/UPRR crossing at Walmart property
      - Planned sewer and waterline ?
   iv. Continue consolidated system ¼ mile west of Watson down to Beloat
   v. Relocate Apache Basin to accommodate planned flow directions by north area developers
   vi. Relocate Rainbow Basin to the east to be adjacent to Town park under construction

5) HYDROLOGY DISCUSSION

- Brian F – Recommends rounding design flows to nearest rounded (10, 20, 50, etc) value for alternatives analysis to reduce iterations.
- Gary W – A discussion on the interim condition (prior to development) should be done. (**A discussion after this meeting led to the determination that an interim analysis and discussion would not be included in the initial hydrology tech memo).

6) LANDSCAPE ARCHITECTURE DISCUSSION

- John – Would like to get the updated Trails master plan information. John to speak with Bob Wisener at TOB Parks/Rec to seek updated trails information.
- Gary W – We need to get some questions clarified such as the maintenance road surface, O&M responsibility
- John – May be valuable to have a meeting with TOB P&R

7) RIVER MECHANICS DISCUSSION

- Would like to receive a copy of the Geotech sampling pit location map.
- Bob to provide a map showing the limits of the cultural evaluation study.

8) UTILITIES DISCUSSION

- Gary to check with L303 utility contacts – possibly mention future geotech borings to occur in the area.

9) TOWN OF BUCKEYE ITEMS

- Scott – Plans to have Rob attend planned meeting on 7/18 to discuss downtown hydrology area.
- Would like to have 7/18 meeting at 1:30 instead of 2pm.

10) ANTICIPATED TASKS PRIOR TO NEXT MEETING

a. Data Collection Memo
b. Existing Conditions Base Maps
c. Hydrology Tech Memo (Draft)
d. FCDMC / TOB Review of these items
e. Preparation for Alternatives Brainstorming Meeting (8/24)
   i. Attendees ?
   - Adam from TOB Planning, Sheryl from TOB P&R
   - Change date to August 23rd
   - Dibble to request Kristin at W.C.S. to set up meeting for Town staff to attend

11) NEXT MEETING: Subsequent to the meeting, the date of the next meeting has been changed to: Thursday, August 23rd @ 9am, at the Town of Buckeye

12) OTHER

13) ACTION ITEMS

No.	Action Item	Responsible Person	Date Due	Status/Comments
1	Set up meeting with Manual at TOB to discuss TOB Waterlines	Kevin		
2	Get UPRR culvert details thru OA	Kevin		
3	Dibble submittal – Base maps, Hydrology Memo, Data Collection	Kevin	7/19/12	Discussed later submittal date with Gary W.

	Memo			
4	Prepare Geotech authorize request letter	Kevin		Need meeting with Brian to discuss boring locations
5	Provide boring locations and access paths in CAD file to Bob S.	Justin B.		
6	Get updated Trails MP info - see Bob Wisner at TOB, possible meeting	John G.		
7	Provide sampling location map to Shimin	Justin B.		
8	Provide Limits of cultural evaluation to Dibble	Bob S.		

Watson Drainage System Pre-Design

FCD 2012C003

MEETING SIGN-IN SHEET

Project Coordination Meeting 7/16/2012

CHECK IN	NAME	SECTION/FIRM	PHONE	EMAIL
	Gary Wesch	FCDMC	602.506.4592	garywesch@mail.maricopa.gov
	Scott Zipprich	Town of Buckeye	623.349.6217	szipprich@buckeyeaz.gov
	Adam Zaklikowski	Town of Buckeye	623.349.6207	azaklikowski@buckeyeaz.gov
	Amir Motamedi	FCDMC	602.506.4871	amm@mail.maricopa.gov
	Bing Zhao	FCDMC	602.506.3293	biz@mail.maricopa.gov
	Rob Sachs	FCDMC	602.506.4744	res@mail.maricopa.gov
	John Holmes	FCDMC	602.506.3320	jwh@mail.maricopa.gov
	Julie Cox	FCDMC	602.506.8401	jrc@mail.maricopa.gov
	Gant Wegner	FCDMC	602.506.7841	gantwegner@mail.maricopa.gov
	Bob Stevens	FCDMC	602.506.4073	rbs@mail.maricopa.gov
	Harry Cooper	FCDMC	602.506.2956	harrycooper@mail.maricopa.gov
	Gary Shapiro	FCDMC	602.506.3076	ghs@mail.maricopa.gov
	Gary Maiers	FCDMC	602.506.0562	gsm@mail.maricopa.gov
	Shimin Li	FCDMC	602.506.4609	shiminli@mail.maricopa.gov
	Kevin Roberts	Dibble	602.957.1155	kevin.roberts@dibblecorp.com
	Josh Papworth	Dibble	602.957.1155	josh.papworth@dibblecorp.com
	Justin Beeler	Dibble	602.957.1155	justin.beeler@dibblecorp.com
	Jeremy Laipple	Dibble	602.957.1155	jeremy.laipple@dibblecorp.com
	Brian Fry	JE Fuller	623.889.0696 X307	brian.fry@jefuller.com
	Jeff Ford	Olsson	602.748.1000	jford@oaconsulting.com
	John Griffin	EPG	602.956.4370	jgriffin@epgaz.com
	Steve Nowaczyk	Ninyo & Moore	602.243.1600	snowaczyk@ninyoandmoore.com
	Jeff Hamilton	Hunter Contracting	480.892.0521	jeffh@huntercontracting.com

Parks & Recreation Meeting (August 8, 2012)

Parks, Trails, O&M and Planning
- Meeting Minutes -

FCD 2012C003
Data Collection Phase

Date Held: Wednesday August 8, 2012
Time: 4:00 PM – 5:30 PM
Attendees:

Gary Wesch	*FCDMC (Project Manager)*
Harry Cooper	*FCDMC*
Robert Wisener	*Town of Buckeye*
Cheryl Sedig	*Town of Buckeye*
Fred Sanchez	*Town of Buckeye*
Kevin Roberts	*Dibble Engineering (Consultant PM)*
Justin Beeler	*Dibble Engineering*
Brian Fry	*JE Fuller*
John Griffin	*EPG, Inc.*

Meeting Purpose

The Watson Drainage System Pre-Design Project will further refine the design of the Watson System identified in the Buckeye ADMP. This meeting between the Town's Parks and Recreation group and the Watson Pre-Design team served as an opportunity to revisit the findings of the ADMP related to recreation and open space resources and facilitate the integration of the Watson System elements into the Town of Buckeye's trails and recreation planning. It will also serve to begin bridging the pre-design effort through final design to the long-term implementation and maintenance needs of the Town.

Meeting Format

A brief overview of the project was provided by Kevin Roberts, the consultant team project manager. This included a discussion of potential alternative alignments for the various channels and basin locations identified in the ADMP.

The remainder of the meeting was organized around the "Key Questions" document previously provided to the Town. (See attached). These key questions included the following:

- Does the Town intend to update the Town of Buckeye Trails Master Plan to co-locate trails along the planned drainage facilities identified in the final ADMP?
- What must be included in the O&M road design to make is acceptable to the Town as a multi-use trail?
- Should the "Active Recreation" designation for the Rainbow Basin remain? Has anything changed related to the Town's parks planning that might impact this designation?

- Is "Passive Recreation/Open Space" still the most appropriate designation for the remaining three basins identified in the ADMP?
- Which department(s) will be responsible to maintain the facilities identified in the Watson Drainage System?
- Are there any operations and maintenance practices or limitations we should be aware of that could be addressed during design? i.e. – limitations on types of vegetation, frequency of maintenance?
- What tools are available to ensure the Pre-Design planning components are implemented if final design and construction must rely on developers to implement? (i.e. – is a zoning overlay district appropriate and feasible? Other planning tools?) This includes potential landscape, channel lining treatments, O&M roads, trails, drop structures, aesthetic themes, and other design elements.
- The 50-50 cost share for the system may include the construction of channels or basins by the Flood Control District but deferring the installation of some landscape and erosion control features to a future phase to be completed by the Town. How might the Town expect to implement these features?

The discussion around each question is summarized below.

Q: Does the Town intend to update the Town of Buckeye Trails Master Plan to co-locate trails along the planned drainage facilities identified in the final ADMP?

Robert Wisener confirmed that the Town would prefer the drainage alignments be integrated into the Town's Trails Master Plan.

The team recommended the Town use the final Buckeye ADMP in order to gain approval of an amendment to the Trails Master Plan rather than waiting for final alignments from the Watson System. This would also allow all of the system alignments from the ADMP to be adopted at one time.

Q: What must be included in the O&M road design to make is acceptable to the Town as a multi-use trail?

The Town's "Flood Control Channel" design guidelines from the master plan was confirmed as the minimum standard for use of an O&M road as a Town of Buckeye Trail. (See attached) This included the minimum of 20' landscape buffer from adjacent uses and a 10-foot wide tread for the road. Gary Wesch described other trail/O&M road surfaces that had been accepted by the Town of Buckeye such as asphalt and concrete. Other road surfaces may be acceptable.

A subsequent discussion regarding the potential for equestrian trail needs resulted in the following:

The Rainbow Road channel alignment is a good candidate for providing an equestrian trail route. This is due to it's proximity to the Town's Skyline Regional Park which is located on the Watson Road alignment north of the I-10. This regional park will include an equestrian trailhead. Having a north-south equestrian trail that connects the White Tank Mountains to the Gila River is

desirable to the Town. Using the channel bottom when possible would be the preferred alignment per the trails master plan design guidelines. A soft surface trail could be used where road crossings or other access issues make this unrealistic.

Q: Should the "Active Recreation" designation for the Rainbow Basin remain? Has anything changed related to the Town's parks planning that might impact this designation?

Yes – this is still planned to be an active use park site. The Town Parks and Recreation also prefers the location shown in the original ADMP rather than the potential location shown next to the Sundance Park site. The Town is planning for a future library and recreation center on the parcel between the Sundance Park site and the Rainbow Basin location.

Q: Is "Passive Recreation/Open Space" still the most appropriate designation for the remaining three basins identified in the ADMP?

Yes. The Town also suggested that basin locations near the canals would be preferred as they could help serve as trailhead locations. The group discussed pros and cons associated with locating a basin in the space between the railroad and the BWCDD canal.

Q: Which department(s) will be responsible to maintain the facilities identified in the Watson Drainage System?

Fred Sanchez was recently hired by the Town to head the Operations and Maintenance group. Currently, the Town is understaffed to maintain a large system such as the Watson Drainage System. However, as development increases which will lead to the construction of much of the system, it is reasonable to expect the Town budget and ability to hire staff for this purpose will increase with the demand.

Q: Are there any operations and maintenance practices or limitations we should be aware of that could be addressed during design? i.e. – limitations on types of vegetation, frequency of maintenance?

At this time, there were no specific practices or limitations indentified beyond staffing.

Q: What tools are available to ensure the Pre-Design planning components are implemented if final design and construction must rely on developers to implement? (i.e. – is a zoning overlay district appropriate and feasible? Other planning tools?) This includes potential landscape, channel lining treatments, O&M roads, trails, drop structures, aesthetic themes, and other design elements. The 50-50 cost share for the system may include the construction of channels or basins by the Flood Control District but deferring the installation of some landscape and erosion control features to a future phase to be completed by the Town. How might the Town expect to implement these features?

The group agreed that much of the Town's responsibility for facility construction will need to be implemented by the development community as they increase the demand. The Town is currently working on its first planning overlay district for the Buckeye Downtown. This was the only planning tool discussed. A future meeting with the Town's planning branch will be useful. Robert and Cheryl asked to be invited to this meeting when it gets scheduled.

Parks, Trails, O&M and Planning Meeting
- Supplemental Materials –

KEY QUESTIONS
Parks, Trails, O&M and Planning

Watson Drainage Pre-Design
FCD 2012C003
Data Collection Phase

Project Overview

The Watson Drainage System is a planned network of storm water conveyance and storage features between Miller Road and Rainbow Road that will extend from upstream of the Roosevelt Irrigation District (RID) canal south to the Gila River as identified in the Buckeye Area Drainage Master Plan (ADMP). The ADMP Recommended Plan for the Watson Drainage is intended to alleviate existing flooding hazards, provide conveyance for runoff accumulation along irrigation canals, and provide drainage outfalls for local developments.

The purpose of the current Watson Drainage System Pre-Design Project is to refine and firmly establish the project alignment and features, determine design constraints, resolve unknowns, and clearly establish the final design criteria for the system. The ultimate product of the Pre-Design will be preliminary plans that define the project in sufficient detail such that the size, alignment, and profile of major project features are developed to the level to transition smoothly into completion of the final design. This includes definition of project rights-of-way requirements, and refinement of project costs.

Parks, Recreation, Maintenance and Planning Goals

The ADMP identified opportunities for adding return value to the community through the integration of multi-use functions into the components of the system. This included the co-location of multi-use paths with the channel Operations and Maintenance (O&M) roads, a future active recreation park site within one proposed basin site near Rainbow Road and the RID, and designating the remaining three basins as passive open space.

The project team has identified the following questions seeking answers during the data collection phase of the project. Timely answers to these questions will assist us in identifying project right-of-way requirements as well as plan the system to function long-term within the operations practices common to the Town of Buckeye:

Trails

- The Buckeye ADMP recommendations were modified subsequent to the approval of the Town of Buckeye's 2008 Trails Master Plan. The Trails Master Plan (pg. 28) indicates that:

  > *"Should the ADMP conclude differently (*meaning the channel alignments were to change*), these trails (*designated as "flood control channel paths"*) should be re-evaluated, but in the alternate, the canal trails serve as the east-west regional connection. "*

  We would like to work with you to re-evaluate potential trail locations and opportunities based on the current status of the Watson Drainage System.

- What must be included in the O&M road design to make is acceptable to the Town as a multi-use trail?
    - ADA compliance (2% max cross-slope, 20% max. longitudinal slope)
    - AASHTO multi-use trail compliance (min. 100-foot curve radii, 3' clearance, 10-foot min. width with 2' graded shoulders per side)
    - Trail surface material

Operations and Maintenance

The Town of Buckeye will assume operations and maintenance responsibilities for the facilities proposed by the Watson Drainage Pre-Design project. We would like to coordinate the pre-design with the typical maintenance practices of the Town to ensure project success through it's lifecycle. Can you provide feedback on the following potential issues and likely design elements:

- Which department(s) will be responsible to maintain channels, trails, passive open space basins, and active recreation basin?
- Feedback on Channel vegetation:
    - Appropriate types, methods of installation and establishment (hydroseed, nursery, tall pots, irrigation, etc.), likely frequency of maintenance, vegetation control practices?
- Feedback on Basin vegetation:
    - Appropriate types, methods of installation and establishment (hydroseed, nursery, tall pots, irrigation, etc.), likely frequency of maintenance, vegetation control practices?

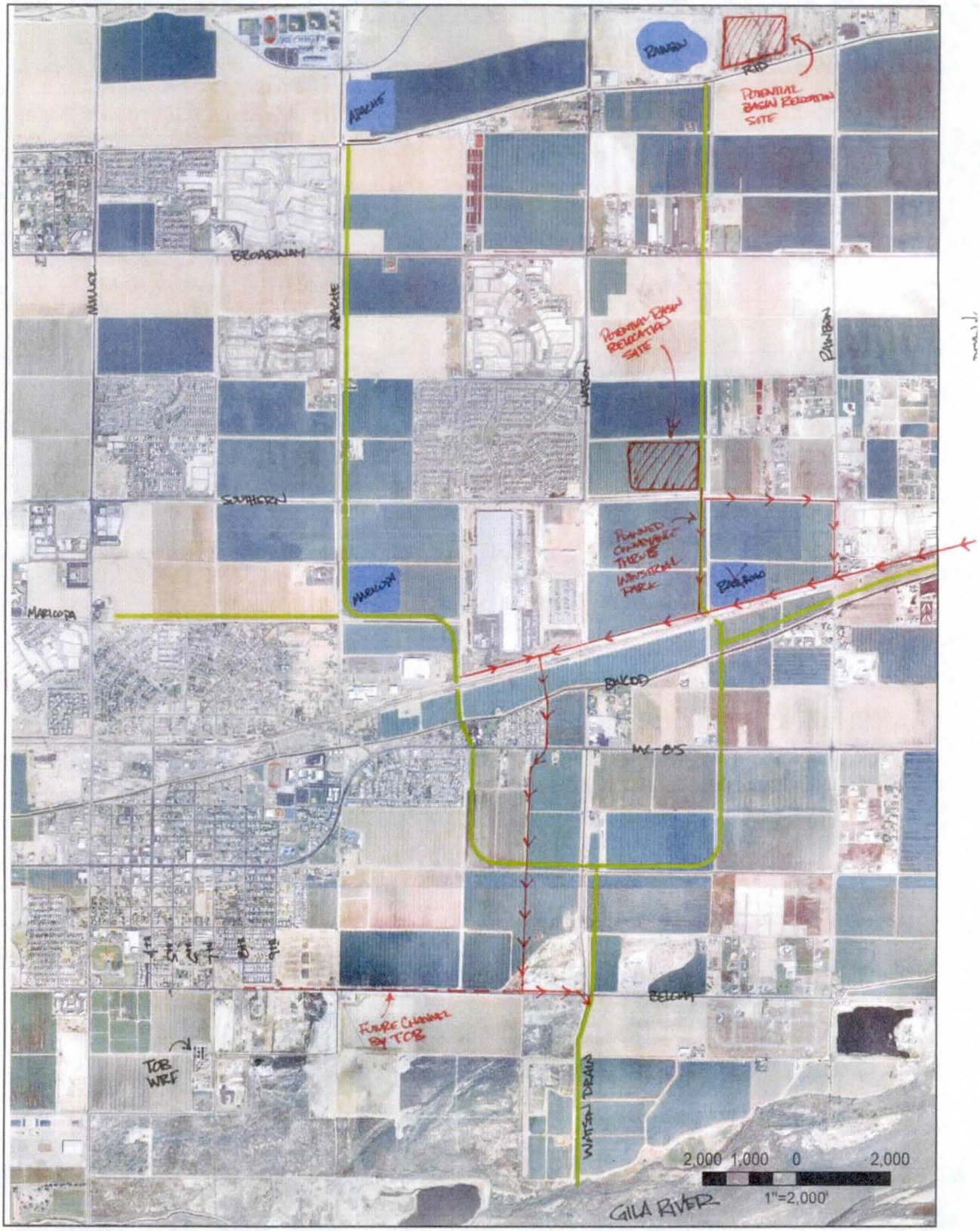
Planning

The project will include a determination on which components of the system will be constructed by the District, and which will be the Town's construction responsibility. Implementation of the Town's cost share responsibilities will likely require partnering with incoming development and other property owners. We would like to discuss the following items related to this topic:

- What tools are available to ensure the Pre-Design planning components are implemented if final design and construction must rely on developers to implement? (i.e. – is a zoning overlay district appropriate and feasible? Other planning tools?) This includes potential landscape, channel lining treatments, O&M roads, trails, drop structures, aesthetic themes, and other design elements.
- The 50-50 cost share for the system may include the construction of channels or basins by the Flood Control District but deferring the installation of some landscape and erosion control features to a future phase to be completed by the Town. How might the Town expect to implement these features?

WATSON DRAINAGE SYSTEM PRE-DESIGN

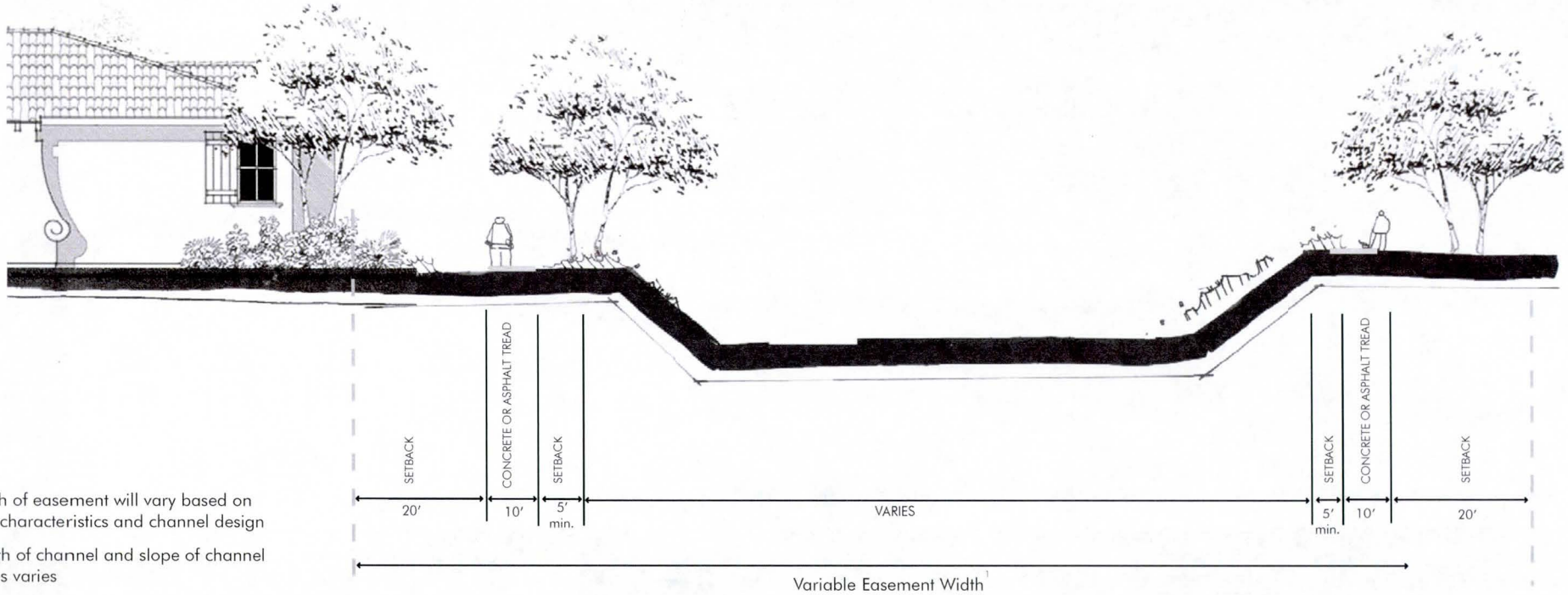
WATSON



Buckeye Trail Standards Matrix

Trail Calssification	Trail Character	Min. Trail Width (ft.)	Surface (Tread) Material	Vertical Clearance (ft.)	Turning Radius (ft.)
Arterial Path	N/A	8	Concrete	12	12
Landmark	N/A	8-10	Depends on Character	12	12
Powerline	Urban	5	Native	12	6-8
	Suburban	5	Native	12	6-8
	Rural	4	Native	N/A	6-8
	Wilderness	4	Native	N/A	6-8
Equestrian	Light Use	2-4	Native	12	8-10
	Heavy Use	5-6	Native	12	8-10
Wash	Urban	12	Concrete	12	12
	Suburban	8	Concrete/Asphalt	12	12
	Rural	5	Native	N/A	6-8
	Wilderness	N/A	N/A	N/A	N/A
Flood Control Channel	Urban	10	Concrete/Asphalt	12	12
	Suburban	8	Concrete/Asphalt	12	12
	Rural	5	Native/Compacted	N/A	6-8
	Wilderness	N/A	Native	N/A	N/A
Canal	N/A			12	12
Riverine	N/A	N/A	Native	N/A	N/A

* Please refer to the Town of Buckeye Transportation Design Manual for recommended easement widths along Arterial Roads.
All other easement widths will vary based on site topography, wash or channel design and other variables as determined by Town Staff and will be identified on a case by case basis.

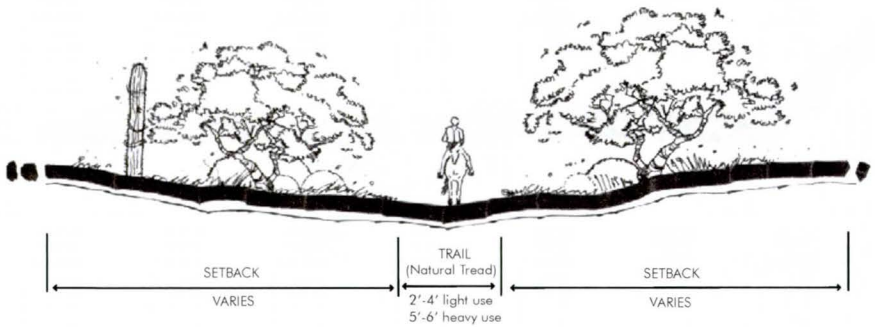


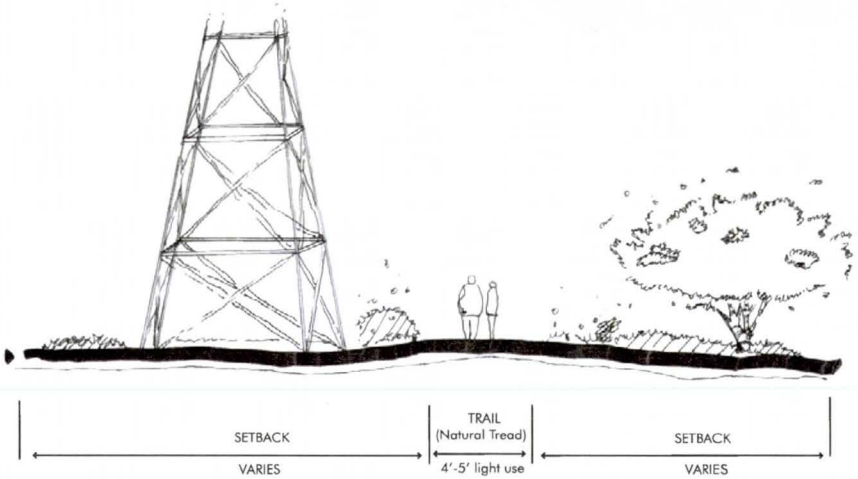
NOTES

1) Width of easement will vary based on flow characteristics and channel design

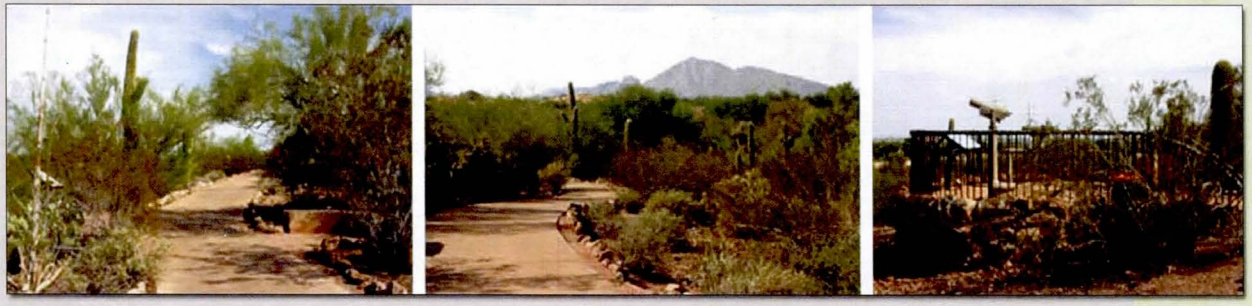
2) Depth of channel and slope of channel sides varies

4.7 DESIGN GUIDELINES FLOOD CONTROL CHANNEL TRAIL *Miller Road*





4.7 DESIGN GUIDLINES EQUESTRIAN TRAIL



3.8 - Trails Theme "Rustic Sophistication"

An important feature to any Trails Master Plan is the overall trail theme. Based largely on input received from the Project Stakeholder meetings and comments received from the citizens of Buckeye during the Community Open Houses, the suggested theme will capture the proud western heritage of Buckeye's past, while celebrating the growth and direction of present day Buckeye. Suggested materials and concepts are as follows:

- Utilize natural or compacted tread surfaces where possible.
- Natural materials such as stone, wood and native plant material should be considered as the primary building and signage material.
- Tastefully accented wayfinding and educational signage can be created with wrought iron, stacked stone, carved wood or steel.
- Suggested materials should be recycled, or environmentally conscious in nature (solar powered lighting, compost bins, etc.)

VI. Operation & Maintenance

For the long-term operations and maintenance of the Buckeye trail system to succeed, the Town must first identify what is to be maintained, and who is responsible for the trail maintenance. There are different entities that become responsible for trail maintenance. Homeowners associations (HOA's), a private landowner, an utility/canal operator, the FCDMC or the Town of Buckeye each may maintain a given stretch of trail throughout Buckeye. Because many different entities may maintain any given section of trail, a minimum set of operation and maintenance guidelines should be established. Once the parameters of the system are defined, strategies, procedures and budgets can be implemented.

Strategy 6.1 - Building from the GIS plan base provided in this Trails Master Plan, develop and inventory an operation and maintenance schedule and map that assigns responsible party, timing and allocated budget for each type of trail being developed.

Strategy 6.2 - The Town of Buckeye will require a public dedication and be responsible for the maintenance of all Landmark Trails.

Strategy 6.3 - Work with the Town Engineer and the Parks Division Departments to develop specific trail maintenance standards for each trail classification type in Buckeye. Considerations for vegetation clearance, tread maintenance, erosion, berm removal and signage upkeep, man hours needed and a regular maintenance schedule shall be incorporated.

Strategy 6.4 - A preliminary maintenance schedule that guides the routine maintenance of all developed trails (regardless of the entity maintaining the trail) should include a regular maintenance cycle of approximately six months for shared use (or built environment) trails and one year for natural trails. The Town and privately maintained trails should share the same maintenance standards to clarify expectations.

Strategy 6.5 - The Town will be responsible for maintaining all of the public trails not within an organized homeowner's association, thereby ensuring a consistent level of maintenance and care.

Strategy 6.6 - As additional trails are added to the Buckeye trail system, the Town shall program additional operation and maintenance monies commensurate with the addition of said trails to the system. The amount of money needed for maintenance directly correlates to the Trail Classification.

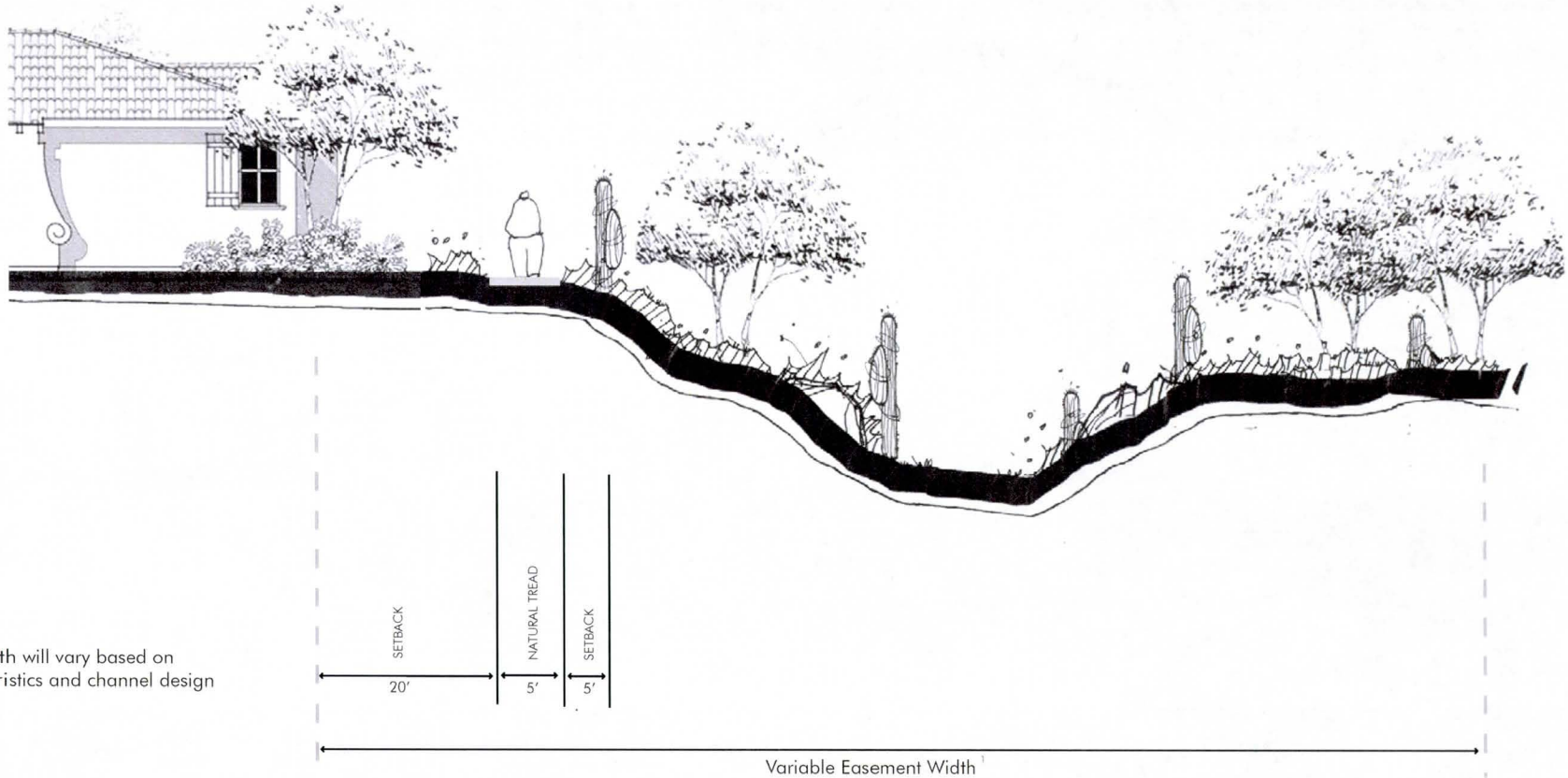
Annual budgets can be determined using an average cost per mile (annual maintenance) multiplied by the miles of trails that are the Town's responsibility.

Strategy 6.7 - A regular cycle of maintenance or "maintenance regime" should be established for every trail under the Town of Buckeye's responsibility. This same regime should be shared with private HOA's so they have an understanding of the Town's expectations.

Strategy 6.8 - An Evaluation Checklist should be created to aid in the evaluation phase of the program. This checklist should identify the trail standard, location, trail name, and notations of deficiencies.

VII. Trail Development Guidelines

This Trails Master Plan has introduced a series of new trail classifications for the Town of Buckeye as identified in Section 3.5. Included in this section are a series of trail development guidelines critical for trail development in the Town, either by projects initiated by the Town itself or on-going private development. This however, is not an exhaustive list of guidelines since the ultimate application of these standards will vary depending upon location, physical impediments and cost.

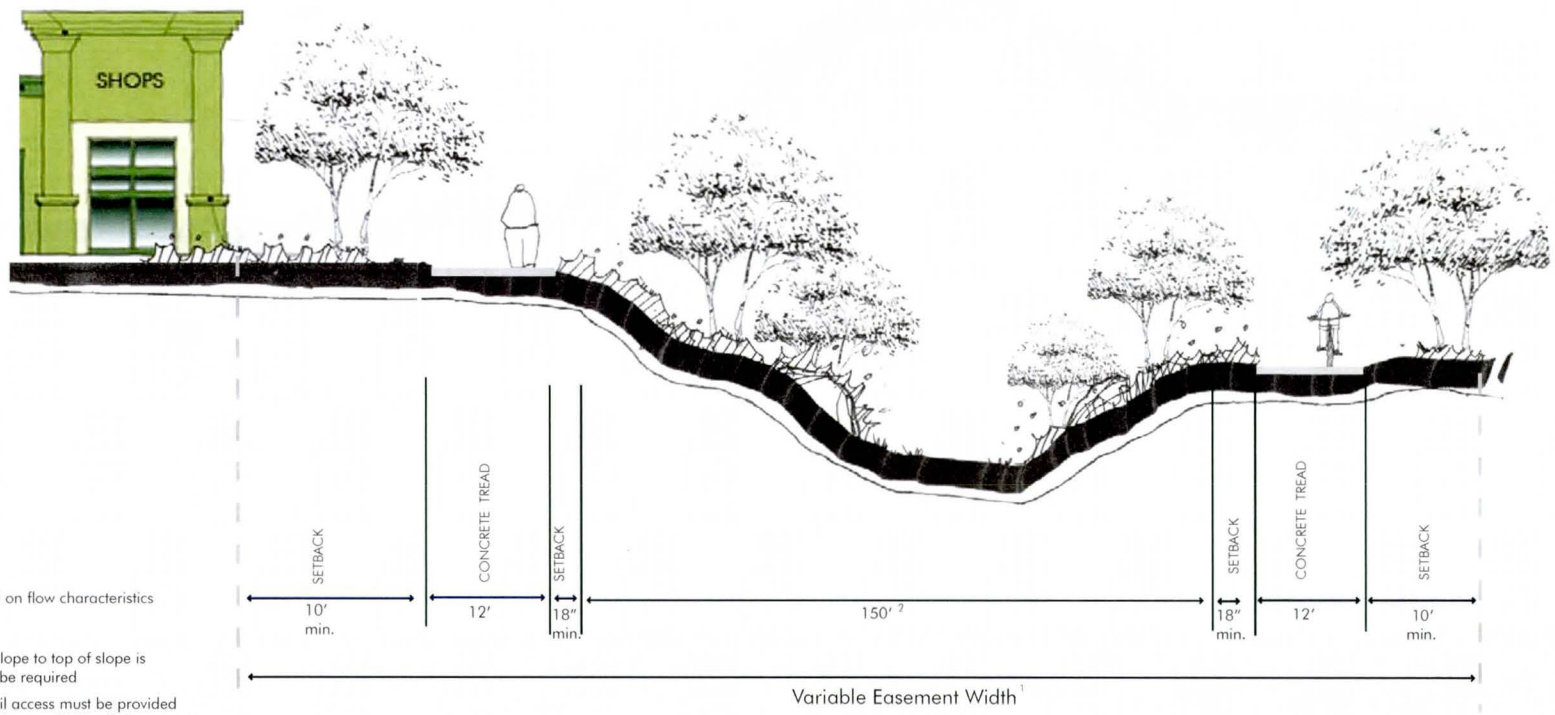


NOTES

1) Easement width will vary based on flow characteristics and channel design

4.7 DESIGN GUIDELINES - WASH TRAIL

Rural Character



NOTES

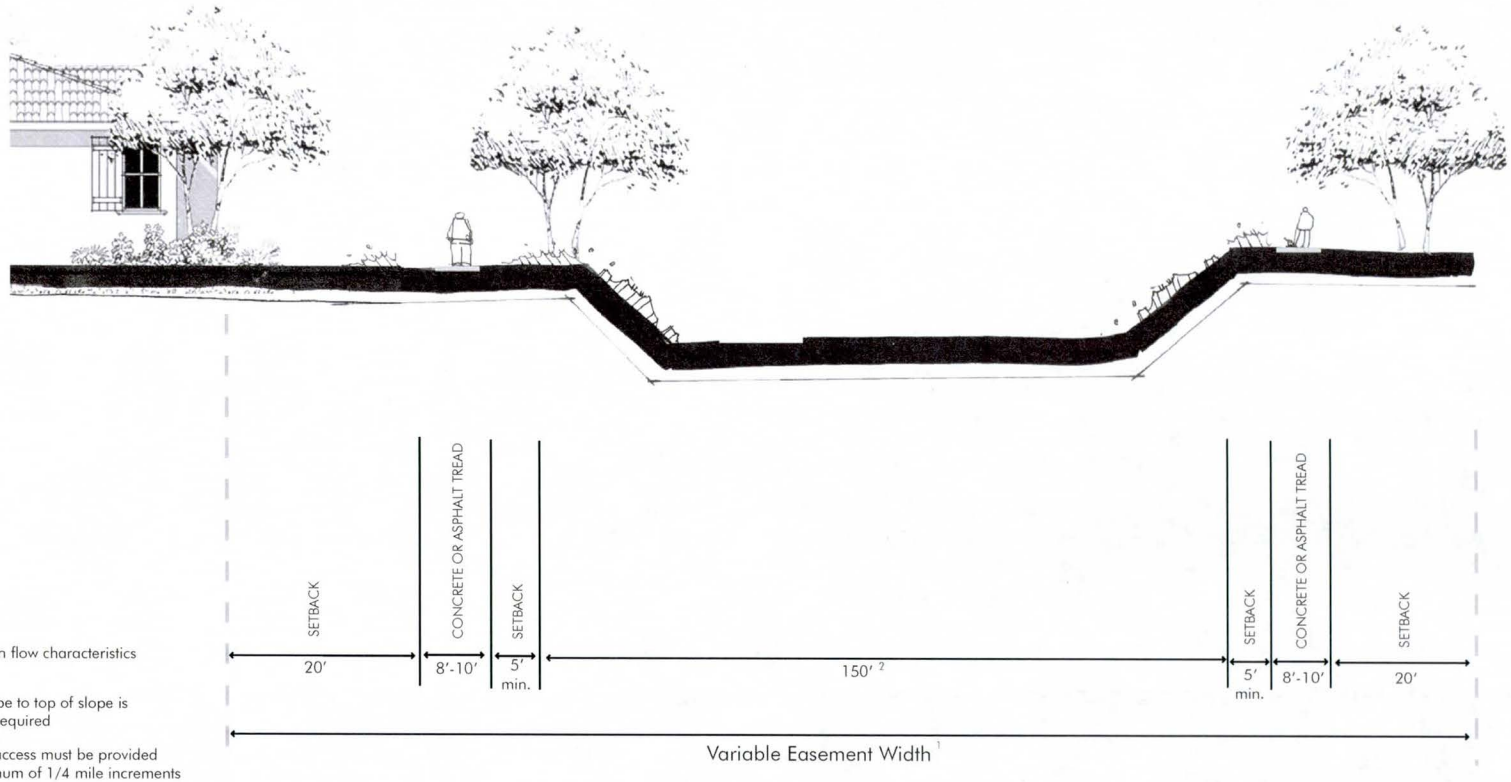
1) Easement width will vary based on flow characteristics and channel design

2) If the distance between top of slope to top of slope is 150′ or less, only one trail will be required

3) If only one trail is provided, trail access must be provided for the "non-trail" side at a minimum of 1/4 mile increments

4.7 DESIGN GUIDELINES WASH TRAIL

Urban Character



NOTES

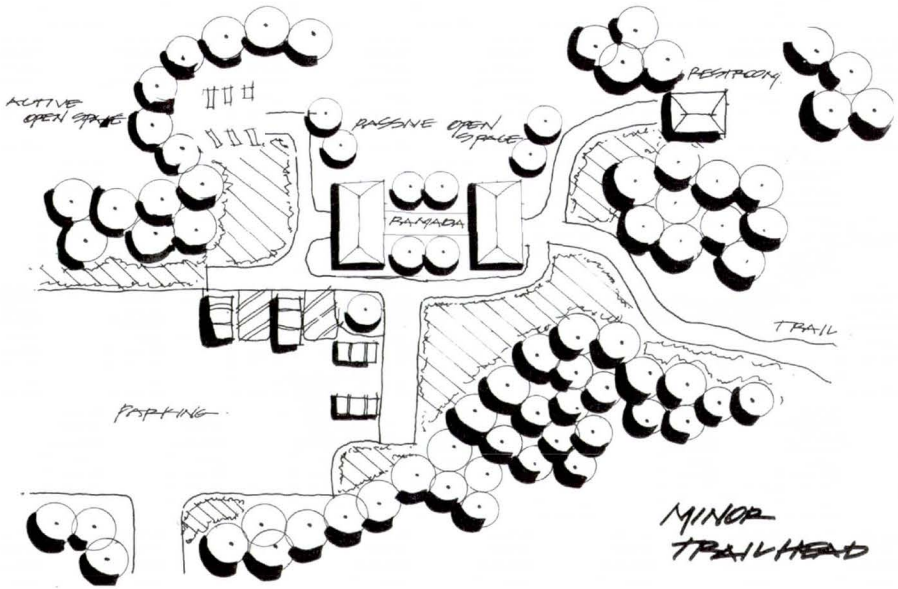
1) Easement width will vary based on flow characteristics and channel design

2) If the distance between top of slope to top of slope is 15' or less, only one trail will be required

3) If only one trail is provided, trail access must be provided for the "non-trail" side at a minimum of 1/4 mile increments

4.7 DESIGN GUIDELINES WASH TRAIL

Suburban Character



Minor Trailhead (typical)

Trailhead Guidelines

Trailhead Level	Qty	Parking	Rest Rooms	Lighting	Ramadas	Equestrian Use	Amenities- signage, maps, drinking water, garbage containers, seating,bike racks
Major[1]	7	30-100	●	●	2-4	●	●
minor	13	10-30	●	●	1-2		●

1- All Major Trailheads provide for equestrian users

* - All Community Parks to have minor Trailheads

* - Equestrian Parking Requirements: 12' min. width, 15' preferred x 60' min. length. 70' length preferred

Project Coordination Meeting #3 (Sept. 17, 2012)

Dibble Engineering

7500 North Dreamy Draw Drive, Suite 200
Phoenix, Arizona 85020
Tel. (602) 957-1157
Fax (602) 957-2838

Meeting Minutes

Project: Watson Drainage System Pre-Design
Date: September 17, 2012 – 2:00 PM
Re: Project Coordination Meeting #3
Contract: FCD 2012C003
Dibble Project: 101206

1) INTRODUCTIONS/ATTENDEES

Gary Wesch	FCDMC
Scott Zipprich	TOB
Kevin Roberts	DIBBLE
Justin Beeler	DIBBLE
Josh Papworth	DIBBLE
Shimin Li	FCDMC
Bing Zhao	FCDMC

John Holmes	FCDMC
Bob Stevens	FCDMC
Gary Shapiro	FCDMC
Gary Maiers	FCDMC
Brian Fry	JE FULLER
John Griffin	EPG

2) REVIEW OF MEETING MINUTES / ACTION ITEMS

No.	Action Item	Responsible Person	Status/Comments
1	Set up meeting with Manual at TOB to discuss TOB Waterlines	Kevin	Received Manuel's input after brainstorming mtg.
2	Get UPRR culvert details thru OA	Kevin	OA gathering details.
3	Dibble submittal – Base maps, Hydrology Memo, Data Collection Memo	Kevin	Submitted and reviewed. Final submittal of Hydrology Tech Memo by 9/21/12.
4	Prepare Geotech authorize request letter	Kevin	Letter provided to Gary W. Need additional information (access routes, alternative locations, pits vs trenches)
5	Provide boring locations and access paths in CAD file to Bob S.	Justin B.	Need additional information (access routes, alternative locations, pits vs trenches)
6	Get updated Trails MP info - see Bob Wisner at TOB, possible meeting	John G.	Met with Town Parks/Planners 8/8/12
7	Provide sampling location map to Shimin	Justin B.	Need additional information (access routes, alternative locations, pits vs trenches)
8	Provide Limits of cultural evaluation to Dibble	Bob S.	Complete

- Manuel provided markups for water/sewer lines on exhibit
  - Gary would like to have these proposed utilities added to the Existing Base Maps.
- Rob Sachs needs to know soil sample type (bore vs trench) for each location

- The Town of Buckeye is in the process of modifying the Town Trails Master Plan to adopt the ADMP channel alignments

3) PROJECT SCHEDULE REVIEW AND STATUS

a. Data Collection
   i. Complete

b. Hydrology Tech Memo
   i. Final by 9/21/12

c. Geotechnical Optional Task Authorization
- Scott to look for Development geotech reports along alignments and near potential boring locations and provide to Dibble.
- Dibble to provide geotech boring location map to Scott, Bob, Rob.

d. Alternatives Development
   i. Brainstorming meeting held 8/23/12 (see distributed exhibits)
   ii. Comments received from 5 participants.
      - 2 participants commented that they "had no comments"
      - 1 participant reiterated the need for coordination with developers and Town planners as alternatives move forward.
      - 1 participant questioned why a one channel system with surge basin was not depicted in the alternatives. This option may have been discussed in a smaller group at the brainstorming meeting, but was not shown on the marked up exhibits produced by the groups at the brainstorming meeting. A single channel system would require several east-west laterals to drain the entire watershed to the single channel. The Watson alignment would be challenging for this channel, considering the planned Watson Parkway. This option is not being advanced due to apparent lack of support.
      - 1 participant provided additional information regarding planned utility lines in the project area.
      - 1 participant expressed a preference for Alt A or Alt B, but also expressed that the evaluation criteria would determine the preferred alternative. This participant also expressed the desire to provide a single crossing of the UPRR and the ANPP 96" reclaimed waterline.

e. Alternatives Analysis
- Scott mentioned that the TOB Town Manager has requested an internal discussion of the proposed alternatives (Steve C., Sheryl, Woody, Scott).
- Scott to invite Dibble representative to meeting to help with any questions that may arise.
- Gary S. mentioned high water table near Beloat where TOB inflow channels will be located.
  - May also want to check with Ron Whitler (TOB) on existing water table information
  - Scott mentioned that water level data may be available from Downtown SD project.

   i. Site Visit #2 (10/2/12 ?)
- Gary requests site visit moved to October 1st (Monday). 3-4 hrs in morning. Focus on alignment options and flaws with proposed alternatives.
- Invite Manual (TOB) to site visit to identify utilities, etc.

   ii. Preliminary Alternatives Memo (10/19/12)
   iii. PAAC Meeting (10/23/12 ?)
- PAAC mtg to come before public meeting. Date TBD. See handout attached to minutes.
- Gary W. to identify potential data for invitees and schedule meeting invite.
- Need to share photos of projects with John Griffin for potential use in PAAC exhibits.
- Scott Zipprich encourages team to hold PAAC Mtg as close to 10/1 as possible.

   iv. Public Meeting (10/24/12) – possible to move to 10/25?
- Will coordinate with Gant to select final date

   v. Alternatives Selection Meeting (10/30/12)
- Date TBD

   vi. Final Alternatives Memo (11/23/12)
- Add a revised submittal of the Existing Conditions Base Maps (based on revisions with planned utility information from Manual.

Dibble Engineering

7500 North Dreamy Draw Drive, Suite 200
Phoenix, Arizona 85020
Tel. (602) 957-1157
Fax (602) 957-2838

4) HYDROLOGY DISCUSSION

a. Technical Memorandum Complete. Comments addressed. JE Fuller peer review complete. Final version to be submitted 9/21/12

b. Other?

- Justin to provide Land Use Code descriptions to Rob (Scoutten) for TOB review. Set up meeting for review if necessary.
- Kn value should be reviewed for land use codes. Default value is 0.02 and will not be accurate.

5) LANDSCAPE ARCHITECTURE DISCUSSION

- Discussion of various lining options and typical sections based on velocities, drop structures, etc.

6) RIVER MECHANICS DISCUSSION

- No items for discussion

7) UTILITIES DISCUSSION

- Gary M. – Should has received information from all utility companies contacted thus far.

8) TOWN OF BUCKEYE ITEMS

- Scott is on the El Rio levee committee, may be resource for updates on that project.

9) ENVIRONMENTAL DISCUSSION

- No items for discussion

10) ANTICIPATED TASKS PRIOR TO NEXT MEETING

a. Hydrology Tech Memo Finalized

b. Site Visit #2 (looking for fatal flaws of proposed alternatives)

c. Preliminary Alternatives Memo

i. Alternatives specific hydrology models

ii. Sizing of proposed facilities

iii. Cost estimating

- Unit prices will be based on median price values from recent project bid tabs

iv. Development of evaluation criteria spreadsheet

d. Invitations for Public Meeting #1

e. Final Arrangements for PAAC Meeting #1

11) ACTION ITEMS

No.	Action Item	Responsible Person	Date Due	Status/Comments
1	Add utility info from Manual to base maps	Justin		
2	Provide information to Rob Sachs regarding soil sample types (bore vs trench)	Kevin		
3	Check for Development geotech reports along alignments and near potential boring locations and provide to Dibble.	Scott		
4	Invite Manual to Field visit #2	Kevin		
5	Provide LU Code comparison review data to Rob for TOB review	Justin		
6				
7				
8				

12) NEXT MEETING: Monday, October 15 @ 9:00 AM

Watson Drainage System Pre-Design

FCD 2012C003

MEETING SIGN-IN SHEET

Project Coordination Meeting 9/17/2012

CHECK IN	NAME	SECTION/FIRM	PHONE	EMAIL
	Gary Wesch	FCDMC	602.506.4592	garywesch@mail.maricopa.gov
	Scott Zipprich	Town of Buckeye	623.349.6217	szipprich@buckeyeaz.gov
	Sean Banda	Town of Buckeye	623.349.6215	sbanda@buckeyeaz.gov
	Amir Motamedi	FCDMC	602.506.4871	amm@mail.maricopa.gov
	Bing Zhao	FCDMC	602.506.3293	biz@mail.maricopa.gov
	Rob Sachs	FCDMC	602.506.4744	res@mail.maricopa.gov
	John Holmes	FCDMC	602.506.3320	jwh@mail.maricopa.gov
	Gant Wegner	FCDMC	602.506.7841	gantwegner@mail.maricopa.gov
	Bob Stevens	FCDMC	602.506.4073	rbs@mail.maricopa.gov
	Harry Cooper	FCDMC	602.506.2956	harrycooper@mail.maricopa.gov
	Gary Shapiro	FCDMC	602.506.3076	ghs@mail.maricopa.gov
	Gary Maiers	FCDMC	602.506.0562	gsm@mail.maricopa.gov
	Shimin Li	FCDMC	602.506.4609	shiminli@mail.maricopa.gov
	Kevin Roberts	Dibble	602.957.1155	kevin.roberts@dibblecorp.com
	Josh Papworth	Dibble	602.957.1155	josh.papworth@dibblecorp.com
	Justin Beeler	Dibble	602.957.1155	justin.beeler@dibblecorp.com
	~~Justin Beeler~~	~~Dibble~~	~~602.957.1155~~	~~justin.beeler@dibblecorp.com~~
	Brian Fry	JE Fuller	623.889.0166 X307	brian.fry@jefuller.com
	Jeff Ford	Olsson	602.748.1000	jford@oaconsulting.com
	John Griffin	EPG	602.956.4370	jgriffin@epgaz.com
	Steve Nowaczyk	Ninyo & Moore	602.243.1600	snowaczyk@ninyoandmoore.com
	Jeff Hamilton	Hunter Contracting	480.892.0521	jeffh@huntercontracting.com

PAAC #1 (Oct. 11, 2012)

Meeting Minutes

Project: Watson Drainage System Pre-Design
Date: December 11, 2012
Re: Watson Pre-Design / Watson CFD
Contract: FCD 2012C003
Dibble Project: 101206

ATTENDEES:
Scott Zipprich (Town of Buckeye)
Bob Wisener (Town of Buckeye)
Eric Orsborn (Town of Buckeye)
Woody Scoutten (WC Scoutten/Town of Buckeye)
Scott Lowe (Town of Buckeye)
Gary Wesch (FCDMC)
Harry Cooper (FCDMC)
Gant Wegner (FCDMC)
David Schlief (APS)
Randy Butler (APS)
Mike Bouche (APS)
Lara Serbin (Serbin Studio Architecture)
Melody Zyburt (Stantec/BWCDD/RID)
Donovan Neese (RID)
John Griffin (EPG)
Kevin Roberts (Dibble)

PURPOSE OF MEEETING:
The purpose of this Project Aesthetics Advisory Committee meeting was to discuss the preferences for the aesthetic character of the proposed Watson drainage system, from which project guidelines could be established.

DISCUSSION:

- "Form Follows Function"
- Some of the UPRR culvert crossings are joint-use with RID for tailwater conveyance. Need to understand what the base flows and the maximum anticipated flows are in order to understand available excess capacity for flood control purposes.
- The Town's responsibility for maintenance will affect their input and preferences regarding the "form" (aesthetics) of the proposed facilities.
- Is there a possibility of utilizing irrigation tailwater for proposed facility landscaping irrigation? Per Melody, only if existing tailwater flow path does NOT enter the delivery system.
    - If the current delivery system accepts tailwater, then this functionality must be maintained. THIS tailwater would not be available for irrigation of landscape improvements
    - But, much of the water in the Watson Drain is pumped de-watering flows. This system (pumps, etc...) is owned and operated by the Town of Buckeye and the resulting water MAY be available for irrigation of proposed landscape improvements.
- Per Scott Lowe: Earthen channels lead to undesired vegetation year round and significant maintenance impacts to the Town of Buckeye.

- Per Melody: Need to restrict pedestrians from accessing RID and BWCDD canals.
- Per Bob Wisener: The Town's Trails Masterplan shows trails along the RID and BWCDD, but would likely be in an easement adjacent to the canals
- If irrigation laterals are relocated to be near main canals, then there will need to be landscape restrictions.
- There is a possibility of utilizing the proposed trail along the Watson system channels in lieu of requiring sidewalks for adjacent parallel roadways.
- The Town of Buckeye will look at the development code to evaluate flexibility regarding "trade offs"... open space requirements, active recreation requirements, etc...
- Typically, will need to have an easement for dry utilities adjacent to any roadway facilty.
- RID feeder ditch along the east side of Apache will probably need to be replaced with a 30" to 36" pipe.
- The RID-preferred location for pipe laterals is under the sidewalk/trail system.
- The proposed channels should not be turf-lined, UNLESS the developers are going to install and maintain it.
    - Active recreation requires turf. Developer have motivation to propose turf.3
    - Town wants to encourage developers to use open space credits on the interior of their developments, not just concentrated along the proposed channels.
- Drop structures could utilize form liners to present appearance of irrigation canal turn-out structure, or some other like feature.
- Need to develop an appropriate channel section for industrial areas (less aesthetic import).
- An earthen section for the channel represents "worst case" from a property requirement perspective. As such, earthen sections could be used for the alternatives evaluation, but need to make accommodation for the proposed Industrial Park.
- If Alternative C moves forward (retention areas upstream of UPRR to utilize existing UPRR culvert crossings), then the collection/retention areas will be used for passive recreation uses.
- Southern-most reach of the system (Watson Drain) needs to be pedestrian friendly. The Town envisions heavy pedestrian/recreation use along the north side of the Gila River.
- The Town of Buckeye does not want a bunch of Mesquite trees and Palo Verde trees.
- The proposed system basins, with the exception of the Rainbow Basin should be passive open space areas.

Meeting Sign-in Roster
Watson Drainage System Pre-design
Project Aesthetics and Advisory Committee (PAAC) Meeting #1
October 11, 2012

Name	Organization or Address	Phone #	E-mail
KEVIN ROBERTS	DIBBLE ENGINEERING	602.957.1155	KEVIN.ROBERTS@DIBBLECORP.COM
GANT WEGNER	FLOOD CONTROL DISTRICT	602-506-7841	GANTWEGNER@MAIL.MARICOPA.GOV
DAVID SCHLIEF	APS	602-371-7295	DAVID.SCHLIEF@APS.COM
LARA SERBIN	SERBIN STUDIO ARCHITECTURE	602.230.1299	LARA@SERBINSTUDIO.COM
Melody Zybart	Stantec BUCDO/RID	602-438-2200	melody.zybart@stantec.com
WOODY SCOUTTEN	TOB	623-349-6204	WSCOUTTEN@BUCKEYEAZ.GOV
SCOTT LOWE	TOB	623 349 6815	SLOWE@BUCKEYEAZ.GOV

Meeting Sign-in Roster
Watson Drainage System Pre-design
Project Aesthetics and Advisory Committee (PAAC) Meeting #1
October 11, 2012

Name	Organization or Address	Phone #	E-mail
GARY WESCH	FCDMC	602-506-4592	garywesch@mail.maricopa.gov
Robert Wisener	Town of Buckeye	623 349 6621	rwisener@buckeyeaz.gov
Scott Zipprich	TOB	6233496200	Szipprich@buckeyeaz.gov
DONOVAN NEESE	RID	623-386-2046	
HARRY COOPER	FCDMC	602-506-2956	harrycooper@mail.maricopa.gov

Meeting Sign-in Roster
Watson Drainage System Pre-design
Project Aesthetics and Advisory Committee (PAAC) Meeting #1
October 11, 2012

Name	Organization or Address	Phone #	E-mail
JOHN GRIFFIN	ERG,	602.956.4370	JGRIFFIN@ERGAZ.COM
Randy Butler	APS - PVNGS	623-393-3003	randy.butler@aps.com
MIKE BOUCHE	APS	602-371-7033	MICHAEL.BOUCHE@APS.com
ERIC ORSBORN	TOB.	623 349-6946	EORSBORN@BUCKEYEAZ.GOV.

Project Coordination Meeting #4 (Oct. 15, 2012)

Dibble Engineering

7500 North Dreamy Draw Drive, Suite 200
Phoenix, Arizona 85020
Tel. (602) 957-1157
Fax (602) 957-2838

Meeting Minutes

Project: Watson Drainage System Pre-Design
Date: October 15, 2012 – 9:00 AM
Re: Project Coordination Meeting #4
Contract: FCD 2012C003
Dibble Project: 101206

1) INTRODUCTIONS/ATTENDEES

Gary Wesch	FCDMC
Scott Zipprich	TOB
Kevin Roberts	DIBBLE
Justin Beeler	DIBBLE
Gant Wegner	FCDMC
Shimin Li	FCDMC

John Holmes	FCDMC
Bob Stevens	FCDMC
Gary Shapiro	FCDMC
Gary Maiers	FCDMC
Brian Fry	JE FULLER
John Griffin	EPG

2) REVIEW OF MEETING MINUTES / ACTION ITEMS

No.	Action Item	Responsible Person	Status/Comments
1	Set up meeting with Manuel at TOB to discuss TOB Waterlines	Kevin	Site meeting scheduled for Wed 10/17
2	Provide additional details regarding soil sampling (revised locations, borings vs. trenches)	Kevin	
3	Schedule meeting with RID/BWCDD – Melody Zyburt	Kevin	
4	Schedule meeting with APS (PVWRF) – Randy Butler	Kevin	
5	Provide geotech reports for developments within study area to Dibble	Scott Z	

- Scott mentioned that the new 16" water line will be placed on an alignment very close to the existing sewer (~7' deep) which has already been abandoned and will be removed when the new water line goes in.
- The available ROW between the Walmart property and the railroad is limited.
- Kevin has a meeting planned with Manuel in Buckeye on Wednesday (10/17) to review the planned sewer/waterlines here. Manual will have plans with him in the field. The Dibble base files will be updated based on the proposed waterline design.
- Scott recommended contacting Rob at Waterworks to obtain the electronic base files for the waterline.
- Soil samples for new proposed locations will be emailed to Gary.
- Scott to check with Scoutten office about existing soils reports for developments.
- Kevin to schedule meeting with irrigation canal companies. Melody Zyburt – was at PAAC mtg. Melody supplied an exhibit showing canal location/functions.
- Gary suggests obtaining digital files from Melody for the canals and hopefully show the function.

- We need to have a good understanding of the existing irrigation facilities and their capacities. A profile showing HGL's for tailwater and delivery levels would be helpful.
- We won't anticipate mixing tailwater or delivery flows in our flood control channels in the northern half of the study area since the tailwater will need to be reused in the downstream fields. For the southern half in the "Watson drain", the low flow channel will need to adequately convey any irrigation flows currently in the channel or a separate system will need to be designed to convey it.
- A meeting will be planned with Randy Butler from APS. Randy mentioned that there doesn't appear to be any existing dipped sections in the APNN line which would allow for a crossing over the line. Currently it is 5-6' of cover.
- Gary mentioned that we need to assemble the limitations and criteria from APS & UPRR, etc for channels within their ROW.
- Gary mentioned that Evergreen Properties is a stakeholder within the study area. They own 7 properties in the area and should be included in future stakeholder meetings.
- Gary would like to see an action item added to schedule a Stakeholder meeting at the Town in January.

3) PROJECT SCHEDULE REVIEW AND STATUS

- Hydrology Tech Memo
  i. Final by 10/19/12
     - Received feedback form WC Scoutten regarding landuse parameters

- PAAC Meeting #1
  i. Held Thursday 10/11
     - Town expressed concerned regarding maintenance costs of system
     - Open to turf lined channels in northern areas, but do not want developers to rely on this facility for open space/active recreation credit
     - Suggested we move forward with the "worst case" channel section with respect to ROW
  ii. Discussion:
     - Not a lot of concern with the aesthetics of the project. Laura Serbin, an architect at the PAAC meeting, expressed interested in maintaining only historic plant life in the proposed channels. Laura also wants to retain the existing salt cedars in the area.
     - Kevin said that Scott Lowe from the Town mentioned that maintenance costs will drive the town preferences on channel lining.
     - Gary said that for the Alternatives Analysis, the Southern portions (FCDMC constructed portion), a 6H:1V slope with rock mulch should be considered for use on the side slopes. The channel will be hydroseeded along the bottom. Some planting to be considered in the n-value used. Sides to be protected with rock mulch. We need to establish what the ultimate condition plant density will be to establish the high n-value. The "Composite" section should be considered for the southern section.
     - Gary said that a concrete channel should only be looked at for low flow channels only.
     - For the Northern section, we should evaluate the alternatives for the maximum section option, which is the earth lining. Developers may want to see Turf be used for a visual appeal adjacent to the roadways.
     - Scott recommended that channel drop locations be aligned to occur at existing irrigation crossing locations.

- Alternatives Analysis
  i. Preliminary Alternatives Memo (11/9/12)
  ii. Alternatives Selection Meeting (11/28/12)
  iii. Final Alternatives Memo (12/21/12)

4) HYDROLOGY DISCUSSION

- Technical Memorandum Complete. Comments addressed. JE Fuller peer review complete. Final version to be submitted 10/19/12.
- Request from Hubbard Engineering (industrial park) for current model
  - We have Existing conditions model from the ADMP, an ADMP Recommended plan model, and our base conditions Watson Pre-Design model.
  - Scott told them in the last meeting that they need to use the Existing conditions ADMP model or the Developed condition recommended plan model – whichever flow was higher. Or prepare an updated model based on developed conditions using NOAA 14 flows which the town and FCDMC would need to review.

Dibble Engineering

7500 North Dreamy Draw Drive, Suite 200
Phoenix, Arizona 85020
Tel. (602) 957-1157
Fax (602) 957-2838

- Kevin would like to see them hold off until we have an updated optimized model for the Watson Pre-Design.
- Gary has provided Hubbard with the Existing Condition model which is the current governing model for the Town of Buckeye. This model should satisfy their request for a model at this point.
- Will need a Stakeholders meeting eventually and Hubbard would be invited. No models will be released to the public from this project until the Pre-Design hydrology is set - ~6 months from now.

5) LANDSCAPE ARCHITECTURE DISCUSSION

- No items for discussion

6) RIVER MECHANICS DISCUSSION

- No items for discussion

7) UTILITIES DISCUSSION

- No items for discussion

8) ENVIRONMENTAL DISCUSSION

- No items for discussion

9) PUBLIC INVOLVEMENT DISCUSSION

a. Public meeting #1
   i. Date: Wednesday 10/24
   ii. Location: Town Hall (Executive Conference Room)
   iii. Time: 6:00-7:30PM (staff there at 5:00PM)
   iv. Exhibits for FCD review (10/15)
   v. Exhibits finalized for printing and mounting (10/17) (By end of the week at the latest for FCDMC mounting)
   - John to update PAAC presentation for public meeting. Boards will be needed to show the typical sections along with photos of channels showing these channel types.
   - Gary said that a PDF of the Alternative options is adequate for them to print the exhibits and mount them.
   - One additional board showing the Base ADMP option along with contours needs to be prepared and sent to Gary to be mounted.

10) TOWN OF BUCKEYE ITEMS

- Gary mentioned that AZ Game & Fish are stakeholders because they own the land near the outlet into the river (Robin Buttes preserve).
- Scott mentioned a potential design flaw. United Metro Materials owns the property on both sides of the Watson Drain and it may be cost prohibitive to purchase the land from them for the channel through this area.

11) ANTICIPATED TASKS PRIOR TO NEXT MEETING

- Final Hydrology Tech Memo
- Meeting with Town regarding planned utilities
- Meeting with RID & BWCDD regarding requirements
- Meeting with APS regarding 96" ANPP line requirements
- Preliminary Alternatives Memo
  i. Alternatives specific hydrology models
  ii. Sizing of proposed facilities
  iii. Cost estimating
  iv. Development of evaluation criteria spreadsheet
- Public Meeting #1

12) ACTION ITEMS

No.	Action Item	Responsible Person	Date Due	Status/Comments
1	Set up meeting with Manual at TOB to discuss TOB Waterlines	Kevin		Site meeting scheduled for Wed 10/17
2	Provide additional details regarding soil sampling (revised locations, borings vs. trenches)	Kevin		
3	Schedule meeting with RID/BWCDD – Melody Zyburt	Kevin		Request digital files, HGL profiles
4	Schedule meeting with APS (PVWRF) – Randy Butler	Kevin		Assemble limitations, channel criteria within ROW.
5	Provide geotech reports for developments within study area to Dibble	Scott Z		
6	Schedule Stakeholder meeting at TOB for January	Gary		Assemble stakeholder list (APS, Evergreen, Hubbard, AZ G&F, UMM, etc)
7	EPG and Dibble to prepare exhibits and presentation for Public Meeting.	John, Kevin	10/17/12	
8				

13) NEXT MEETING: Monday, November 5 @ 9:00 AM

Watson Drainage System Pre-Design

FCD 2012C003

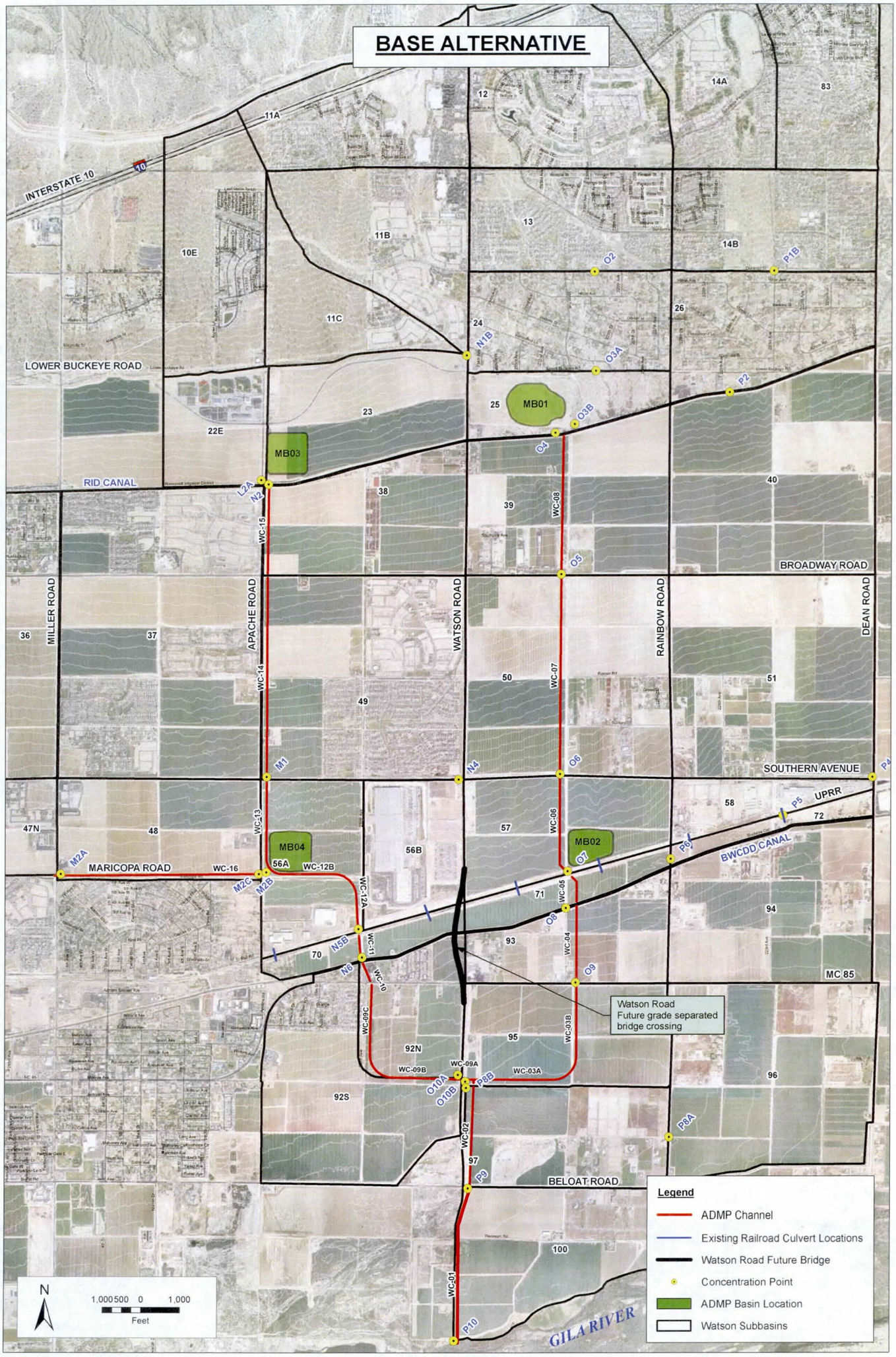
MEETING SIGN-IN SHEET

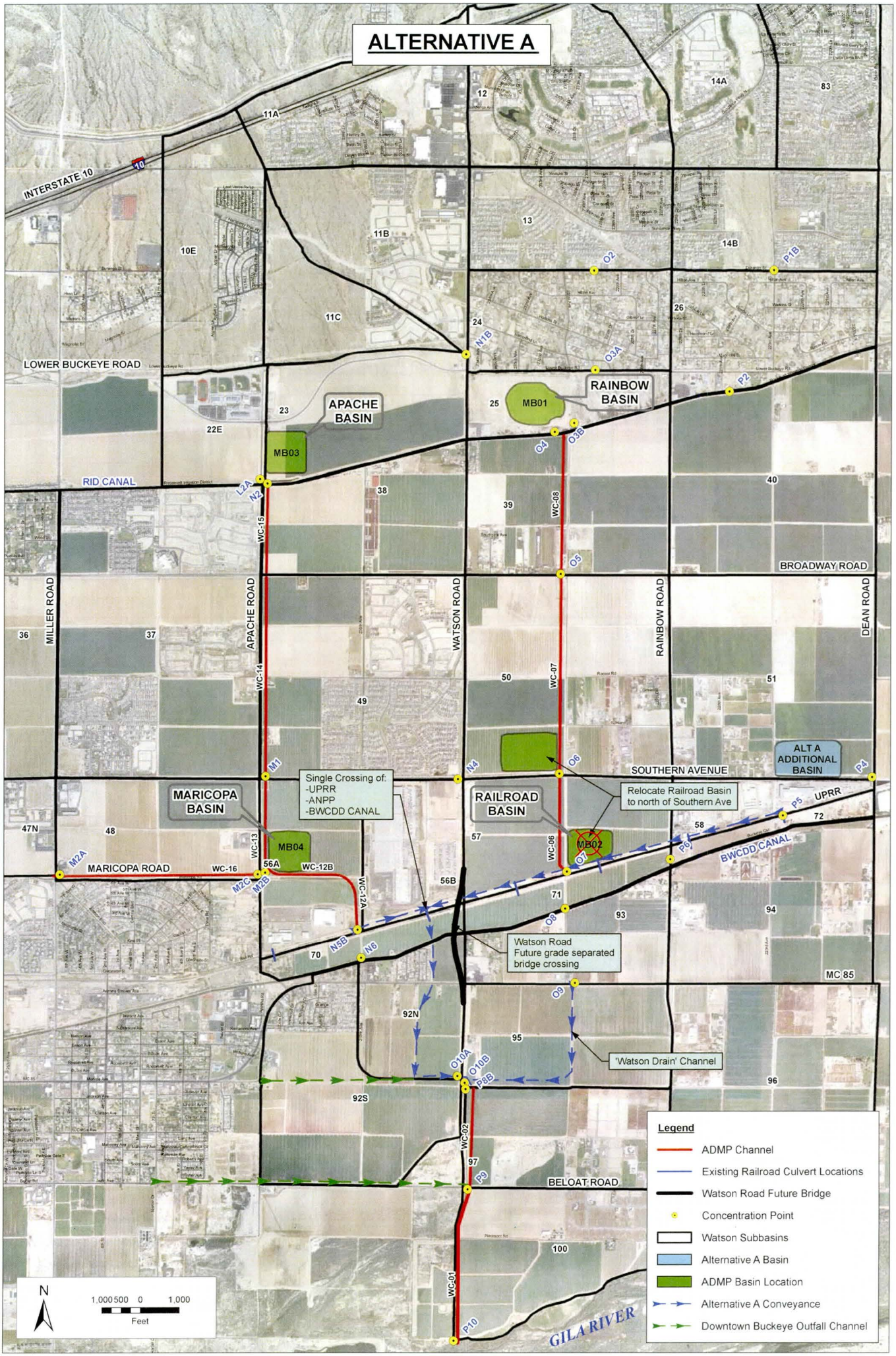
Project Coordination Meeting 10/15/2012

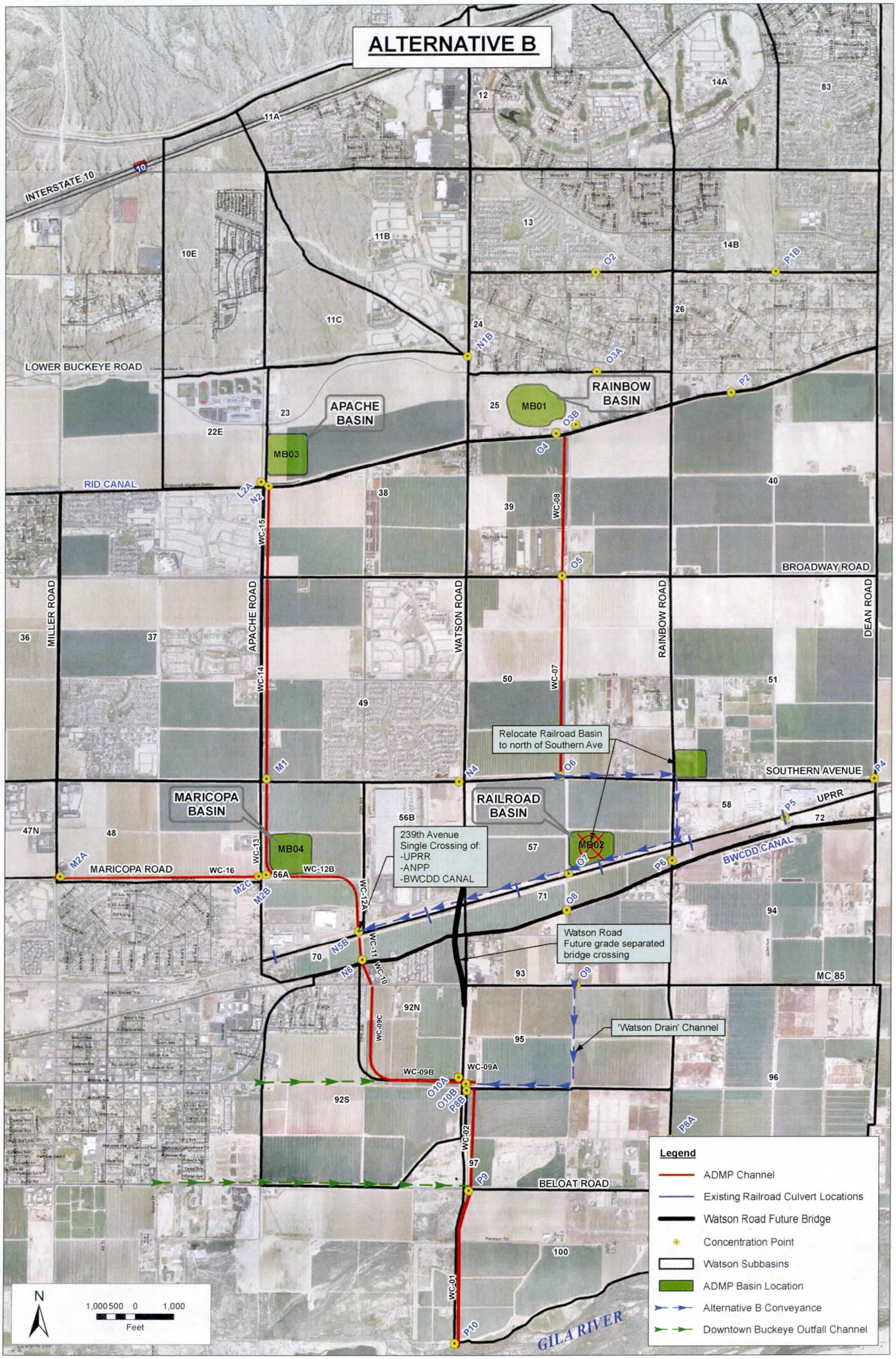
CHECK IN	NAME	SECTION/FIRM	PHONE	EMAIL
GWW	Gary Wesch	FCDMC	602.506.4592	garywesch@mail.maricopa.gov
SZ	Scott Zipprich	Town of Buckeye	623.349.6217	szipprich@buckeyeaz.gov
	Sean Banda	Town of Buckeye	623.349.6215	sbanda@buckeyeaz.gov
	Amir Motamedi	FCDMC	602.506.4871	amm@mail.maricopa.gov
	Bing Zhao	FCDMC	602.506.3293	biz@mail.maricopa.gov
	Rob Sachs	FCDMC	602.506.4744	res@mail.maricopa.gov
JH	John Holmes	FCDMC	602.506.3320	jwh@mail.maricopa.gov
GW	Gant Wegner	FCDMC	602.506.7841	gantwegner@mail.maricopa.gov
RBS	Bob Stevens	FCDMC	602.506.4073	rbs@mail.maricopa.gov
	Harry Cooper	FCDMC	602.506.2956	harrycooper@mail.maricopa.gov
	Gary Shapiro	FCDMC	602.506.3076	ghs@mail.maricopa.gov
	Gary Maiers	FCDMC	602.506.0562	gsm@mail.maricopa.gov
SL	Shimin Li	FCDMC	602.506.4609	shiminli@mail.maricopa.gov
KWR	Kevin Roberts	Dibble	602.957.1155	kevin.roberts@dibblecorp.com
	Josh Papworth	Dibble	602.957.1155	josh.papworth@dibblecorp.com
JB	Justin Beeler	Dibble	602.957.1155	justin.beeler@dibblecorp.com
BRF	Brian Fry	JE Fuller	623.889.0166 X307	brian.fry@jefuller.com
	Jeff Ford	Olsson	602.748.1000	jford@oaconsulting.com
JG	John Griffin	EPG	602.956.4370	jgriffin@epgaz.com
	Steve Nowaczyk	Ninyo & Moore	602.243.1600	snowaczyk@ninyoandmoore.com
	Jeff Hamilton	Hunter Contracting	480.892.0521	jeffh@huntercontracting.com

Public Meeting #1 (Exhibits) (Oct. 24, 2012)

BASE ALTERNATIVE




ALTERNATIVE A
INTERSTATE 10
LOWER BUCKEYE ROAD
RID CANAL
APACHE BASIN
MB03
RAINBOW BASIN
MB01
BROADWAY ROAD
MILLER ROAD
APACHE ROAD
WATSON ROAD
RAINBOW ROAD
DEAN ROAD
SOUTHERN AVENUE
ALT A ADDITIONAL BASIN
MARICOPA BASIN
MB04
Single Crossing of:
-UPRR
-ANPP
-BWCDD CANAL
RAILROAD BASIN
MB02
Relocate Railroad Basin to north of Southern Ave
UPRR
BWCDD CANAL
MARICOPA ROAD
Watson Road Future grade separated bridge crossing
'Watson Drain' Channel
BELOAT ROAD
GILA RIVER
Legend
ADMP Channel
Existing Railroad Culvert Locations
Watson Road Future Bridge
Concentration Point
Watson Subbasins
Alternative A Basin
ADMP Basin Location
Alternative A Conveyance
Downtown Buckeye Outfall Channel
N
1,000 500 0 1,000
Feet


ALTERNATIVE B
INTERSTATE 10
LOWER BUCKEYE ROAD
RID CANAL
APACHE BASIN
MB03
RAINBOW BASIN
MB01
MILLER ROAD
APACHE ROAD
WATSON ROAD
RAINBOW ROAD
DEAN ROAD
BROADWAY ROAD
SOUTHERN AVENUE
UPRR
BWCDD CANAL
MARICOPA BASIN
MB04
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MB02
Relocate Railroad Basin to north of Southern Ave
239th Avenue Single Crossing of: -UPRR -ANPP -BWCDD CANAL
Watson Road Future grade separated bridge crossing
'Watson Drain' Channel
MC 85
BELOAT ROAD
GILA RIVER
Legend
ADMP Channel
Existing Railroad Culvert Locations
Watson Road Future Bridge
Concentration Point
Watson Subbasins
ADMP Basin Location
Alternative B Conveyance
Downtown Buckeye Outfall Channel
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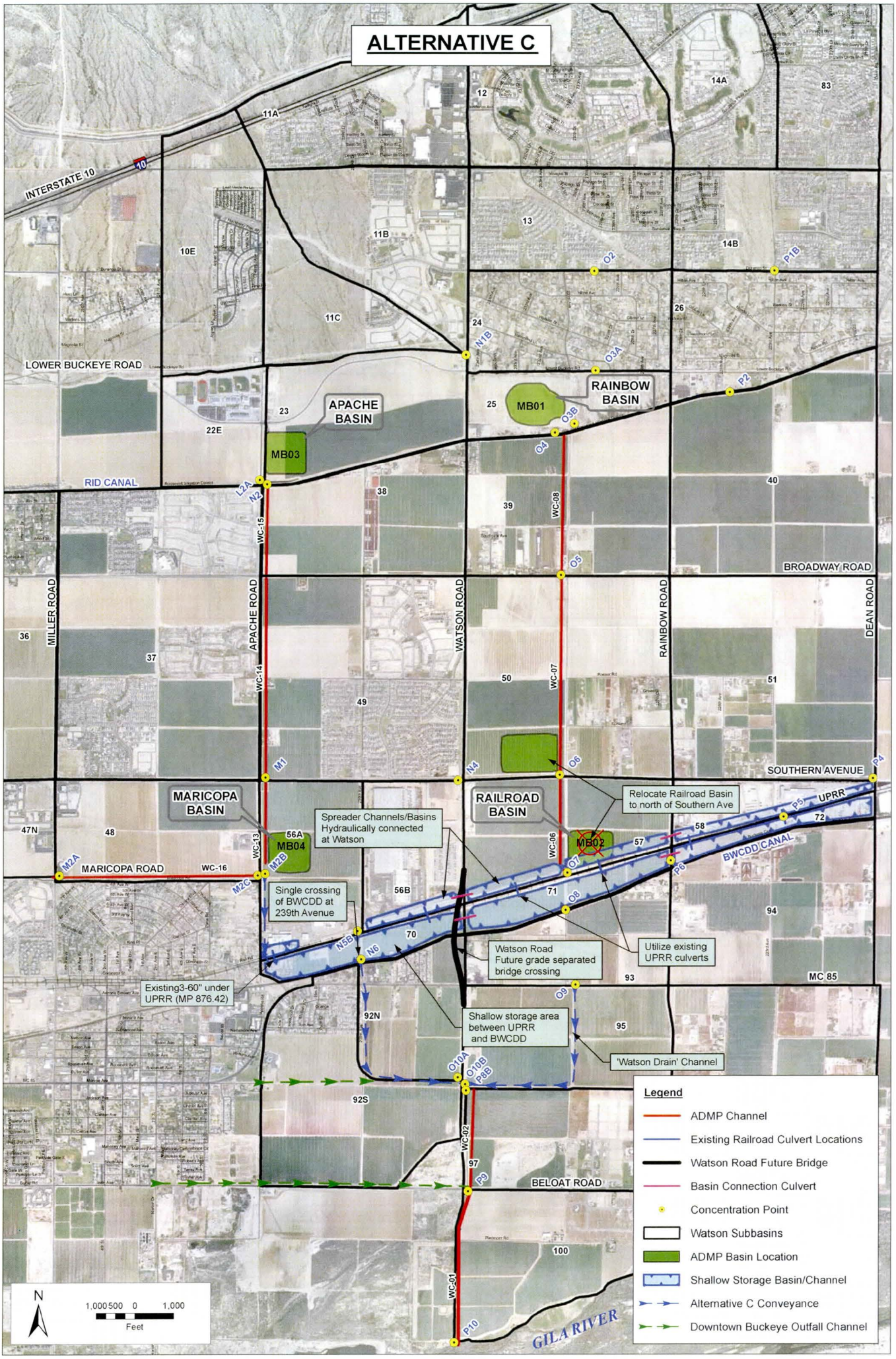
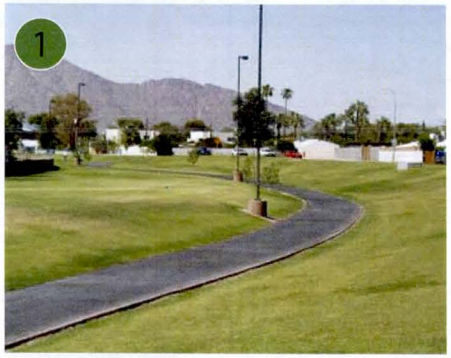

ALTERNATIVE C
INTERSTATE 10
LOWER BUCKEYE ROAD
RID CANAL
APACHE BASIN
MB03
RAINBOW BASIN
MB01
MILLER ROAD
APACHE ROAD
WATSON ROAD
RAINBOW ROAD
DEAN ROAD
BROADWAY ROAD
SOUTHERN AVENUE
MARICOPA BASIN
MB04
MARICOPA ROAD
RAILROAD BASIN
MB02
Relocate Railroad Basin to north of Southern Ave
Spreader Channels/Basins Hydraulically connected at Watson
Single crossing of BWCDD at 239th Avenue
Watson Road Future grade separated bridge crossing
Utilize existing UPRR culverts
Existing3-60" under UPRR (MP 876.42)
Shallow storage area between UPRR and BWCDD
'Watson Drain' Channel
UPRR
BWCDD CANAL
MC 85
BELOAT ROAD
GILA RIVER
Legend
ADMP Channel
Existing Railroad Culvert Locations
Watson Road Future Bridge
Basin Connection Culvert
Concentration Point
Watson Subbasins
ADMP Basin Location
Shallow Storage Basin/Channel
Alternative C Conveyance
Downtown Buckeye Outfall Channel
N
1,000 500 0 1,000
Feet

Watson Drainage System Pre-Design

Channel Examples



STORM DRAIN AND SWALE

CONCRETE

RIPRAP

TURF-LINED

COMPOSITE – EARTHEN WITH LOWFLOW

EARTHEN WITH HYDROSEED

EARTHEN WITH ROCK MULCH

EXISTING AGRICULTURE CHANNEL

Watson Drainage System Pre-Design

Drop Structure Examples

RIPRAP DROP EXAMPLES

HISTORIC AGRICULTURAL CHARACTER

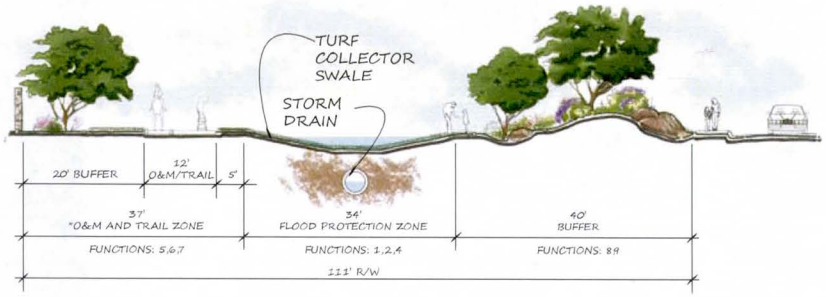
CONCRETE DROP EXAMPLES

Watson Drainage System Pre-Design

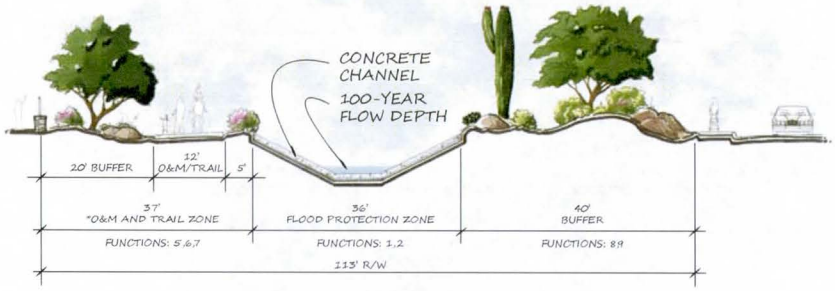
North Channel Lining Options

OPTIONS FOR CHANNELS NORTH OF BELOAT ROAD

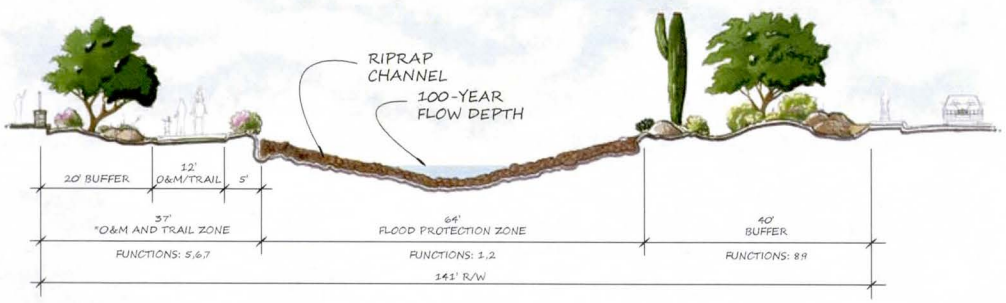
1 STORM DRAIN



2 CONCRETE CHANNEL



3 RIPRAP CHANNEL



FLOOD PROTECTION ZONE FUNCTIONS

1 - STORMWATER CONVEYANCE (PRIMARY FUNCTION)
2 - PRESERVE VIEWS TO MAJOR MOUNTAIN AREAS (WHITE TANK MOUNTAINS AND BUCKEYE HILLS/NORTH MARICOPA MOUNTAINS)
3 - PASSIVE OPEN SPACE
4 - ACTIVE RECREATION/OPEN SPACE

O&M AND TRAIL ZONE FUNCTIONS

5 - ACCOMMODATE TOWN OF BUCKEYE TRAILS MASTERPLAN*
6 - CONNECT SIGNIFICANT RECREATION AREAS AT SYSTEM ORIGIN (SKYLINE REGIONAL PARK) AND OUTFALL (GILA RIVER)
7 - ACCOMMODATE EQUESTRIAN USE (POTENTIALLY ONE ROUTE ONLY)

BUFFER FUNCTIONS

8 - PASSIVE OPEN SPACE/WILDLIFE HABITAT
9 - SOFTEN CHANNEL APPEARANCE

* O&M ROAD AND TRAIL ZONE DIMENSIONS FROM TOWN OF BUCKEYE TRAILS MASTERPLAN

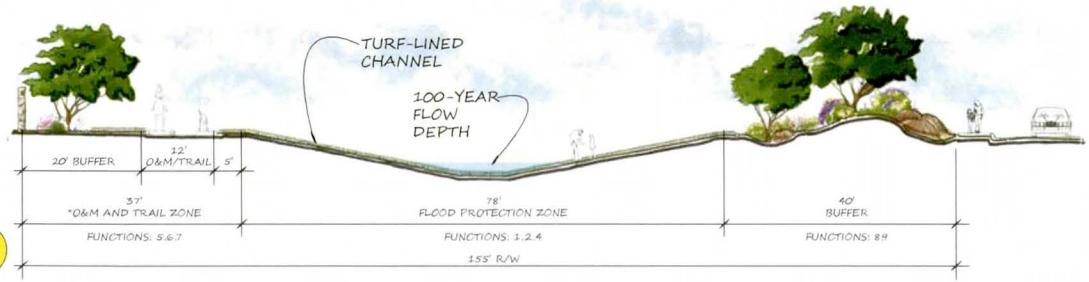
Watson Drainage System Pre-Design

North Channel Lining Options

OPTIONS FOR CHANNELS NORTH OF BELOAT ROAD

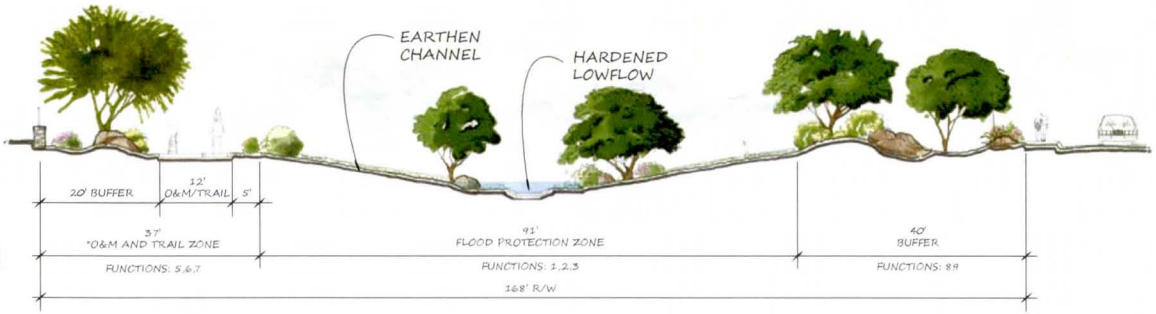
TURF-LINED

4



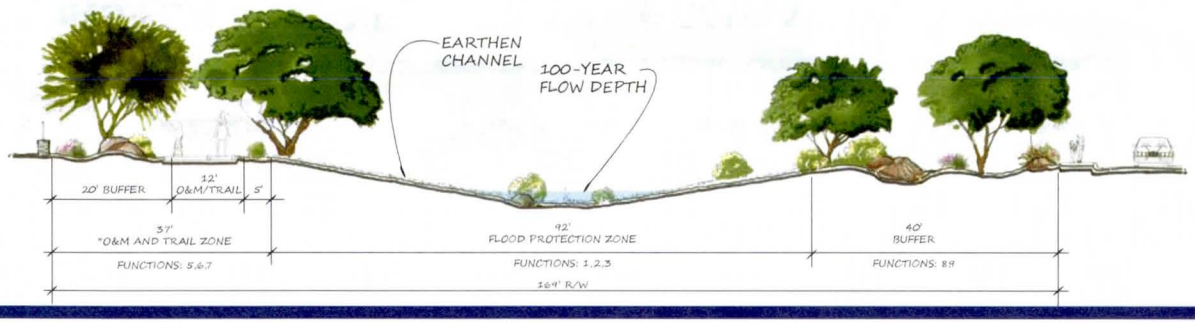
COMPOSITE

5



EARTHEN

6



FLOOD PROTECTION ZONE FUNCTIONS
1 - STORMWATER CONVEYANCE (PRIMARY FUNCTION)
2 - PRESERVE VIEWS TO MAJOR MOUNTAIN AREAS (WHITE TANK MOUNTAINS AND BUCKEYE HILLS/NORTH MARICOPA MOUNTAINS)
3 - PASSIVE OPEN SPACE
4 - ACTIVE RECREATION/OPEN SPACE

O&M AND TRAIL ZONE FUNCTIONS
5 - ACCOMMODATE TOWN OF BUCKEYE TRAILS MASTERPLAN*
6 - CONNECT SIGNIFICANT RECREATION AREAS AT SYSTEM ORIGIN (SKYLINE REGIONAL PARK) AND OUTFALL (GILA RIVER)
7 - ACCOMMODATE EQUESTRIAN USE (POTENTIALLY ONE ROUTE ONLY)

BUFFER FUNCTIONS
8 - PASSIVE OPEN SPACE/WILDLIFE HABITAT
9 - SOFTEN CHANNEL APPEARANCE

* O&M ROAD AND TRAIL ZONE DIMENSIONS FROM TOWN OF BUCKEYE TRAILS MASTERPLAN

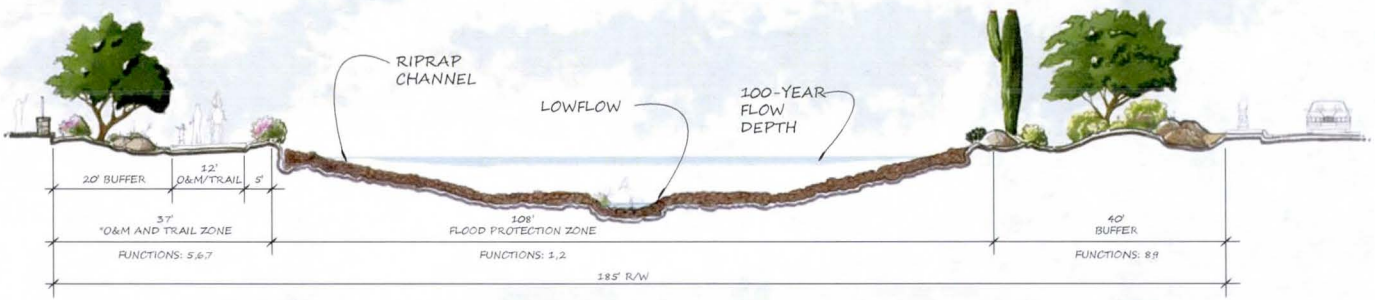
Watson Drainage System Pre-Design

South Channel Lining Options

OPTIONS FOR CHANNELS FROM BELOAT ROAD TO THE GILA RIVER

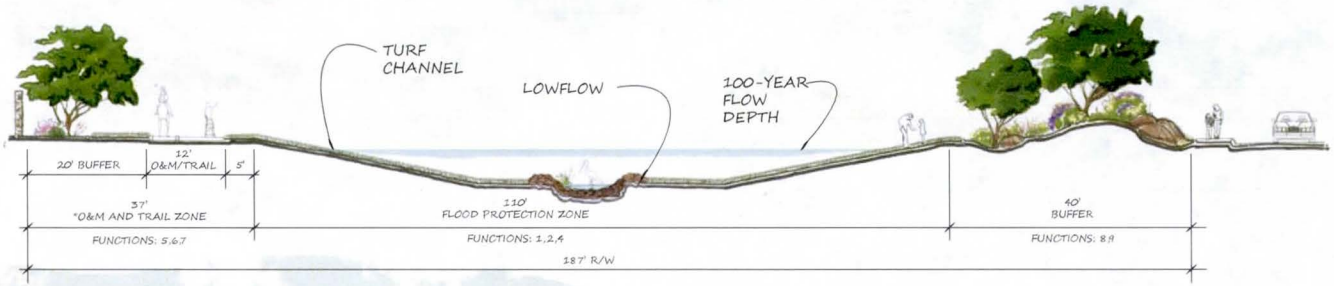
RIPRAP W/ LOWFLOW

2



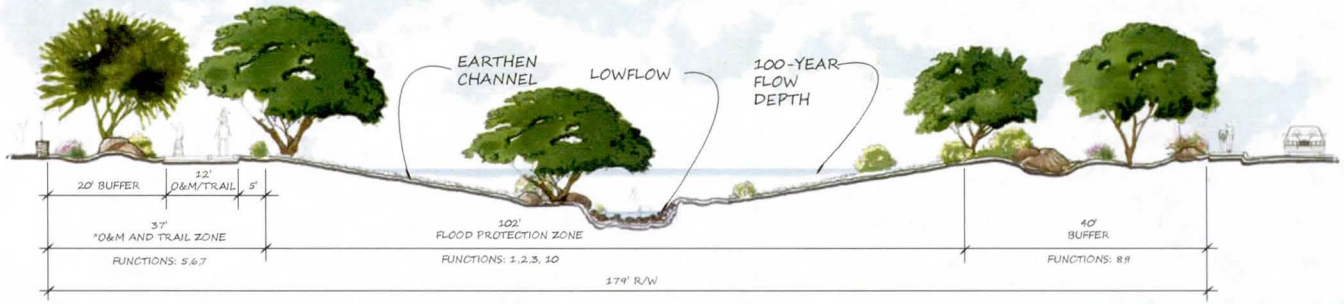
TURF-LINED W/ LOWFLOW

4



EARTHEN W/ LOWFLOW

5 6



FLOOD PROTECTION ZONE FUNCTIONS

1 - STORMWATER CONVEYANCE (PRIMARY FUNCTION)
2 - PRESERVE VIEWS TO MAJOR MOUNTAIN AREAS (WHITE TANK MOUNTAINS AND BUCKEYE HILLS/NORTH MARICOPA MOUNTAINS)
3 - PASSIVE OPEN SPACE
4 - ACTIVE RECREATION/OPEN SPACE

O&M AND TRAIL ZONE FUNCTIONS

5 - ACCOMMODATE TOWN OF BUCKEYE TRAILS MASTERPLAN*
6 - CONNECT SIGNIFICANT RECREATION AREAS AT SYSTEM ORIGIN (SKYLINE REGIONAL PARK) AND OUTFALL (GILA RIVER)
7 - ACCOMMODATE EQUESTRIAN USE (POTENTIALLY ONE ROUTE ONLY)

BUFFER FUNCTIONS

8 - PASSIVE OPEN SPACE/WILDLIFE HABITAT
9 - SOFTEN CHANNEL APPEARANCE
10 - EXTEND GILA RIVER CHARACTER INTO THE WATSON DRAINAGE SYSTEM

* O&M ROAD AND TRAIL ZONE DIMENSIONS FROM TOWN OF BUCKEYE TRAILS MASTERPLAN

Project Coordination Meeting #5 (Nov. 5, 2012)

Dibble Engineering

7500 North Dreamy Draw Drive, Suite 200
Phoenix, Arizona 85020
Tel. (602) 957-1157
Fax (602) 957-2838

Meeting Minutes

Project: Watson Drainage System Pre-Design
Date: November 5, 2012 – 9:00 AM
Re: Project Coordination Meeting #5
Contract: FCD 2012C003
Dibble Project: 101206

1) INTRODUCTIONS/ATTENDEES To be updated

Gary Wesch	FCDMC
Scott Zipprich	TOB
Kevin Roberts	DIBBLE
Justin Beeler	DIBBLE
Gant Wegner	FCDMC
Shimin Li	FCDMC

John Holmes	FCDMC
Bob Stevens	FCDMC
Gary Shapiro	FCDMC
Gary Maiers	FCDMC
Brian Fry	JE FULLER
John Griffin	EPG

2) REVIEW OF MEETING MINUTES / ACTION ITEMS

No.	Action Item	Responsible Person	Status/Comments
1	Provide additional details regarding soil sampling (revised locations, borings vs. trenches)	Kevin	Data provided. Approved? Need to provide authorization letter for optional task.
2	Schedule meeting with RID/BWCDD – Melody Zyburt	Kevin	Complete
3	Schedule meeting with APS (PVWRF) – Randy Butler	Kevin	Mtg scheduled for 11/6
4	Provide geotech reports for developments within study area to Dibble	Scott Z	

- Kevin to prepare soil boring authorization letter
- Soil boring location south of Beloat is not in public ROW. Move it to Beloat ROW in the shoulder
- Discussed meetings with RID & BWCDD. Melody to provide digital data for exhibits. Other requirements for both irrigations companies for channels were received.
- Meeting with APS scheduled for 11/6. One possible location with 7-8' of cover. However, if we can go over ANPP, we would still need to go under BWCDD.
- Irrigation companies prefer that we avoid siphons of delivery lines due to sedimentation. Possibilities to pipe over their channels or reduce conflicts based on spacing drop structures appropriately.
- Scott to request geotech reports for developments within study area.
- Public meeting was well attended (25-30). Lots of concern about system and property impacts. Some owner claiming that they had final plats ready.

- Met with Jeff Garrett of Evergreen to learn more about Watson Road Communities Facilities District (CFD). CFD started in 2005 and has invested ~$30 million in water/sewer infrastructure. An additional $49 million is planned. Assessment of fee's has not yet been handed off to parcels. To acquire a site for a basin or channel will require more than just condemning the property, but will also need to assume debt from CFD and complicates the land acquisition process. Planning to have additional meetings to discuss impact to project caused by CFD.
- CFD may result in need to go with a pipe option instead of open channel.
- Schedule adjustments based on CFD findings are expected to be necessary.
- Kevin to reissue PDF of schedule via email after we have a better understanding of the CFD issues.
- Greg mentioned that we will need to get direction from the Town on how whether the CFD or the ADMP will take precedence.
- Discussion of Town staff involved in the ADMP process – Mike Manola and Dave Showen are no longer with the Town.
- Scott mentioned that CFD debt will day with the land and get redistributed at the platting stage to final lots. Based on lots that will utilize the sewer/water services. Developers concerned that if property spaces are lost to channel that this would increase the debt assessed to the remaining lots. At this point CFD assessments are done on an acreage basis - $25K per acre. Brian noted that it would be beneficial to acquire the property prior to recording of final plat.
- Scott is trying to change the development code to force developers to record their final plats when they are approved by the town council. In Buckeye, preliminary plats do not expire. Construction drawings expire after 1 year.
- Developments were required to address 100yr6hr offsite discharges. May be a way to account for this conveyance handled by development.
- Discussion of possible relocation of Maricopa Basin.
-

3) PROJECT SCHEDULE REVIEW AND STATUS

- Discussion of geotech work and request to see this added to schedule. Environmental approval expected to take 4-6 weeks. Shouldn't show completion of approval for 4-6 weeks out.

- Hydrology Tech Memo
  i. Final to be provided this week

- Public Meeting #1
  i. Held Thursday 10/24
     - Well attended
     - Land owners expressed concerns over final plats
     - Community Facilities District exists within Watson watershed that has encumbered properties with debt… may be more complicated to acquire properties for flood control… discovery process ongoing.

- Meetings held with BWCDD and RID
  i. Both agencies provided description of how system works, and requirements for crossings/joint use, etc…

- Alternatives Analysis
  i. Discussion to be held this afternoon regarding how to proceed with alternatives analysis, and potential impacts to the schedule.

4) HYDROLOGY DISCUSSION

- Hydrology Technical memo to be reviewed, stamped and submitted this week.

5) LANDSCAPE ARCHITECTURE DISCUSSION

- Some discussion by John Griffin regarding the channel buffer zones and discussions with Bob – inaudible.

6) RIVER MECHANICS DISCUSSION

- No items for discussion

7) UTILITIES DISCUSSION

Dibble Engineering

7500 North Dreamy Draw Drive, Suite 200
Phoenix, Arizona 85020
Tel. (602) 957-1157
Fax (602) 957-2838

- No items for discussion

8) ENVIRONMENTAL DISCUSSION

- No items for discussion

9) PUBLIC INVOLVEMENT DISCUSSION

- No items for discussion

10) TOWN OF BUCKEYE ITEMS

- Discussion of Industrial site and channel through this site. Possible land upstream of site set aside for purchase to construct detention basin to reduce offsite flow.
- Kevin suggests a meeting facilitated by the town with the industrial site engineer (Hubbard).
- Industrial engineer claims reduction in flow from 1,200 cfs to 400 cfs based on NOAA 14 rainfall change. Could be related to difference in time interval from 5 minutes to 15 minutes.

11) ANTICIPATED TASKS PRIOR TO NEXT MEETING

- Meeting with APS regarding 96" ANPP line requirements
- Progress on Alternatives Evaluation
  i. Understanding of impacts of existing CFD in watershed
  ii. Alternatives specific hydrology models
  iii. Sizing of proposed facilities
  iv. Cost estimating
  v. Development of evaluation criteria spreadsheet

12) ACTION ITEMS

No.	Action Item	Responsible Person	Date Due	Status/Comments
1	Prepare soil boring authorization letter	Kevin		
2	Scott to request geotech reports for developments within study area.	Scott Z.		
3	Add geotech work and env review to schedule	Kevin		
4				
5				
6				
7				
8				

13) NEXT MEETING: Monday, January 7 @ 9:00 AM (?)

Project Coordination Meeting #6 (Jan. 7, 2013)

Dibble Engineering

7500 North Dreamy Draw Drive, Suite 200
Phoenix, Arizona 85020
Tel. (602) 957-1157
Fax (602) 957-2838

Meeting Minutes

Project: Watson Drainage System Pre-Design
Date: January 7, 2013 – 9:00 AM
Re: Project Coordination Meeting #6
Contract: FCD 2012C003
Dibble Project: 101206

1) INTRODUCTIONS/ATTENDEES

Gary Wesch	FCDMC
Scott Zipprich	TOB
Kevin Roberts	DIBBLE
Justin Beeler	DIBBLE
Rob Sachs	FCDMC
Shimin Li	FCDMC
John Holmes	FCDMC

Harry Cooper	FCDMC
Bob Stevens	FCDMC
Gary Shapiro	FCDMC
Gary Maiers	FCDMC
Brian Fry	JE FULLER
John Griffin	EPG

2) REVIEW OF MEETING MINUTES / ACTION ITEMS

No.	Action Item	Responsible Person	Status/Comments
1	Provide geotech reports for developments within study area to Dibble	Scott Z	Complete
2	Prepare soil boring authorization letter	Kevin	Complete
3	Add geotech work and environmental work to schedule	Kevin	Complete (estimated)
4	Address comments/finalize Hydrology Technical Memorandum	Dibble	In process

- Review of meeting minutes and action items completed.
- Geotech reports were provided by Town

3) PROJECT SCHEDULE REVIEW AND STATUS

- CFD Impacts
  i. Alternatives analysis to proceed
     - Minor revisions to alternatives are probable to minimize impact to CFD properties
  - Per Gary W, the ADMP shows facilities that conflict with already platted developments (ie, Windgate East) and will be in conflict with the base condition alignment.

- Hydrology Tech Memo
  i. FCDMC Comments issued 12/18/2012
     - Typos

- Modeled retention volumes for existing developed areas
- Truncated unit hydrographs – use FCDMC model results

- In process of addressing the comments and preparing an approved model for the base condition.
- Most existing basins were designed for 100Yr, 2Hr (NOAA2) + 1ft of Freeboard. Sundance used 100Yr, 6Hr. Need to determine how to handle existing retention.
- Need to determine which reports we're missing and need.
- A meeting needs to be held with John Holmes (and others?) to determine best approach and to finalize base hydrology model.

- Meetings held with:
  i. BWCDD
  ii. RID
  iii. APS
  iv. Evergreen
  v. Walton

- Geotechnical Testing
  i. Optional task authorized
  ii. Map has been sent to sub-consultant with request for work to be scheduled
  - Schedule will be updated once Geotech sub-consultant (Ninyo and Moore) has a chance to schedule the work.

- Alternatives Analysis
  i. Channel Section Design Charette scheduled for 1/23/13 at TOB (8 AM -12 PM)
     - Channel configuration discussion
     - Components for conveyance/maintenance/multi-use
     - Relationship/interface with arterial roads and existing irrigation facilities
  ii. Development of "Typical Approach" for probable conditions:
     - Road crossings
     - Drop structures
     - Irrigation laterals
     - Canal crossing
     - ANPP crossing
     - UPRR crossing
     - Waterline relocation
     - Gila River discharge location
     - Other?
- Per Gary, the purpose of the Charette is to get Town staff input prior to reaching the Recommended Plan level.
- Initial understanding was that the Town would lead the discussion. However, Scott mentioned that the Town assumes that the meeting will be similar to the PAAC meeting and run by others.
- Based on a post-meeting discussion, it was decided that EPG would prepare a "preview packet" to list the goals of the meeting and responsibilities expected by various parties. The packet is to be prepared by this Friday. (*TASK COMPLETE – distributed via email 1/14/13*)
- There will need to be a discussion of the various uses allowed within the channel ROW, such as: conveyance, trails, open space, retention, etc. (*Discussion scheduled for 1/15/13*)

  iii. Cost Estimating Spreadsheet to be assembled by Dibble
  iv. Evaluation Criteria Spreadsheet to be assembled by JEF

4) HYDROLOGY DISCUSSION

- An offline meeting is necessary to document the preferred approach to addressing the onsite retention calculation for the Watson Pre-Design project.

5) LANDSCAPE ARCHITECTURE DISCUSSION

- No items for discussion

6) RIVER MECHANICS DISCUSSION

Dibble Engineering

7500 North Dreamy Draw Drive, Suite 200
Phoenix, Arizona 85020
Tel. (602) 957-1157
Fax (602) 957-2838

- District to review geotech reports from Town for relevant information useful for this project.
- Some discussion of recommended outfall design concept at the Gila River and project termination location.
- Need to determine if data for Gila river is available to establish outfall conditions hydraulic control (10 yr in Gila & 100 yr in Channel, vs. 100 yr in Gila & 10 yr in channel)
- Impacted ADWR well sites will need to be identified and accounted for in the cost for each alternative. Additional data for each "permitted" well is available on an ADWR interactive website.
- Some discussion on required effort to cap a well or relocate and the associated estimated costs. One estimate from Scott to relocate a large commercial well is approximately $1 million.
- The preferable solution is to keep the runoff within an extended culvert to avoid a wide channel conflict with an existing well.
- Melody provided information on various private wells (Global water/Valencia) in the area.

7) UTILITIES DISCUSSION

- No further action until a preferred alignment is selected.
- Gary to obtain cost information for crossing various utilities and canals from the recent L303 channel project.

8) ENVIRONMENTAL DISCUSSION

- Some discussion of where the 404 jurisdictional boundary line for the river will be.
- Bob Stevens disagrees with the most recent delineation of the wash for the El Rio project and believes that the JD boundary will be right at the northern bank. Further discussion with the Corps is necessary. Bob to follow up.

9) PUBLIC INVOLVEMENT DISCUSSION

- No items for discussion

10) TOWN OF BUCKEYE ITEMS

- No items for discussion

11) ANTICIPATED TASKS PRIOR TO NEXT MEETING

i. Soil Borings
ii. Channel Section Design Charrette
iii. Development of Typical Design Approaches
iv. Development of Cost Estimating Spreadsheet
v. Development of Evaluation Criteria
vi. Develop Gila River outfall design concept

12) ACTION ITEMS

No.	Action Item	Responsible Person	Date Due	Status/Comments
1	Determine additional drainage reports needed. Set up meeting to discuss retention approach.	Kevin		
2	Discussion of 404 limits with the Corps.	Bob Stevens		To be completed this month
3	Obtain cost information from recent L303 channel project.	Gary Maiers		
4	Get soil boring sub to provide schedule and commence work.	Kevin		
5	Prepare for Design Charette	All		
6	Prepare typical design approach concepts for anticipated conditions to	Kevin		

	be presented at design charette			
7	Develop Cost Estimate Spreadsheet	Kevin		
8	Develop Evaluation Criteria spreadsheet	Brian Fry		

13) NEXT MEETING: Monday, February 4 @ 9:00 AM

Design Charrette (Jan. 23, 2013)

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
2801 W. Durango Street
Phoenix, AZ 85009

TOWN OF BUCKEYE
530 E. Monroe Avenue
Buckeye, AZ 85326

MEETING MINUTES – DESIGN CHARRETTE January 23, 2013

PROJECT NAME: Watson Drainage Project - Predesign

PURPOSE: Town of Buckeye Design Charrette Meeting: 8:00AM – 12:00PM

LOCATION: Town of Buckeye – Buckeye Conference Room

MEETING DESCRIPTION

A participatory interactive meeting intended to:

- Gather input from Town of Buckeye staff and representatives
- Foster creative, actionable multi-functional design and implementation solutions for the channels and basins being considered for the Watson Drainage Project.

MEETING ATTENDEES

Buckeye: Adam Copeland, Andrea Marquez, Ed Boik, Fred Sanchez, Larry Harmer, Robert Weisner, Scott Lowe, Scott Zipprich, Woody Scoutten,
FCDMC: Gary Wesch, Harry Cooper
Dibble: Kevin Roberts
EPG: John Griffin
JE Fuller: Brian Fry

Meeting Objectives:

I. Reach consensus regarding channel configurations
II. Reach consensus regarding appropriate buffer widths
III. Identify the Town's vision for this area
   a. As identified in the PAAC, the Town would like to see solutions that are responsive to the specific land uses and settings rather than a "one-size-fits-all" approach.
   b. Future Town Lake @ Gila River connected to the Downtown via multi-modal transportation (i.e. – multi-use paths or trails).
   c. Maricopa Channel alignment to provide a direct connection to Downtown Buckeye
   d. Apache Channel – coordination with development along this route is critical. Existing Watson CFD is an example constraint.
   e. 231st Channel – Most conducive for extended trail connections to recreational areas. Town noted that the planning for the future is focused on becoming a great City. Amenities such as an equestrian trail along this route may be difficult to implement today but should not be precluded by current planning.
   f. Watson Drain channel alignment – No current development plans for this area. Town envisions Watson Drainage facilities in this area as temporary as future unidentified development will likely modify what gets built. Should not preclude a range of development options (i.e. – suburban or commercial).
IV. Other Town of Buckeye objectives identified in the meeting include:
   a. Consider options for how to acquire needed right-of-way

b. Consider incentives for developers to participate
c. Consider multi-use opportunities that can be incorporated into the plan

General Discussion and Results

I. During the meeting, the charrette team identified 4 distinct "characters" that exist in this area:
   a. Suburban residential
   b. Downtown
   c. Industrial
   d. Riparian - (This area is not anticipated to experience development for many years)

II. These characters lead to the identification of the following five reaches, each to have their own distinctive channel configuration and character:
   a. Watson-Gila
   b. Maricopa Rd
   c. Apache Rd
   d. 231st residential
   e. Industrial area (includes Walmart distribution center, railroad, future industrial)

Discussion of each reach is summarized in the narrative below as well as the Channel Configuration Summary Table at the end of these minutes.

III. Watson at Gila outlet
   a. Utilitarian - (This area is not anticipated to experience development for many years)Not a near-term residential development area
   b. Concrete lined was considered an option. Minimizing maintenance is the primary factor. Allowing for future flexibility is second.
   c. Don't want to create an unintended wetland at the downstream end (becomes 404 issue for future development, creates problems that do not currently exist)
   d. Limitations on clearing & maintenance if wetland
   e. Town does not see it as a turf channel
   f. High ground water will encourage vegetation to grow rapidly
   g. Hardened channel helps dewatering
   h. Must be able to maintain with large equipment
   i. Riprap was removed as an option. Vegetation can still grow through it, makes it difficult to maintain.
   j. Earthen, mowable, maintainable is most desirable to the Town
   k. Need 6:1 side slopes for mowing
   l. 14 ft wide O&M road both sides
   m. 40 ft buffer both sides

IV. Maricopa Road

a. 40 ft buffer
b. Collector road usually includes a 10-20 ft buffer
c. Reduce buffer for adjacent lower classification road
d. If trail on opposite side of road, less cross traffic across channel
e. Problem getting users over to intersection at road crossings, they tend to jaywalk across road
f. If trail on road side, buffer to include ROW/PUE/Irrig/Trail & 5-10 ft space on residential side
g. Composite section of pipe under channel – Town likes this option unless Town owns pipe
h. Turf surface-depends on developer, might prefer decomposed-granite.
i. Private development may convert turf to rock if not active and to conserve water
j. Farmers responsible for tailwater connection to relocated irrigation, might use siphon under channel
k. Developer on NE quadrant of Maricopa/Apache might be allowed to use potential regional basin site at that location for onsite retention
l. Development or commercial signage can be allowed near channel road side on 8-12 ft footing

V. Apache Rd/231st Ave

a. Interim development, put channel in place, spreader at downstream side
b. Dove Cove-owner coordinated point discharge with downstream owner/developer
c. Channel lining-
d. gunite with boulders, aggregate seeding-discourages skateboarding
e. reinforced with welded wire fabric 6x6
f. no credit for open space
g. if gunite assumed, less attenuation of flows, alternatives proposed by developers would increase attenuation (drops, earthen)
h. turf-could allow credit for open space
i. consider using a low flow plus a terrace area for onsite retention within channel ROW
j. 231st may have equestrian trail (in bottom of channel? Or next to multi-use?)

VI. Industrial Area

a. W. Scoutten-Watson road is major arterial, not parkway section
b. Do trail crossing of UPRR & canal at Watson?
c. Channel in industrial area should require minimal land
d. Want to get people through, not encourage them to linger. Minimal right-of-way is desired by Town.
e. Concrete lining ok, must be safe. Max. 4:1 side-slope so safety railing is not required.

VII. General Discussion Items

a. Scott Lowe- Town is very concerned about maintenance costs associated with proposed facilities. It is difficult to separate this concern from other "factors", even at this stage of the project

b. ROW acquisition costs

   i. "How to acquire?" is a concern for the Town. Channel configurations need to account for developer-driven implementation.

   ii. What incentives to developer to donate to Town?

      a. Open space credits (passive vs. active). Active requirement is driven by City ordinance Level-of-Service (LOS) requirements. Passive is determined on a case-by-case basis.

      b. Combination of channels and buffers with required street setbacks could be an incentive and encourage irrigated, maintained landscape in the channel corridor.

      c. Consider the need for monument signage. Developers need to advertise their developments. At road intersections, consider signage easements in configuring channels. Could be an incentive for developers as well.

      d. Can onsite retention be incorporated into the channel?

      e. Landscape buffer zone location/requirements will either encourage participation or be a constraint. Identified channel configurations were developed based on the charrette participant's understanding of the development need as well as the integration of multiple functions within the corridor.

c. Town guidelines could be used to establish unified theme – Adam mentioned special channel corridor design guidelines similar to streetscape guidelines could be developed

d. For industrial users, reduction of a floodplain can be incentive to allow for use of the site

e. Woody-Town Lake on Gila River, use channel system to facilitate a trail connected to Town Lake

f. Easement over underground conveyances was considered desirable. The Town liked the idea of a turfed swale over top of a conveyance stormdrain where practicable.

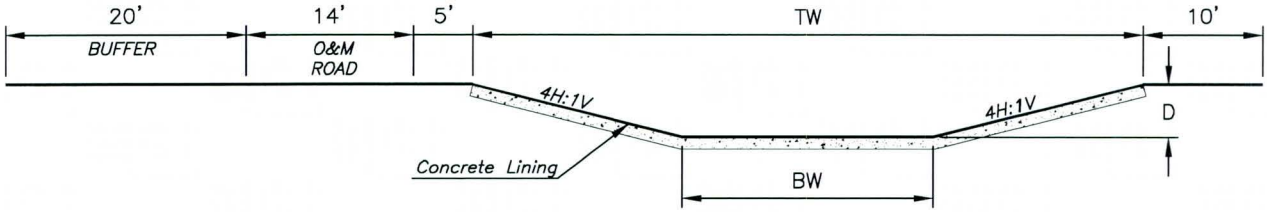
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
2801 W. Durango Street
Phoenix, AZ 85009

TOWN OF BUCKEYE
530 E. Monroe Avenue
Buckeye, AZ 85326

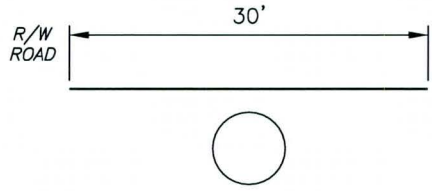
Channel Configuration Summary Table

Reach	Lining	Buffer (L)	O&M Road (L)	Side Slope (L)	Bottom Width	Side Slope (R)	O&M Road (R)	Buffer (R)
Watson Drain (Near Gila)	Earthen with mowable hydroseed	40'	14'	6:1	10' (Concrete low-flow) + 10' min each side for equipment	6:1	14'	40'
Maricopa Road	Earthen with rock mulch or turf	10' (+ 24' if irrigation relocation)	n/a	6:1	As needed hydraulically	6:1	n/a	40'
Apache Road (North)	Gunite with aesthetic treatment (i.e. - Fiesta Ranch)	60'	(included in 60')	6:1 / 4:1	As needed hydraulically	4:1 / 6:1	n/a	10'-15'
231st Ave	Turf	40'	(included in 40' buffer)	6:1	As needed hydraulically	6:1	(included in 40' buffer)	40'
Industrial Area	Concrete	20'	14' + 5' Buffer	4:1	As needed hydraulically	4:1	n/a	10'

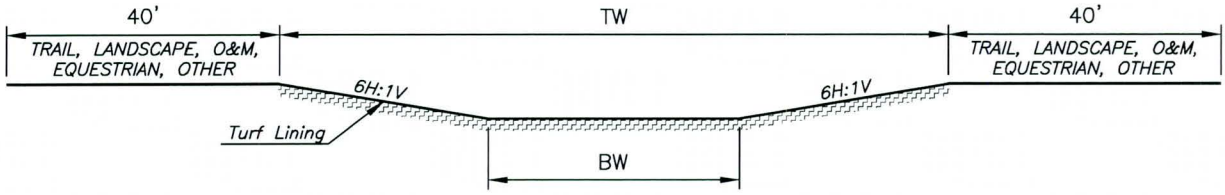
INDUSTRIAL REACH
MINIMUM SECTION REQUIREMENTS



INDUSTRIAL REACH
MINIMUM SECTION REQUIREMENTS
UNDERGROUND PIPE ALTERNATE

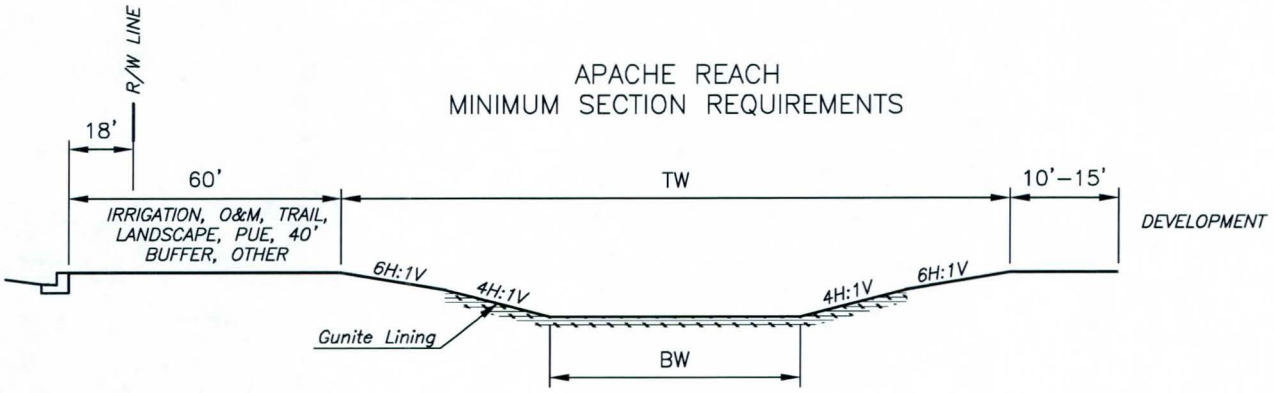


231ST REACH
MINIMUM SECTION REQUIREMENTS

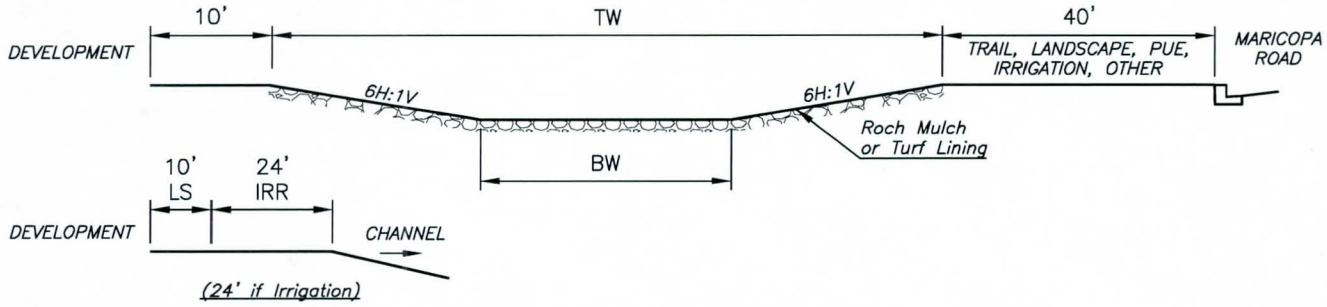


N.T.S.

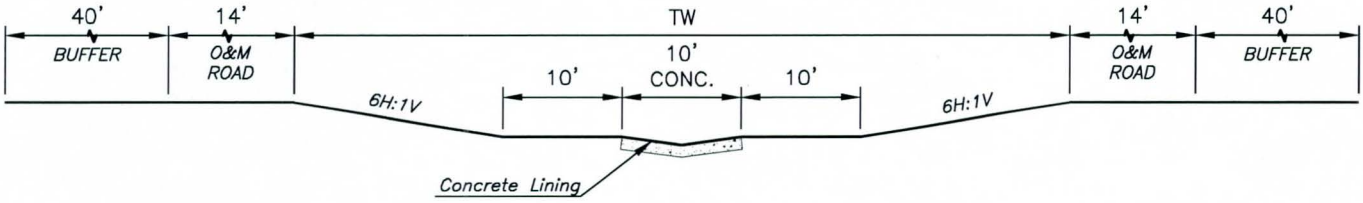
APACHE REACH
MINIMUM SECTION REQUIREMENTS



MARICOPA REACH
MINIMUM SECTION REQUIREMENTS



WATSON DRAIN REACH
MINIMUM SECTION REQUIREMENTS



N.T.S.

Project Coordination Meeting #7 (Feb. 4, 2013)

Dibble Engineering

7500 North Dreamy Draw Drive, Suite 200
Phoenix, Arizona 85020
Tel. (602) 957-1157
Fax (602) 957-2838

Meeting Minutes

Project: Watson Drainage System Pre-Design
Date: February 4, 2013 – 9:00 AM
Re: Project Coordination Meeting
Contract: FCD 2012C003
Dibble Project: 101206

1) INTRODUCTIONS/ATTENDEES

Gary Wesch	FCDMC
Kevin Roberts	DIBBLE
Justin Beeler	DIBBLE
Rob Sachs	FCDMC
Shimin Li	FCDMC

Harry Cooper	FCDMC
Gary Shapiro	FCDMC
Brian Fry	JE FULLER
John Griffin	EPG

2) REVIEW OF MEETING MINUTES / ACTION ITEMS

No.	Action Item	Responsible Person	Status/Comments
1	Address comments/finalize Hydrology Technical Memorandum	Dibble	In process
2	Determine additional drainage reports needed. Set up meeting to discuss retention approach.	Dibble	Complete (received 8 additional reports).
3	Discussion of 404 limits with the Corps.	Bob Stevens	?
4	Obtain cost information from recent L303 channel project.	Gary Maiers	Complete
5	Get soil boring sub to provide schedule and commence work.	Kevin	Drilling scheduled for 2/5. Results will be provided within a week.
6	Prepare for Design Charette	All	Complete
7	Prepare typical design approach concepts for anticipated design conditions.	Team	In process
8	Develop Cost Estimate Spreadsheet	Dibble	In process
9	Develop Evaluation Criteria spreadsheet	JE Fuller	In process

- Bob has not yet confirmed JD limits with Corp
- We need an outfall concept – Gary to provide Bullard Wash plans as example
  - Bullard has a graded channel to river low flow
  - Bob S may have concept for what may work for environmental approach.
- Gary to provide cost info from L303 project, estimate from Kinder Morgan L303 crossing
- Soil borings scheduled for 2/5.
  - Watson Drain reach will be earthen w/ hydroseed – need geotech info

- Brian Fry suggested having a map with color coded channel section to distinguish the various reach/section types in the project.
- Discussion on Apache Reach – how high to extend Gunite section.
- Discussion on Watson Reach – concrete bottom, very flat, 12-14' deep. 10' BW & concrete with are minimum values only and may be larger (denote dimensions are variable).
- Discussion of Bullard Wash outfall concept.

3) PROJECT SCHEDULE REVIEW AND STATUS

- Alternatives Analysis
  - Channel Section Design Charette held 1/23/13
    - Channel configuration discussion
    - Components for conveyance/maintenance/multi-use
    - Relationship/interface with arterial roads and existing irrigation facilities
  - Development of "Typical Approach" for probable conditions:
    - Road crossings
    - Drop structures
    - Irrigation laterals
    - Canal crossing
    - ANPP crossing
    - UPRR crossing
    - Waterline relocation
    - Gila River discharge location
    - Other?
  - Cost Estimating Spreadsheet to be assembled by Dibble
  - Evaluation Criteria Spreadsheet to be assembled by JEF

- Discussion of project schedule
- Approximately 6 weeks to preliminary alts memo.
- Kevin to prepare authorization letter for survey/potholes
- Preliminary Alts section meeting – tentative date 4/3/13
- Value Analysis Meeting to be used for Recommended plan (~midway through 15% plan production)
- John mentioned that the PAAC and Public meeting are typically 7-10 days apart.
- PAAC meeting tentatively planned for early May during FCDMC review.
- Brian suggests adding back original scheduled time to complete 15% design plans
- Gary requests schedule to be revised for what is needed and resubmit it to him.
- Brian plans to use ADMP evaluation criteria along with ideas from project kickoff.
  - T.O.B. is very concerned with project maintenance cost
- Discussion of meeting to establish typical design concepts for project – date set for Tuesday, February 12, 2013

4) HYDROLOGY DISCUSSION

a. Finalize base hydrology model

- Amir suggests that Dibble use Town of Buckeye Land use C-value instead of default 0.65 value.
- Inflow hydrographs to be provided to John/Richard for combine point 'O6'.

5) LANDSCAPE ARCHITECTURE DISCUSSION

- No items for discussion

6) RIVER MECHANICS DISCUSSION

- Report will need to include test for our assumptions for the future El Rio levee
- Will need to obtain Gila River 10 yr & 100 yr flows and profile

7) UTILITIES DISCUSSION

- No items for discussion

8) ENVIRONMENTAL DISCUSSION

- No items for discussion

9) PUBLIC INVOLVEMENT DISCUSSION

- No items for discussion

10) TOWN OF BUCKEYE ITEMS

- No items for discussion

11) ANTICIPATED TASKS PRIOR TO NEXT MEETING

- Soil Borings & Results
- Typical Design Approaches
- Cost Estimating Spreadsheet
- Evaluation Criteria
- Gila River outfall design concept
- Commencement of Supplemental Survey (if needed)
- Identification of needed pothole locations

12) ACTION ITEMS

No.	Action Item	Responsible Person	Date Due	Status/Comments
1	Bullard Wash outfall plans	Gary W		
2	Cost Estimate for Kinder-Morgan	Gary M		
3	Revise Hydrology per Amir comment	Justin		
4	Meeting for Typical Approach	Kevin		
5	Prepare Authorization letter for Survey & Potholes	Kevin		
6	Revise schedule & redistribute	Kevin		
7	Provide Gila River 10/100 prof/flows	Gary		

13) NEXT MEETING: Monday, March 4 @ 9:00 AM

Watson Drainage System Pre-Design

FCD 2012C003

MEETING SIGN-IN SHEET

Project Coordination Meeting 02/04/2013

CHECK IN	NAME	SECTION/FIRM	PHONE	EMAIL
	Gary Wesch	FCDMC	602.506.4592	garywesch@mail.maricopa.gov
	Scott Zipprich	Town of Buckeye	623.349.6217	szipprich@buckeyeaz.gov
	Sean Banda	Town of Buckeye	623.349.6215	sbanda@buckeyeaz.gov
	Amir Motamedi	FCDMC	602.506.4871	amm@mail.maricopa.gov
	Bing Zhao	FCDMC	602.506.3293	biz@mail.maricopa.gov
	Rob Sachs	FCDMC	602.506.4744	res@mail.maricopa.gov
	John Holmes	FCDMC	602.506.3320	jwh@mail.maricopa.gov
	Gant Wegner	FCDMC	602.506.7841	gantwegner@mail.maricopa.gov
	Bob Stevens	FCDMC	602.506.4073	rbs@mail.maricopa.gov
	Harry Cooper	FCDMC	602.506.2956	harrycooper@mail.maricopa.gov
	Gary Shapiro	FCDMC	602.506.3076	ghs@mail.maricopa.gov
	Gary Maiers	FCDMC	602.506.0562	gsm@mail.maricopa.gov
	Shimin Li	FCDMC	602.506.4609	shiminli@mail.maricopa.gov
	Kevin Roberts	Dibble	602.957.1155	kevin.roberts@dibblecorp.com
	Josh Papworth	Dibble	602.957.1155	josh.papworth@dibblecorp.com
	Justin Beeler	Dibble	602.957.1155	justin.beeler@dibblecorp.com
	Brian Fry	JE Fuller	623.889.0166 X307	brian.fry@jefuller.com
	Jeff Ford	Olsson	602.748.1000	jford@oaconsulting.com
	John Griffin	EPG	602.956.4370	jgriffin@epgaz.com
	Steve Nowaczyk	Ninyo & Moore	602.243.1600	snowaczyk@ninyoandmoore.com
	Jeff Hamilton	Hunter Contracting	480.892.0521	jeffh@huntercontracting.com

Project Coordination Meeting #8 (March 4, 2013)

Dibble Engineering

7500 North Dreamy Draw Drive, Suite 200
Phoenix, Arizona 85020
Tel. (602) 957-1157
Fax (602) 957-2838

Meeting Minutes

Project: Watson Drainage System Pre-Design
Date: March 4, 2013 – 9:00 AM
Re: Project Coordination Meeting
Contract: FCD 2012C003
Dibble Project: 101206

1) INTRODUCTIONS/ATTENDEES

Gary Wesch	FCDMC
Scott Zipprich	BUCKEYE
Kevin Roberts	DIBBLE
Justin Beeler	DIBBLE
Gary Maiers	FCDMC
Gary Shapiro	FCDMC
John Holmes	FCDMC

Amir Montamedi	FCDMC
Bob Stevens	FCDMC
Aisha Alexander	FCDMC PIO
Jennea Bono	FCDMC PIO
Brian Fry	JE FULLER
John Griffin	EPG

2) REVIEW OF MEETING MINUTES / ACTION ITEMS

No.	Action Item	Responsible Person	Status/Comments
1	Address comments/finalize Hydrology Technical Memorandum	Dibble	Complete. (Submittal 3/4/13)
2	Discussion of 404 limits with the Corps.	Bob Stevens	In process
3	Discussion of Gila River Area with AZ Game and Fish	Bob Stevens	In process
4	Soil Investigations	Kevin	Drilling complete. Lab analysis complete. Preliminary results 3/4/13. Final report 3/18/13.
5	Provide Bullard Wash outfall plans	Gary W	Complete
6	Provide updated utility costs for Loop 303 project	Gary M	Complete
7	Provide Gila River 10/100 year flows	Gary W	Complete
8	Obtain well facility date from Global/Valencia Water	Dibble	Complete
9	Determine Attendees for Alternatives Selection Meeting	TOB	In process

- Bob Stevens provides update on 404 JD. Trying to determine G&F has a restricted property usage in place. Trying to set up meeting with G&F and he needs to get approval from them to process JD. Rod Lucas is G&F contact. Planning to set up meeting sometime in March.
- Geotech analysis has been completed and report to be complete by March 18th. Purpose for geotech analysis was to determine existing soil properties and maximum channel velocities for earth lined channels. Data to be sent to FCDMC/JEF when available.
- Map showing existing well facilities owned by Global/Valencia was obtained.

- Need to determine attendees for Alternatives Selection Committee from Town of Buckeye. Proposed date is April 24th. Need to check with schedules for possible attendees. Scott to get with Becky for other TOB attendees. Planning to have meeting at TOB. Current available time slot is 8-10 AM. Important for attendees to have preliminary ranking on alternatives since meeting time is limited.

3) PROJECT SCHEDULE REVIEW AND STATUS

- Alternatives Analysis
  - Basin Modeling Approach
    - Inline vs Offline
- Modeling approach discussion on basins
  - Discussion of charts, inline vs offline, and sensitivity test results & findings.
  - As observed, offline basins perform better than inline in terms of basin size and downstream conveyance required and this was agreed upon by Amir M.
  - Developers will still be required to retain 100-year, 2-hour volume onsite, but additional runoff beyond this amount will be collected and routed past a proposed offline basin which will allow a certain amount to bypass until a threshold amount is reached. These peak flows will be captured and detained in a proposed basin.
  - If developer will put their retention in the proposed basin site, their basin additional volume cost needs to be accounted for in our total basin cost. If the proposed basin is on a developer site, the benefit for the developer having the basin on their site is to be able to put their development storage volume within the regional basin. The Apache (MB03), Maricopa (MB04), and Railroad (MB02) basins should account for the development storage costs within those basins sites. Only portion of development will be stored in MB03 basin.

    - Regional vs Local
- Participant review and evaluation (3 weeks prior to Alternatives Selection Meeting)
  - 1 week review and comments of alternatives memo
  - 1 week to address FCDMC comments and prepare meeting materials
  - 1 week to meeting attendees to review materials prior to meeting
- Gary W would like to have electronic submittal to FCD & TOB of Alternatives memo on March 28th, Thursday EOD. Five hard copies sent to FCD/TOB on Friday.
- Two week review period after alternatives selection meeting – keep schedule showing 2 weeks per Gary.
- Industrial Park may purchase MB02 basin site to obtain fill material from basin for their site.
- Railroad crossing discussion – will require precast box or steel pipes.
- Scott would like to see pipe through Industrial section to continue through a UPRR crossing and put into an open channel or possibly stay in a pipe (based on the depth of the pipe), to the BWCDD crossing.
- Canal crossings require 4' of clearance from the canal invert. Proposed concept will go over ANPP pipe and under canal.
- Discussion of using a pipe to convey flows around Industrial area in Watson corridor.

4) HYDROLOGY DISCUSSION

a. Finalize base hydrology model

- John Holmes to retire in 2 weeks. Hydrology to be reviewed by Amir in the interim.

5) LANDSCAPE ARCHITECTURE DISCUSSION

- No items for discussion

6) RIVER MECHANICS DISCUSSION

- No items for discussion

7) UTILITIES DISCUSSION

- No items for discussion

8) ENVIRONMENTAL DISCUSSION

- USACOE discussion
- AZ Game and Fish discussion

- Discussion of need to minimize impacts to river at channel outlet
- Should there be a decision criteria for each alternative based on the size of the outlet into the river?
- We need to meet with G&F to determine if there are any restrictions on the land use where we want to have our outlet.

9) PUBLIC INVOLVEMENT DISCUSSION

- New FCDMC Public Involvement Contact
- PAAC Meeting No. 2 – 4/30/2013
- Public Meeting No. 2 – 5/8/13

10) TOWN OF BUCKEYE ITEMS

- No items for discussion

11) CRITICAL TASKS

- Alternatives Analysis & Memo
  - Modeling Iterations
  - Facility Sizing
  - Cost Estimating
- Alternatives Selection Meeting
- Preparation for PAAC Meeting No. 2
- Preparation for Public Meeting No. 2

12) ACTION ITEMS

No.	Action Item	Responsible Person	Date Due	Status/Comments
1	Bob Stevens to meet with AZGFD in March to get land use info and project approval to finalize 404 PJD.	Bob Stevens	March	
2	Provide Geotech results to FCDMC & JEF.	Kevin	3/18/13	
3	Gary Maiers to provide electronic well location data from Global water	Gary M.	March	
4	Scott Z to determine attendees for Alternatives Selection Meeting	Scott Z.	ASAP	Provide list to Becky to get on their calendars.
5				
6				
7				

13) NEXT MEETING: Tuesday, April 9 @ 9:00 AM

Watson Drainage System Pre-Design

FCD 2012C003

MEETING SIGN-IN SHEET

Project Coordination Meeting 03/04/2013

CHECK IN	NAME	SECTION/FIRM	PHONE	EMAIL
	Gary Wesch	FCDMC	602.506.4592	garywesch@mail.maricopa.gov
	Scott Zipprich	Town of Buckeye	623.349.6217	szipprich@buckeyeaz.gov
	Sean Banda	Town of Buckeye	623.349.6215	sbanda@buckeyeaz.gov
	Amir Motamedi	FCDMC	602.506.4871	amm@mail.maricopa.gov
	Bing Zhao	FCDMC	602.506.3293	biz@mail.maricopa.gov
	Rob Sachs	FCDMC	602.506.4744	res@mail.maricopa.gov
	John Holmes	FCDMC	602.506.3320	jwh@mail.maricopa.gov
	Gant Wegner	FCDMC	602.506.7841	gantwegner@mail.maricopa.gov
X	Bob Stevens	FCDMC	602.506.4073	rbs@mail.maricopa.gov
	Harry Cooper	FCDMC	602.506.2956	harrycooper@mail.maricopa.gov
	Gary Shapiro	FCDMC	602.506.3076	ghs@mail.maricopa.gov
	Gary Maiers	FCDMC	602.506.0562	gsm@mail.maricopa.gov
	Shimin Li	FCDMC	602.506.4609	shiminli@mail.maricopa.gov
	Kevin Roberts	Dibble	602.957.1155	kevin.roberts@dibblecorp.com
	Josh Papworth	Dibble	602.957.1155	josh.papworth@dibblecorp.com
	Justin Beeler	Dibble	602.957.1155	justin.beeler@dibblecorp.com
	Brian Fry	JE Fuller	623.889.0166 X307	brian.fry@jefuller.com
	Jeff Ford	Olsson	602.748.1000	jford@oaconsulting.com
	John Griffin	EPG	602.956.4370	jgriffin@epgaz.com
	Steve Nowaczyk	Ninyo & Moore	602.243.1600	snowaczyk@ninyoandmoore.com
	Jeff Hamilton	Hunter Contracting	480.892.0521	jeffh@huntercontracting.com
X	Aisha Alexander	FCD	602-506-6162	aishaalexander@mail.maricopa.gov
	Jennea Bono	FCD PIO		jenneabono@mail.maricopa.gov

Project Coordination Meeting #9 (April 9, 2013)

Meeting Minutes

Project: Watson Drainage System Pre-Design
Date: April 9, 2013 – 9:00 AM
Re: Project Coordination Meeting
Contract: FCD 2012C003
Dibble Project: 101206

1) INTRODUCTIONS/ATTENDEES

Gary Wesch	FCDMC
Kevin Roberts	DIBBLE
Rob Sachs	FCDMC
Gary Maiers	FCDMC
Gary Shapiro	FCDMC
Richard Harris	FCDMC
Amir Montamedi	FCDMC

Bob Stevens	FCDMC
Harry Cooper	FCDMC
Shimin Li	FCDMC
Justin Beeler	DIBBLE
Brian Fry	JE FULLER
John Griffin	EPG

2) REVIEW OF MEETING MINUTES / ACTION ITEMS

No.	Action Item	Responsible Person	Status/Comments
1	Address comments/finalize Hydrology Technical Memorandum	Dibble	In process(Submittal 3/4/13) Minor revisions by Gary W Comments by WC Scoutten
2	Discussion of 404 limits with the Corps.	FCDMC	In process
3	Discussion of Gila River Area with AZ Game and Fish	FCDMC	In process
4	Soil Investigations/Geotech Report	Ninyo & Moore	Drilling complete. Lab analysis complete. Draft Report in Review
5	Determine Attendees for Alternatives Selection Meeting	TOB	Complete
6	Draft Alternatives Memo Submittal	Dibble/Consultants	Complete (3/29/13)
7	Draft Alternatives Memo Review	FCDMC/TOB	Complete (4/5/13)
8	Revisions to Alternatives Memo	Dibble/Consultants	In process – 4/15/13 Submittal
9	Gila River Outfall Exhiibt	Dibble/Consultants	In process – 4/11/13

- Richard Harris will take over the hydrology review for John Holmes.
- Gary W: remaining comments pertaining to hydrology memo can be addressed after an alternative is selected and a Recommended plan report is prepared.
- Gary and Bing are reviewing the soils report – trying to understand if there is information regarding erodible velocities for the study area.

3) PROJECT SCHEDULE REVIEW AND STATUS

- Draft Memo Comments and Responses
  - Discussion of memo comments, responses
    - Scoring results to be collected & graphed at meeting, then added to final submittal.
    - Rewrite section to avoid repetitiveness.
    - Rewrite section on CFD impacts, send to TOB for review.
    - ANPP/canal crossing process to match L303 prices, or explain difference.
    - Gary, add notes to unit cost sheet to qualify costs – add footnotes

- Excavation = $6/cy – no place to haul materials
- Need to discuss reason for increased flow at outlet from existing condition in text.
- Add outfall for Dean basin – graphic/cost
- Discussion on synergy definition & "landscaping" scoring. Decided to use scoring criteria used in ADMP per Gary W.

- Alternatives Selection Meeting - Wed 4/24/13
  - Kevin to verify that Becky is aware of the total number of meeting attendees
  - Reminder for attendees to review memo/scoring prior to meeting. Meeting is only 2 hours.
  - Meeting Agenda/Logistics
  - Discussion of draft agenda and time allotted for each topic.
  - Approximately 20 attendees are expected (include Richard Harris on invite)
  - Discussion on having a specific person present each scoring category for further clarification (~3 mins.)
    - Constructability = Gary W., Implementation = Woody, Public/Political Acceptance = Rob Sachs or Larry Harmer, Natural/Cult. Res. = Bob Stevens, Flood Haz. Reduc. = Gary/Dibble, Synergy/Multi-use – Adam ? (TOB).
  - Brian to send updated agenda to Gary W. for review.
  - Scoring Alternatives
  - Weighting Criteria

4) HYDROLOGY DISCUSSION

- Minor revisions requested by Gary W
- Comments issued by TOB (4/1/13)
  - Richard Harris will take over the hydrology review for John Holmes.
  - Gary W: remaining comments pertaining to hydrology memo can be addressed after an alternative is selected and a recommended plan report is prepared.

5) LANDSCAPE ARCHITECTURE DISCUSSION

- No items for discussion

6) RIVER MECHANICS DISCUSSION

- No items for discussion

7) UTILITIES DISCUSSION

- No items for discussion

8) ENVIRONMENTAL DISCUSSION

- USACOE discussion
  - A formal PJD is needed and requires a property owner approval signature.
  - Approval signature should be easier for AZGFD, but Sand/Gravel company may require a detailed concept and feedback on approach prior to getting PJD approved.
  - According to Cindy Lester at ACOE, the habitat/wetland area dictates the basis for delineation (instead of hydraulic conveyance area). This habitat area correlates with the Arlington canal limits.
  - There may be threatened and endangered species within the Arlington canal.
  - We need to show that this project will enhance and sustain the habitat (versus providing enhancement for other areas).
  - We need to avoid disturbing the Arlington "drain"/canal with this project and define those limits.
  - Graphics need to show that the potential future lake (by others) near outfall is not part of this project.
- AZ Game and Fish discussion
- Gila River Lake, LLC discussion
- United Metro Materials discussion

9) PUBLIC INVOLVEMENT DISCUSSION

- PAAC Meeting No. 2 – 4/30/2013
- Public Meeting No. 2 – 5/8/13

10) TOWN OF BUCKEYE ITEMS

- No items for discussion

11) CRITICAL TASKS

- Alternatives Selection Meeting
- Preparation for PAAC Meeting No. 2
- Preparation for Public Meetign No. 2

12) ACTION ITEMS

No.	Action Item	Responsible Person	Date Due	Status/Comments
1	Verify total number of meeting attendees, update Becky	Kevin		
2	Kevin to have Scott/Woody at T.O.B. review rewritten section regarding CFD impacts to concur on wording.	Kevin		
3	Send updated Selection meeting agenda to Gary W. for review	Brian F.		
4				
5				
6				
7				

13) NEXT MEETING: TBD

PAAC #2 (April 30, 2013)

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
2801 W. Durango Street
Phoenix, AZ 85009

TOWN OF BUCKEYE
530 E. Monroe Avenue
Buckeye, AZ 85326

MEETING MINUTES **April 30, 2013**

PROJECT NAME: Watson Drainage Project - Predesign

PURPOSE: Project Aesthetics Advisory Committee (PAAC) Meeting #2: 8:00AM – 10:00AM

LOCATION: Town of Buckeye – Executive Conference Room

NOTE

Welcome/Introductions ..... John Griffin, Consultant LA, EPG

Recommended Plan Description ..... Kevin Roberts, Consultant PM, Dibble

Kevin Roberts described the recommended plan that was selected by a committee from four alternatives. The recommended plan was the low-cost alternative and one of two alternatives that performed the highest as evaluated by the selection committee.

Elements of the recommended plan include:

- Five basins, designated as the Apache, Rainbow, Maricopa, Railroad, and Dean basins. A sixth basin was suggested during the selection meeting between the UPRR and BWCDD corridors. This basin would potentially reduce the size of the crossing of the ANPP line and BWCDD as well as provide open space opportunity
- A regional channel system with five distinct channel types developed during a previous meeting with the Town of Buckeye
- A single, consolidated crossing of the Union Pacific Railroad and the ANPP/BWCDD corridors
- Optional channel alignments to be evaluated by the team that may result in adjustments near the industrial park along Southern Ave., as well as south of the BWCDD

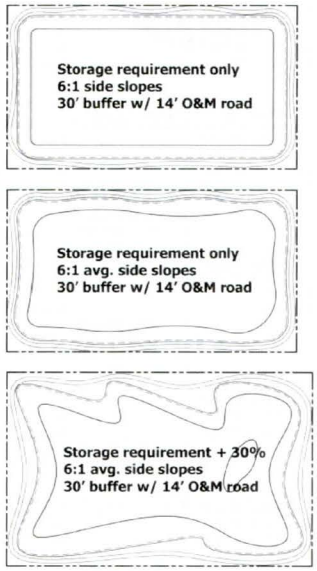
Project Aesthetics and Landscape ..... PAAC, Facilitated Discussion

Basins – John Griffin provided an overview of the District's *Aesthetic & Multi-Use Design Guidelines for Flood Control Basins and Channels*. The basin site should include sufficient space to allow for basin shaping such as varied gentle side slopes, islands and peninsulas, meandered basin edges that do not follow the property lines, and buffers to provide a transition between the basin and adjacent properties. As a guideline, a 30'-50' buffer and 30% additional area should be included with the engineering requirement to achieve these results. The schematic (next page) illustrates comparative land requirements between a basin with 30' buffer only, a basin with 30' buffer and side-slope meander, and a basin site that included 30% additional right-of-way to achieve the design guidelines.

Dibble prepared graphics showing the updated basin footprints based on two channel depths (3' and 6') plus a 30' buffer for discussion purposes.

The PAAC discussed each of the basin sites and identified key considerations related to the right-of-way requirement, multi-use opportunities, and landscape design intent as summarized below.

Comparative Sizing



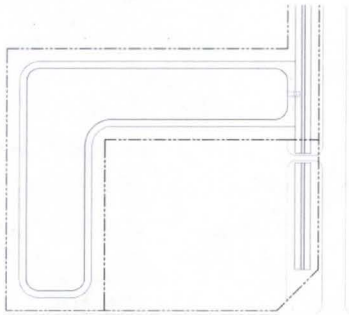
- **Rainbow Basin:** Located north of the RID along the 231st Avenue alignment
  - Multi-Use: Active recreation to include unprogrammed, open turf. Town does not want sports field lighting in retention basin. Basin site will likely become part of the larger Sundance Park complex. Town needs additional space for ball fields on this site as there is a higher demand for this use than can be met by the existing park. The Town is also planning a multi-gen center and aquatics center on the parcel currently owned by the Town that would be between the Rainbow Basin site and the existing Sundance Park.
  - Right-of-Way: Engineering need plus 30' buffer and an additional 30%. The engineering need is greatly reduced from that shown in the ADMP (ADMP: 102 ac-ft, Current: 48 ac-ft) which reduces the opportunity to co-locate recreation with storage. An additional 30% of right-of-way for basin shaping is desired by the Town and recommended to form the basin in an aesthetic manner. The Town may need to acquire even more land to provide access to the park/basin site from Lower Buckeye Road.
  - Landscape: To match the Sundance Park landscape design. Includes irrigated turf, desert and desert-adapted shrubs and tree species. Examples described in the meeting include palo verde, mesquites, and sissoo trees.
  - Other considerations: Roosevelt Irrigation District asked if the park site would encroach on RID right-of-way? The design of the basin does not require this. However, both the Town of Buckeye's Trails Master Plan and the Maricopa Regional Trail Master Plan indicate a trail along the RID. This could be an opportunity for an agreement between the various agencies to include a trailhead at the basin site.

- **Apache Basin:** Located north of the RID along the Apache Road alignment on an existing platted site
  - Multi-Use: Passive recreation per ADMP, but to be determined by developer. The Town may offer the developer incentives to help facilitate implementation of the basin such as open space credits, density credits, or allow co-location of some of their on-site retention.
  - Right-of-Way: Engineering need plus 30' buffer and an additional 30%, to be negotiated with developer. The property owner is going to expect compensation for having to replat and for the loss of lots due to the basin.
  - Landscape: To be determined by the developer. If Town-maintained, no irrigation and easy to maintain
  - Other considerations: The basin could provide additional neighborhood park-level recreation since Monte Verde has a low recreation level-of-service for neighborhood park needs.

    Action Item: *Larry Harmer/Town of Buckeye to find filed plat and provide to team*

- **Maricopa Basin:** Located on the NW corner of Apache and Maricopa Road, adjacent to Odyssey Elementary School
  - Multi-Use: Determined by developer through discussions with the Town, may include partnering with the Odyssey Elementary School. Multi-use opportunities discussed in the meeting include a sports practice field, an outdoor classroom/environmental education area, passive open space areas with trails, or active recreation for the school.
  - Right-of-Way: Engineering need plus 30′ buffer and an additional 30%, to be negotiated with developer.
  - Landscape: To be determined by the developer. If Town-maintained, no irrigation will be included and landscape should be very easy to maintain.
  - Other considerations: The basin could also function as a gateway feature into the downtown. It will provide a buffer between the future residential and industrial areas.

- **Railroad Basin:** Located at the intersection of 231st and Southern Ave. Current site of the Ventura Ranch development
  - Multi-Use: Passive open space, to be determined by developer and Town. The Town may offer the developer incentives to help facilitate implementation of the basin such as open space credits, density credits, or allow co-location of some of their on-site retention. The 231st Channel was identified as a potential location for an equestrian trail and this basin could include an equestrian trailhead.
  - Right-of-Way: Engineering need plus 30′ buffer only. Town recommended the basin be 6′ deep rather than 3′ in order to reduce the footprint required.
  - Landscape: To be determined by the developer. If Town-maintained, no irrigation will be included and landscape should be very easy to maintain.
  - Other considerations: The basin is located on a corner that may have commercial value to the developer. The Town suggested that the basin could be reconfigured into an "L"-shape to preserve the value of the corner lot. This basin could also provide visual buffering between the future residential and industrial areas if designed correctly.



  Action Item: *Larry Harmer to check on the status of the Ventana Ranch Plat which is on the site of the proposed basin*

- **Dean Basin:** Located on Southern Ave. west of Dean Road. May be the site of the Henry Park development, to be confirmed by the Town (Larry Harmer)
  - Multi-Use: Passive open space. The Town may offer the developer incentives to help facilitate implementation of the basin such as open space credits, density credits, or allow co-location of some of their on-site retention.
  - Right-of-Way: Engineering need plus 30′ buffer and an additional 30% for shaping. Developer could co-locate on-site retention in same footprint by going deeper.
  - Landscape: Desert-themed, to compliment passive open space use. If Town-maintained, no irrigation will be included and will consist of native desert hydroseed and tall pot trees.

- Other considerations: The Henry Park development plat may have expired. If so, the Town will be renegotiating the development agreements for the site which will provide opportunity for the Town to determine basin requirements for the CMP.
  Action Item: *Larry Harmer to check into status of the Henry Park development and provide team with update*

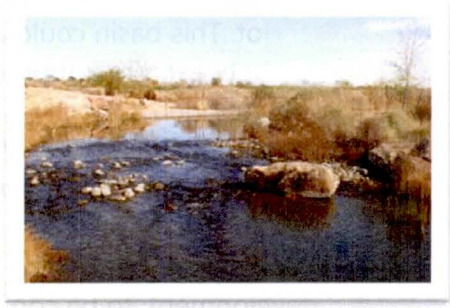
- **Additional BWCDD/ANPP Crossing Basin:** Located between UPRR and the BWCDD. Based on discussions in the PAAC between Town of Buckeye staff and the team, there was limited support for having a basin in this location. The Town sees the site as having access challenges that would negate the open space value of any basin in this location. The PAAC recommended that this basin be eliminated from the recommended plan. Harry Cooper would also like to see the cost comparison for including the basin vs eliminating it. If the basin reduces the cost of the crossing at the ANPP line and BWCDD, and this is not fully offset by the cost for the basin, that may be grounds for including it in the recommended plan.

  Multi-use options discussed with this basin site included a future Railroad park, maintaining agriculture uses in the basin post-construction, or having a trailhead/passive open space area. Besides access issues, the Town also was concerned about having a park next to the railroad for public safety

Gila River Outlet Design – Gary Wesch, FCDMC PM, provided an overview of the ownership issues and design considerations the team is examining for the outlet of the Watson Drainage System into the Gila River. This includes owner/agency coordination between Cemex, Arizona Game and Fish Department, the Army Corp of Engineers (404 evaluation), and the Gila River LLC sand and gravel company.

Design considerations for the concept include:

- Relocation of the existing Watson Drain into the channel alignment
- Grade-control and cut-off walls plus buried rip-rap to protect the channel
- An O&M road with access into the bottom of the channel as well as to the existing agriculture roads along the river bank
- Culvert crossings of the channel along alignments indicated in the Town's transportation master plan
- The creation of a natural-appearing "riffle, pool, run" low-flow in the buried rip rap area to make use of the perennial flows in the Watson Drain to create the appearance of a natural stream
- Seeding of the buried riprap with a native riparian seed mix and tree pole plantings to create a desired plant community at the confluence with the Gila River



Riffle, Pool, Run Example

Discussion items related to this feature included:

- Concern was raised about salt cedar invasion into the system and what thought the team had given to controlling this. The team acknowledged this is an issue that will be part of the maintenance concerns for the project. The planting of a desirable plant community at the outlet will help create competition for invasive species such as salt cedar but there is no substitute for active management given the aggressive invasive nature of the species. The Town provided

input regarding the El Rio Levee project and that this was coming back to life with the potential to be a vehicle for this level of management in the near future.

- Maintenance IGA's for the area need to be worked out. Town currently has BWCDD do maintenance in canals because they have the appropriate equipment. Maintenance access to area south of grade control structure needs to be included in the design.
- Bob Stevens raised concern that design needs to consider T&E species impacts.
- The Arlington Canal in this area does not function as part of the Arlington Canal, but is a remnant of the previous system.

Channels – The PAAC reviewed the previously developed channel cross-sections and discussed refined landscape and aesthetic requirements for the channels.

The Town of Buckeye does not have landscape standards and does not wish to develop anything that may be construed as such. This is due to an agreement the Town has with Verrado. As soon as the Town develops landscape standards, the Town's agreement with Verrado is affected and the Town will be required to start O&M operations in Verrado. Design recommendations are ok to develop as part of the Watson System. The Town felt that it is better to allow the developers latitude in selecting landscape and structural aesthetics for their portions of the channel to create interest and blend the channel into the development rather than have a consistent theme for the entire channel.

Due to the above, the Town's landscape requirements for the channels are per the Town's Development Code Section 7-5-6 (species to be on the ADWR Low-Water Plant List for the Phoenix AMA, one tree and three shrubs per every 30 linear foot along streets, per the table below for landscape areas).

TABLE 5-B LANDSCAPING REQUIRED FOR NEW DEVELOPMENT (BY LAND USE TYPE)

	Residential	Commercial	Industrial
Percentage of parcel to be landscaped	15%	10%	5%
Plantings required for landscaped area (gallons)	Ten gallons for each 25 square feet	Ten gallons for each 50 square feet	ten gallons for each 75 square feet
Acceptable groundcover	Turf, Granite	Turf, Granite, Undisturbed desert	Granite, Undisturbed desert

*Groundcover plantings and layout must be approved by the Community Development Director.
*Plantings shall be measured by the size of container containing the root structure.
*Plant variety shall be on the Arizona Department of Water Resources approved plant list.
*Residential requirements include only common areas within subdivisions and multiple family developments.
*24" box equals 50 gallons and 36" box equals 75 gallons.

Water harvesting swales should be included on the top-of-bank of all channels to both make use of rainwater as well as control run-off into the channels to minimize bank erosion. The PAAC discussed

possibility of using water harvesting as a 1st flush off of roads prior to run-off entering the channel system.

Discussion items specific to the channel cross-sections are included below. Not all of the channel cross-sections included specific design recommendations by the PAAC beyond the general items discussed above.

- **Apache Channel:** Gunite should include integral color and texturing. Color should be compatible with adjacent rock mulch or decomposed granite.

- **Maricopa Channel:** Channel rock mulch needs to be engineered to stand up to flows in channel without decomposing. Rock should be selected that also is aesthetic and approved by the Town. Selection of rock should complement other landscape and aesthetic design of the development.

- **231st Channel:** The Town would like to minimize turf irrigation when the Town is responsible for maintenance. Where this occurs, turf should be replaced with native plant materials that can subsist on natural precipitation.

Structural Aesthetics – John Griffin presented a board that was shown at the last public meeting that included typical drop structure types. Based on input from the public, most preferred either a simple concrete drop that blended into the channel or one that retained the rural character of the area.

PAAC-Preferred Drop Structure Example

The PAAC reviewed the examples shown and determined that a drop that appeared "naturalized" was preferred over a drop that is intended to be an aesthetic feature such as a rural-themed drop structure. While the PAAC described the preferred drop as natural, the drop example may also be described as a concrete drop that includes texture and color to blend into the channel.

The pre-design team will provide engineering requirements for the drop structures including height and configuration requirements but the Town prefers that the aesthetic design of the structures be up to the developer.

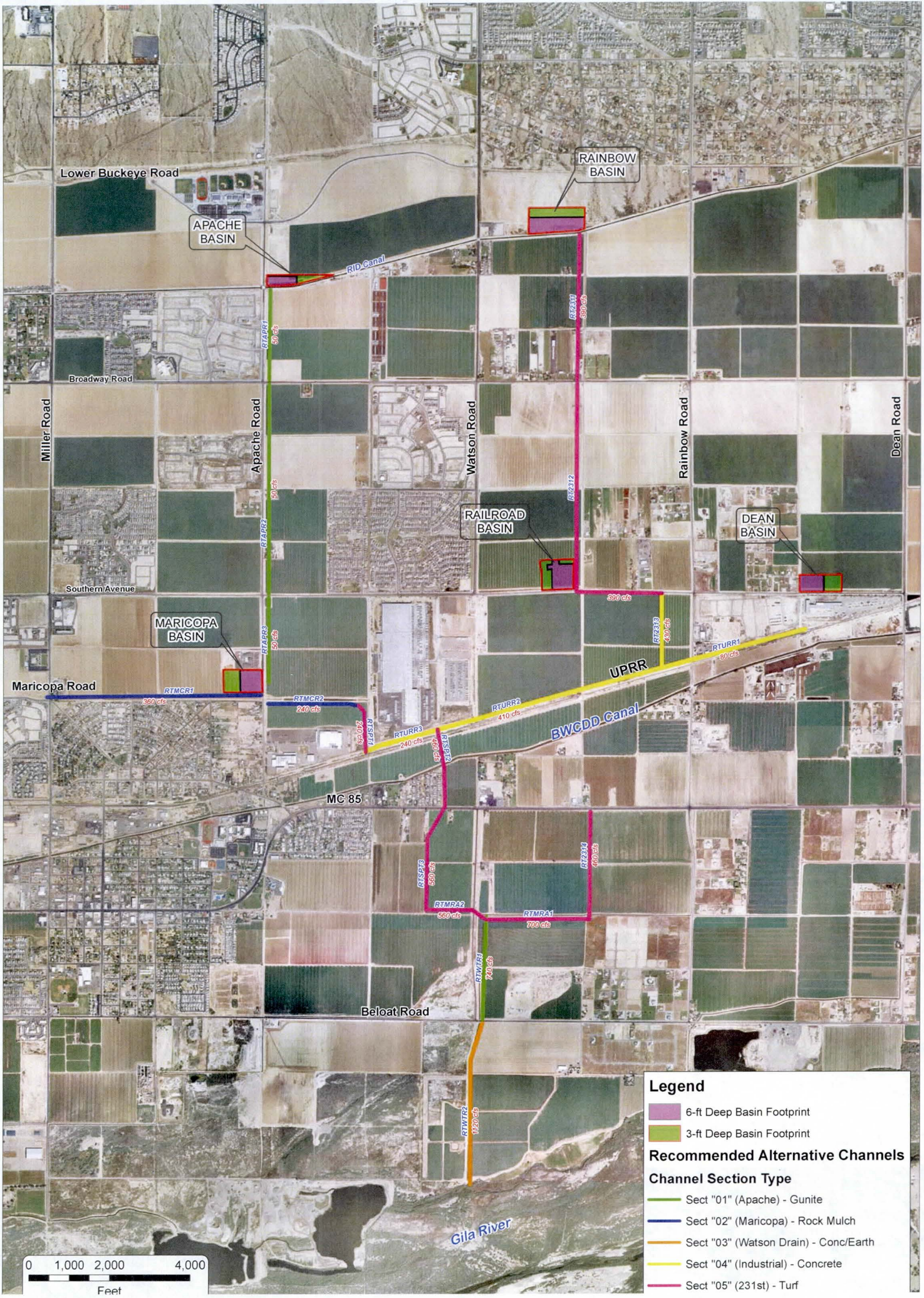
Culvert and other headwall structures will be developed by the pre-design team and finalized during final design for the District-implemented portion of the system.

UPRR Comments on the Recommended Plan – The representative from the Union Pacific Railroad had the following comments regarding the recommended plan:

- UPRR is concerned about underground sections of the alignments
- UPRR asked if there would be any other type of structure in their right-of-way than concrete? The team expects that the entire segment in the UPRR system will be pipe or culvert.
- UPRR want all infrastructure to be outside of the UPRR right-of-way except the crossing (i.e. – no channels)
- Woody Scoutten, Town of Buckeye, expressed concern about the entire channel shown north of the UPRR and how congested this area is with utilities. Questioned if this section may need to be undergrounded as well.

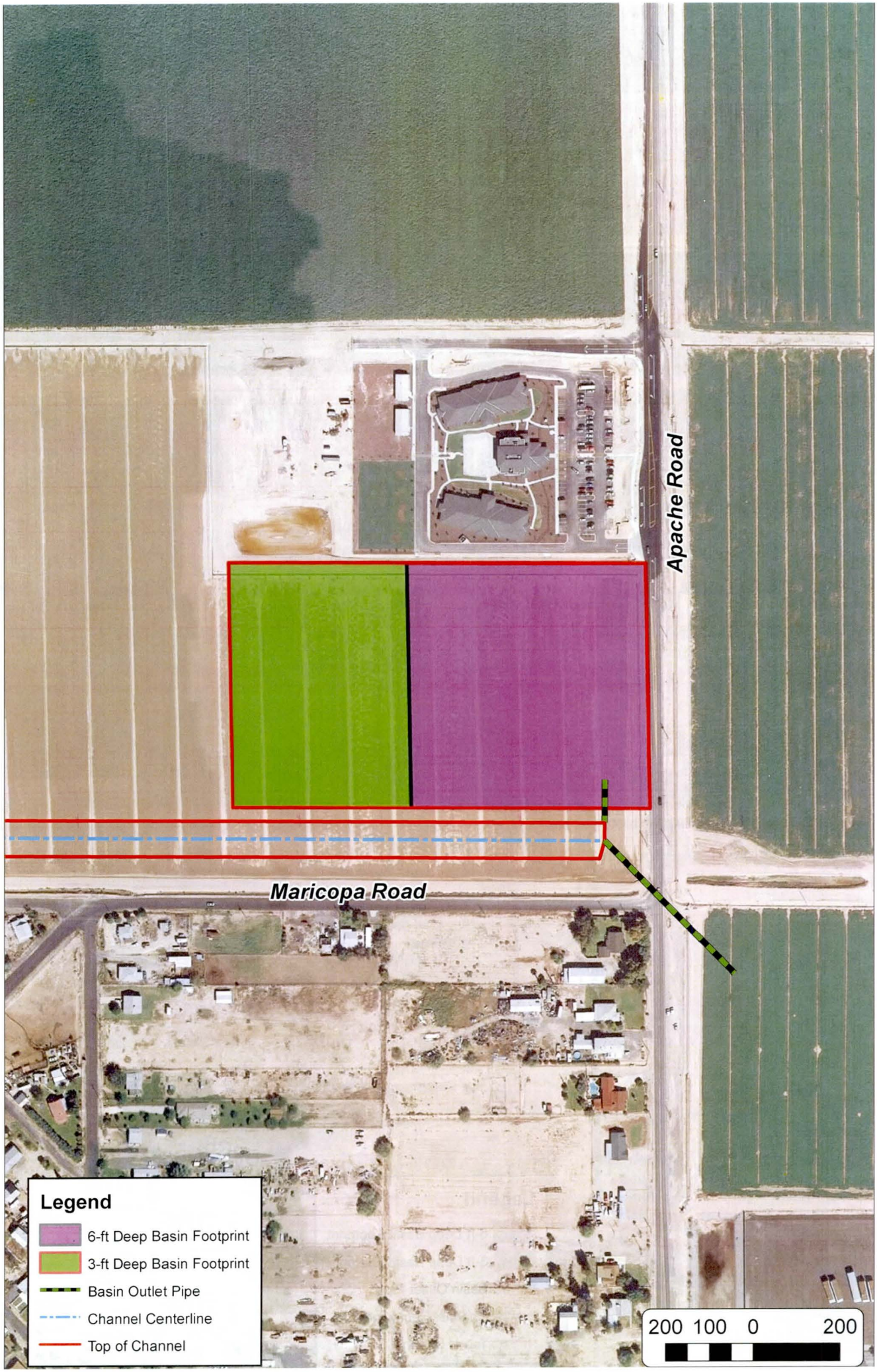
  Action Item: *Team to follow-up with UPRR on questions asked regarding the recommended plan*

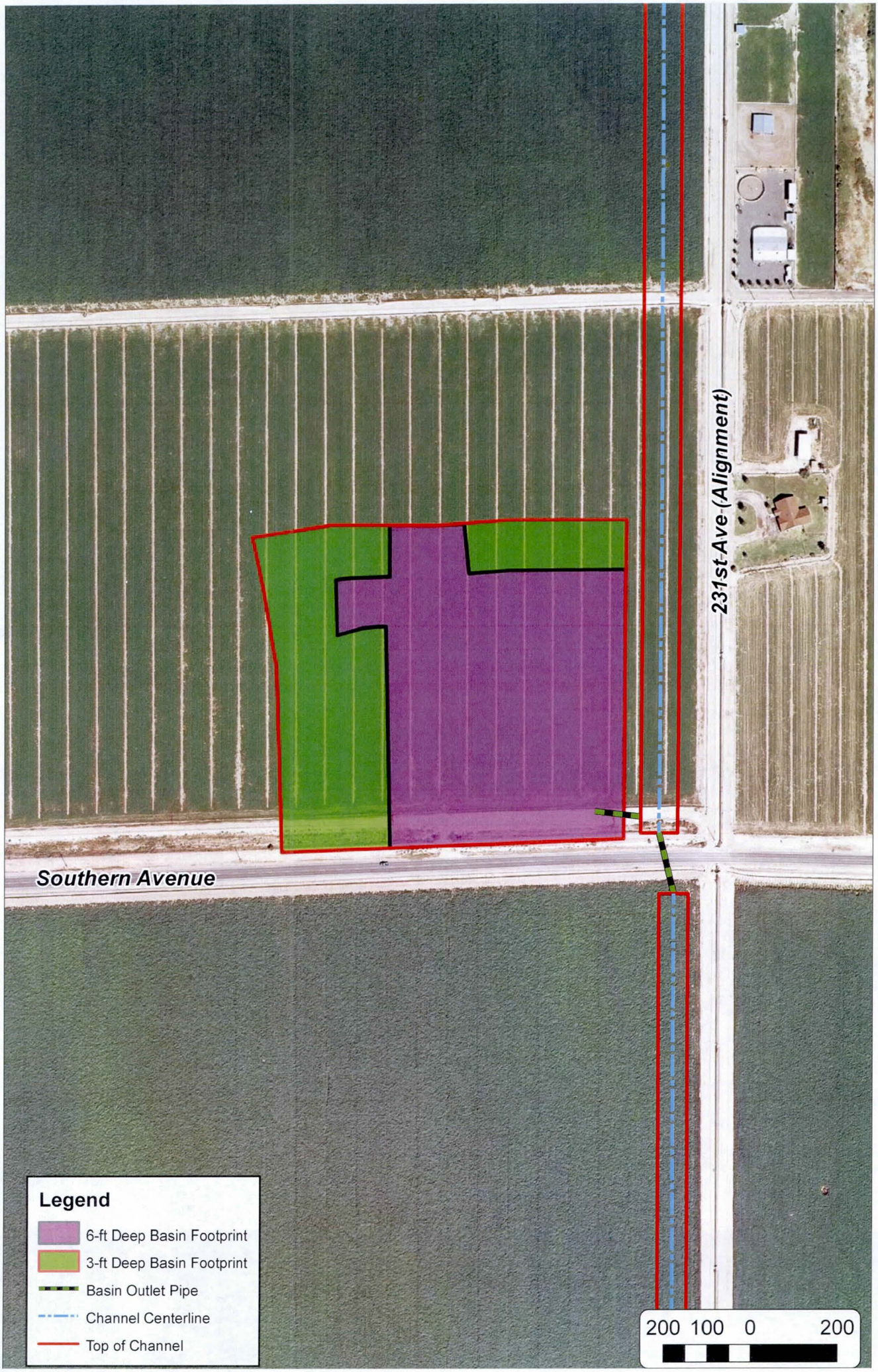
Public Meeting #2 (Exhibits) (May 8, 2013)

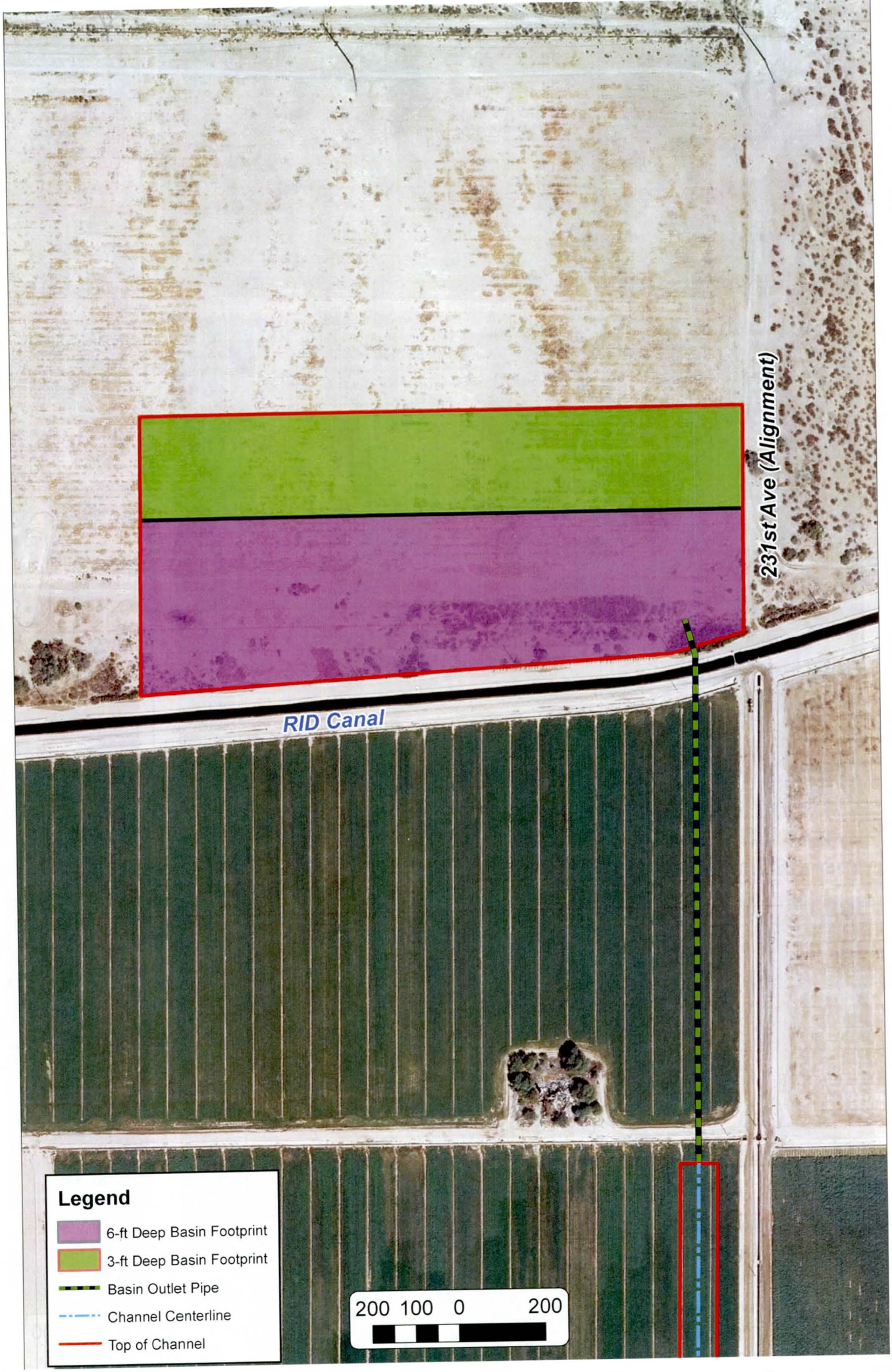

Lower Buckeye Road
APACHE BASIN
RAINBOW BASIN
RID Canal
RTAPR1
50 cfs
RTR2311
800 cfs
Broadway Road
Miller Road
Apache Road
Watson Road
Rainbow Road
Dean Road
RTAPR2
50 cfs
RTR2312
RAILROAD BASIN
DEAN BASIN
Southern Avenue
390 cfs
MARICOPA BASIN
RTAPR3
50 cfs
RTR2313
430 cfs
RTURR1
80 cfs
UPRR
Maricopa Road
RTMCR1
360 cfs
RTMCR2
240 cfs
RTURR2
410 cfs
BWCDD Canal
RTSP11
70 cfs
RTURR3
240 cfs
RTSP12
140 cfs
MC 85
RTSP13
560 cfs
RTR2314
460 cfs
RTMRA2
560 cfs
RTMRA1
700 cfs
RTWTR1
740 cfs
Beloat Road
RTWTR2
1120 cfs
Gila River
0 1,000 2,000 4,000
Feet
Legend
6-ft Deep Basin Footprint
3-ft Deep Basin Footprint
Recommended Alternative Channels
Channel Section Type
Sect "01" (Apache) - Gunite
Sect "02" (Maricopa) - Rock Mulch
Sect "03" (Watson Drain) - Conc/Earth
Sect "04" (Industrial) - Concrete
Sect "05" (231st) - Turf

Lower Buckeye Road
Apache Road
RID Canal
Legend
6-ft Deep Basin Footprint
3-ft Deep Basin Footprint
Basin Outlet Pipe
Channel Centerline
Top of Channel
200 100 0 200

223rd Avenue (Alignment)
Southern Avenue
UPRR
Legend
6-ft Deep Basin Footprint
3-ft Deep Basin Footprint
Basin Outlet Pipe
Channel Centerline
Top of Channel
200 100 0 200


Apache Road
Maricopa Road
Legend
6-ft Deep Basin Footprint
3-ft Deep Basin Footprint
Basin Outlet Pipe
Channel Centerline
Top of Channel
200 100 0 200


231st Ave (Alignment)
Southern Avenue
Legend
6-ft Deep Basin Footprint
3-ft Deep Basin Footprint
Basin Outlet Pipe
Channel Centerline
Top of Channel
200 100 0 200


231st Ave (Alignment)
RID Canal
Legend
6-ft Deep Basin Footprint
3-ft Deep Basin Footprint
Basin Outlet Pipe
Channel Centerline
Top of Channel
200 100 0 200

Irrigation Coordination Meeting (July 9, 2013)

Meeting Minutes

Project: Watson Drainage System Pre-Design
Date: July 9, 2013 – 2:00 PM
Re: Watson Pre-Design / Irrigation Systems Coordination
Contract: FCD 2012C003
Dibble Project: 101206

ATTENDEES:
Ed Gerak (BWCDD)
Melody Zyburt (Stantec)
Jared Grandy (Stantec)
Jeremy Laipple (Dibble)
Kevin Roberts (Dibble)

PURPOSE OF MEEETING:
The Watson project is moving into the plan preparation phase. Alternatives were developed and evaluated. From this process, a recommended system plan has emerged. Plans will be developed for the recommended alternative to a 15% level design. The purpose of this discussion was to fully understand the functionality and requirements of both the RID and BWCDD systems within the Watson project area.

DISCUSSION:

- No siphons will be allowed in either the RID or the BWCDD systems. Too many maintenance issues result from sediment deposition in siphons. (The only exception to this rule is when the irrigation system is siphoning itself with clear water- i.e. delivery water, not tail water).
- Relocated laterals will need to be 30" to 36" RGRCP. Delivery boxes will be required with 24" RGRCP turnouts for deliveries. A 24' wide maintenance road will be required over pipe sections of irrigation systems.
- For the BWCDD system, a manhole will be required for pipe sections every 200'.
- For the RID system, a manhole will be required for pipe sections every ¼ mile.
- After a review of the Watson recommended alternative, there appear to be no impacted sections of the irrigation systems that would not be suitable for pipes in lieu of open ditches.
- Where the Watson drainage system will cross the RID main canal and the BWCDD main canal, 6" reinforced concrete lining will be required with a slurry backfill.
- Standard irrigation ditches are constructed of 4" concrete with fibermesh. Any affected ditches that are proposed to be replaced in kind will be required to utilize this section.
- Regarding potential relocation of the BWCDD main canal to allow the drainage crossing to be constructed, Bureau of Reclamation design standards are used for alignments, allowable curve radii, etc...
- The preferred process for planning and design is for BWCDD to engage Stantec to perform a concept design (10% design level) for modifications to the BWCDD system. This would allow the 15% Watson System plans to accurately depict allowable modifications to the BWCDD system. Then, during final design of the Watson System, BWCDD would again engage Stantec to perform the final design for the BWCDD required

modifications. The Stantec plans could be incorporated into the Watson system construction documents. In order for BWCDD to engage Stantec, FCDMC needs to make a formal request for design to commence. Ed would then need to approach the BWCDD Board for authorization.

- BWCDD owns the easement through the CEMEX property north of the Gila River. BWCDD would be open to selling the easement to FCDMC, and then allowing FCDMC and CEMEX work through the details of whatever agreement needs to be in place.

- The Watson System design needs to maintain the functionality of the existing diversion structure approximately ¼ mile north of Beloat in the Watson Drain (@ salt flats).

- The main canal relocation and other significant changes to the BWCDD system will have to be presented to the Board. Ed Gerak will likely do the presentation, but may want FCDMC/Dibble staff present in a support role.

- There is an annual dry up period in the BWCDD main canal in November (11/9/2013 - 11/23/2013). The RID system conducts a dry up period at approximately the same time (11/11/2013 – 11/22/2013). FCDMC should plan to perform some survey during the 2013 dry up to assist in final design of the improvements.

- The BWCDD main canal requires capacity for 400 cfs.

- Once Dibble has advanced the Watson System design, digital CAD linework will be provided to Stantec.

- The Watson System should avoid the footprint of the existing and future well site along the east side of Apache Road between Southern and Broadway. This location is a good candidate to underground the Watson system and take it into the Apache Road corridor to ensure impacts to the well site are avoided.

- The RID system has "2 partnership ditches" at 14-½ and Southern and ½ north of Southern. These partnership ditches are not owned by RID, but are part of the system by agreement. These ditches are able to convey flow in both directions, depending on head/tail water elevations. Functionality of these partnership ditches must remain.

- The RID system at Rainbow and Southern (near the proposed Dean Basin) has the ability to deliver water to the south and to the east. This ability may be able to be retired, based on current land uses in the area. This will need to be verified by Stantec if the Watson System intends to impact these delivery ditches.

- Regarding crossing the RID and BWCDD main canals with drainage infrastructure:
  If the drainage crossings are constructed using conventional open trench methods, then only be required 2' of vertical clearance may be required between the bottom of the canal and the top of the drainage facility. If the crossing is constructed using jack and bore, then the RID requires 4' of vertical clearance and the BWCDD requires 6' of vertical clearance (because the BWCDD canal is unlined).

- Drainage crossings of underground irrigation laterals:
  Irrigation pipe generally requires 2' of ground cover. Vertical separation of 1' between bottom of irrigation lateral and top of drainage pipe is required.

- Any trail/pathway crossings of the RID or the BWCDD system needs to go before the board for approval. The RID board is generally open to bridge crossings of the main canal every ½ mile. The RID will likely push for their delivery system to be underground if adjacent to a trail system for public use. The BWCDD may be a little more open to joint use facilities.

- Board meetings generally occur every month. Need to request to be on agenda 2 weeks in advance.

APS Discussion (Dec. 11, 2013)

Dibble Engineering

7500 North Dreamy Draw Drive, Suite 200
Phoenix, Arizona 85020
Tel. (602) 957-1157
Fax (602) 957-2838

Meeting Minutes

Project: Watson Drainage System Pre-Design
Date: December 11, 2013 – 2:30 PM
Re: APS ANPP Water Line Coordination
Contract: FCD 2012C003
Dibble Project: 101206

1) INTRODUCTIONS/ATTENDEES

Gary Wesch	FCDMC
Robert Eroh	BUCKEYE
Kevin Roberts	DIBBLE
Jeremy Laipple	DIBBLE

Mohammad Afzai	APS
Rafael Balderrama	APS
Mike Bouche	APS
Dave Schlief	APS

2) PURPOSE OF MEETING

A pothole of the 96" ANPP Water Line conducted for the Watson Drainage System Pre-design revealed that the water line was constructed at an elevation 1.49 feet higher than indicated on as-built plans. This change has a potentially significant impact on the drainage system as a result, and the Flood Control District would like to ensure that the proposed approach to crossing this line is acceptable to APS.

3) PROJECT SUMMARY AND PALO VERDE NGS OVERVIEW

- Palo Verde NGS Overview
  - NGS has 3 units, with 2 shut-downs per year
  - Shut-downs are 14 days long, with 1 day shutdown, 12 day outage, and 1 day startup
- Watson Drainage System Project Summary
  - Buckeye Area Drainage Master Plan – regional plan for the City of Buckeye
  - ADMP identified 4 major drainage facilities, one of which is the Watson Drainage System
  - Refer to Overview map of the system for general location and location of the ANPP immediately north of the BWCDD Canal

4) ANPP LINE CROSSING

- Proposed crossing approach
  - Crossing detail shown on Sheet 15 and Sheet 72
  - Detail mimics the design utilized for the Bullard Wash crossing, located approximately 10 miles east of the Watson crossing
- FCDMC experience in crossing the ANPP Water Line
  - In the past, FCDMC has paid APS for reinforcement of the line
  - APS has standard designs for the reinforcement of the line
    - APS has contracted with SG&H, an independent consultant, to coordinate maintenance and modifications to the ANPP line
    - SG&H conducts an inspection of the segment of the line where the crossing is to take place, and will then determine reinforcement requirements and crossing limitations
    - Previous crossings with as little as 6" of encasement have been used in the past, but requirement is dependent on pipe condition, pressure zone, etc.
- APS Reinforcement Design Process
  - APS will send design request to SG&H

    - Depending on the scope of the investigative work and engineering analysis required, SG&H may complete the work under their existing contract with APS, and the cost of this task may be rolled into the cost of the required pipe reinforcement. If the required work is substantial, then SG&H may provide a proposal to APS for the work, which APS will forward to FCDMC for approval and payment.
  - A detail was presented to APS showing a reinforcement plan for the ANPP line showing 12" of concrete encasement above the pipe, the top of which will be integrated into the upstream drainage channel. This approach is proposed so that the upstream channel will function at this alignment.
    - The pre-design plans will be used to develop final construction documents
    - Any change to an approved crossing plan will have a major detrimental effect on the project
    - FCDMC prefers waiting to get a reliable answer to getting a quick approval that may not be conclusive
- Schedule
  - APS will forward request to SG&H as soon as it is received
  - APS anticipates receiving a proposal for the work from SG&H mid-January
  - If inspection and reinforcement design is straightforward, a two-week turnaround is possible; four week turnaround is more likely

5) POTHOLING

- FCDMC and Dibble apologized for potholing contractor's lack of communication prior to potholing line
- FCDMC requests 2-3 additional potholes of the line, in the general vicinity of the first hole
  - APS will allow FCDMC to conduct additional potholes
    - Dibble to provide exhibit to APS, indicating proposed locations of additional holes
    - Potholing contractor shall contact Moe with APS to coordinate permit
    - APS may require a representative to be on site during all potholing operations
- APS mentioned that the water line was built on a project specific datum; discrepancy between NAVD88 and as-builts were about 1.5-feet on another recent crossing project

6) RIGHT-OF-WAY AND MAINTENANCE ACCESS

- APS has agreement to BWCDD canal maintenance road
- Pipeline inspections are conducted using standard pickup trucks; as long as a pickup can access the channel bottom, and can travel the BWCDD right-of-way unobstructed, APS will have no maintenance issues with the design

7) ACTION ITEMS

No.	Action Item	Responsible Person	Date Due	Status/Comments
1	Dibble to revise plan sheet and detail to show concrete channel lining and minimal crossing width.	Kevin	12/18/13	
2	Dibble to provide exhibit to APS showing proposed pothole locations	Kevin	12/18/13	
3				
4				
5				
6				
7				

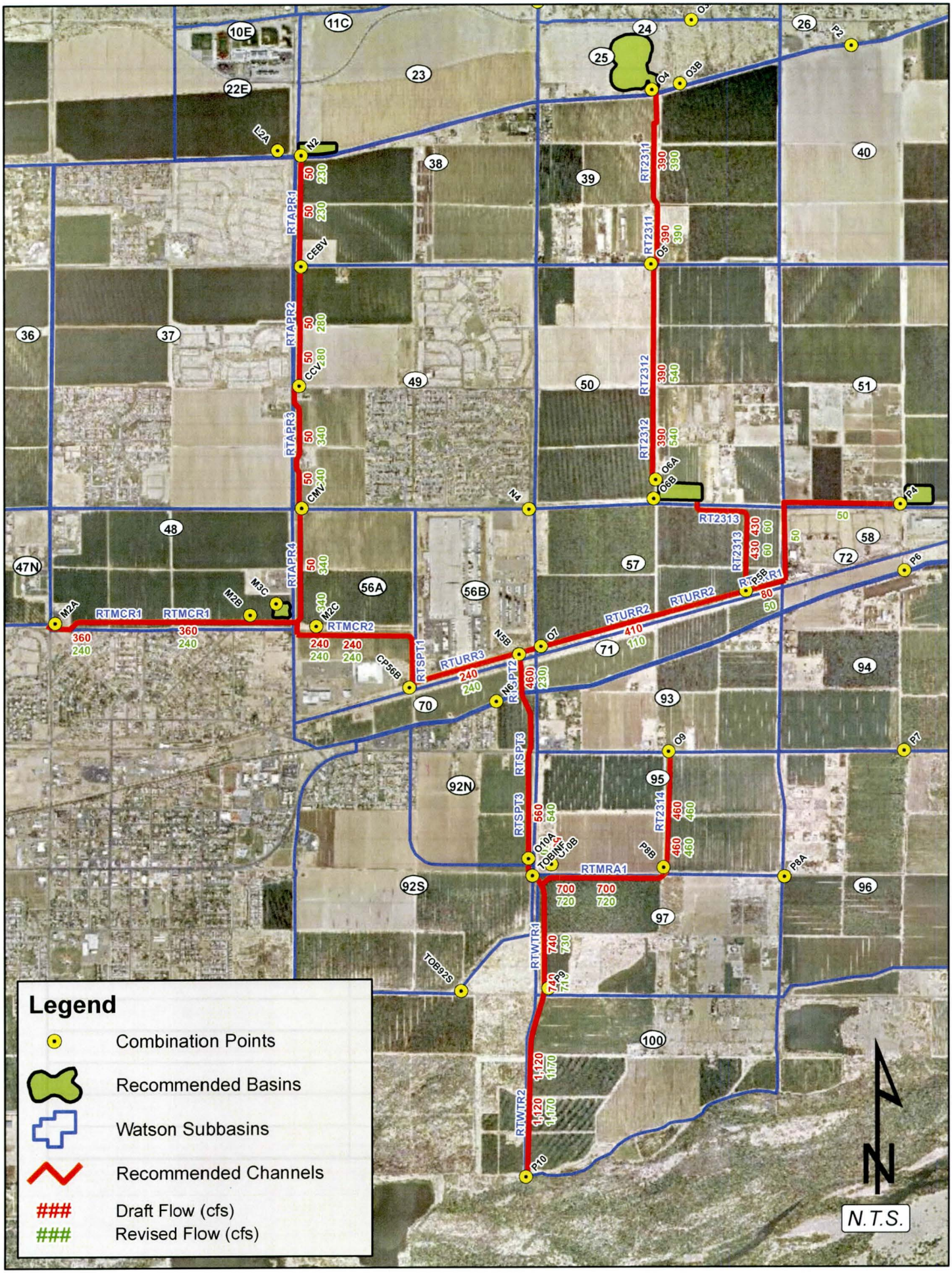
Watson Drainage System Pre-Design

FCD 2012C003

MEETING SIGN-IN SHEET

ANPP 96-inch WL Crossing Coordination Discussion 12/11/2013

CHECK IN	NAME	SECTION/FIRM	PHONE	EMAIL
	Gary Wesch	FCDMC	602.506.4592	garywesch@mail.maricopa.gov
	Gary Maiers	FCDMC	602.506.0562	gsm@mail.maricopa.gov
	Mohammad Afzai	APS	623.393.3003	mohammad.afzai@aps.com
MB	Mike Bouche	APS	602.371.7033	michael.bouche@aps.com
	Gary Gene	APS		gary.gene@aps.com
RCB	Rafael Balderrama	APS	602 423-9685	rafael.balderrama@aps.com
	Scott Zipprich	Town of Buckeye	623.349.6217	szipprich@buckeyeaz.gov
KWR	Kevin Roberts	Dibble	602.957.1155	kevin.roberts@dibblecorp.com
	Jerem Laipple	Dibble	602.957.1155	jeremy.laipple@dibblecorp.com
	Robert Erch	Buckeye	623-~~[illegible]~~ 349-6245	rerch@buckeyeaz.gov
DS	DAVE Schlief	APS	602-371-7295	DAVID.SCHLIEF@APS.com


Legend
Combination Points
Recommended Basins
Watson Subbasins
Recommended Channels
Draft Flow (cfs)
Revised Flow (cfs)
N.T.S.
N
RTAPR1
RTAPR2
RTAPR3
RTAPR4
RTMCR1
RTMCR2
RTSPT1
RTSPT2
RTSPT3
RTURR1
RTURR2
RTURR3
RTWTR1
RTWTR2
RTMRA1
RT2311
RT2312
RT2313
RT2314
CEBV
CCV
CMV
CP56B
TOB92S
TOBINF
L2A
N2
N4
N5B
N6
O3B
O4
O5
O6A
O6B
O7
O9
O10A
O10B
P2
P4
P5B
P6
P7
P8A
P8B
P10
M2A
M2B
M2C
M3C
10E
11C
22E
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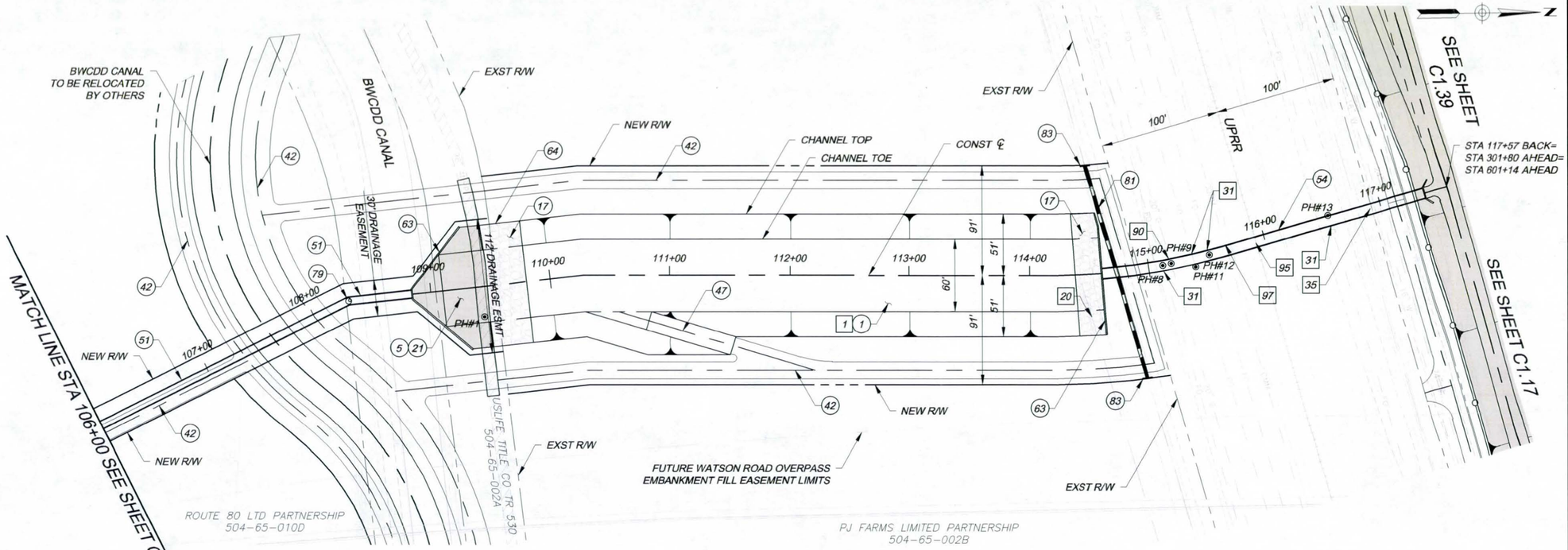
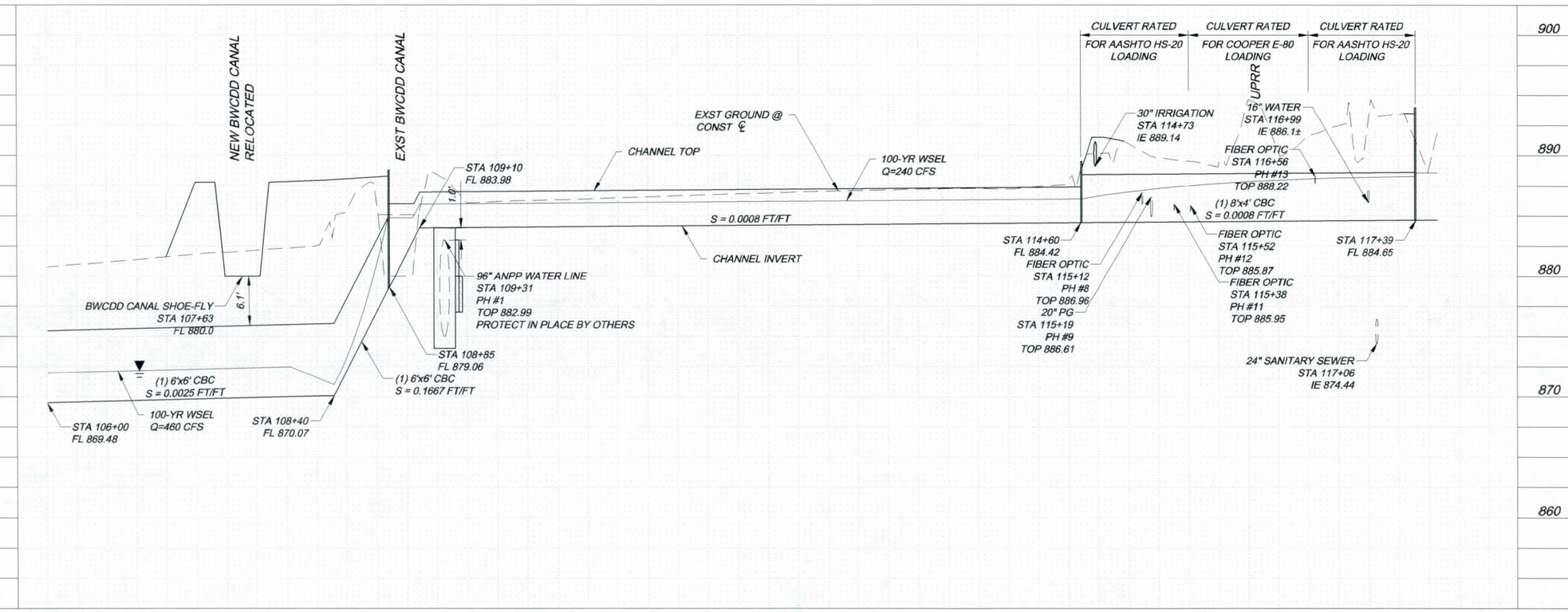


NOTE:
MEANDER CHANNEL BOTTOM VARY SIDE SLOPES FROM 4:1 TO 8:1



REMOVAL NOTES

1	CLEAR & GRUB
20	REMOVE CONCRETE DITCH
31	FIBER OPTIC LINE RELOCATION BY OTHERS
35	WATER MAIN RELOCATION (16")
90	KINDER-MORGAN 20" GAS PIPELINE CROSSING
95	RAILROAD CROSSING TEMPORARY REMOVAL & RELOCATION BY OTHERS
97	UPRR COMMUNICATION LINE RELOCATION BY OTHERS

CONSTRUCTION NOTES

1	CHANNEL EXCAVATION
5	CHANNEL SUBGRADE PREPARATION
17	DUMPED RIPRAP (D50=12")
21	REINFORCED CONCRETE CHANNEL LINING STR SEC 3, DWG G1.04
42	ABC MAINTENANCE ROAD STR SEC 2, DWG G1.04
47	ABC MAINTENANCE ROAD RAMP STR SEC 2, DWG G1.04
50	(2) 6' X 4' CONCRETE BOX CULVERT
51	(1) 6' X 6' CONCRETE BOX CULVERT
54	(1) 8' X 4' CONCRETE BOX CULVERT
63	CONCRETE BOX CULVERT WING WALLS ADOT STD DTL SD6.10, TYPE B
64	CONCRETE CUTOFF WALL MAG STD DTL 552
79	BOX CULVERT STORM DRAIN MANHOLE
81	30" IRRIGATION PIPE
83	IRRIGATION HEADWALL MAG STD DTL 501-1

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

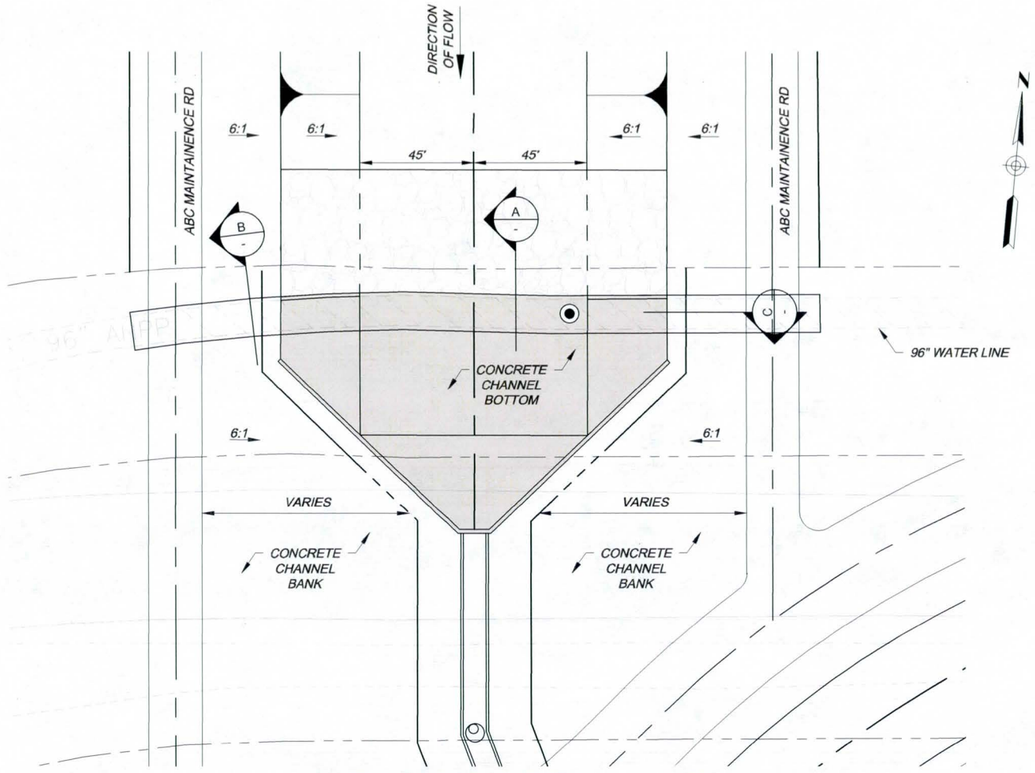
WATSON DRAINAGE SYSTEM
PRE-DESIGN
FCD NO. 2012-C003

PRELIMINARY SUBMITTAL
15%
NOT FOR CONSTRUCTION OR RECORDING

	BY	DATE
DESIGNED	J. Laipple	11/13
DRAWN	Staff	11/13
CHECKED	K. Roberts	11/13

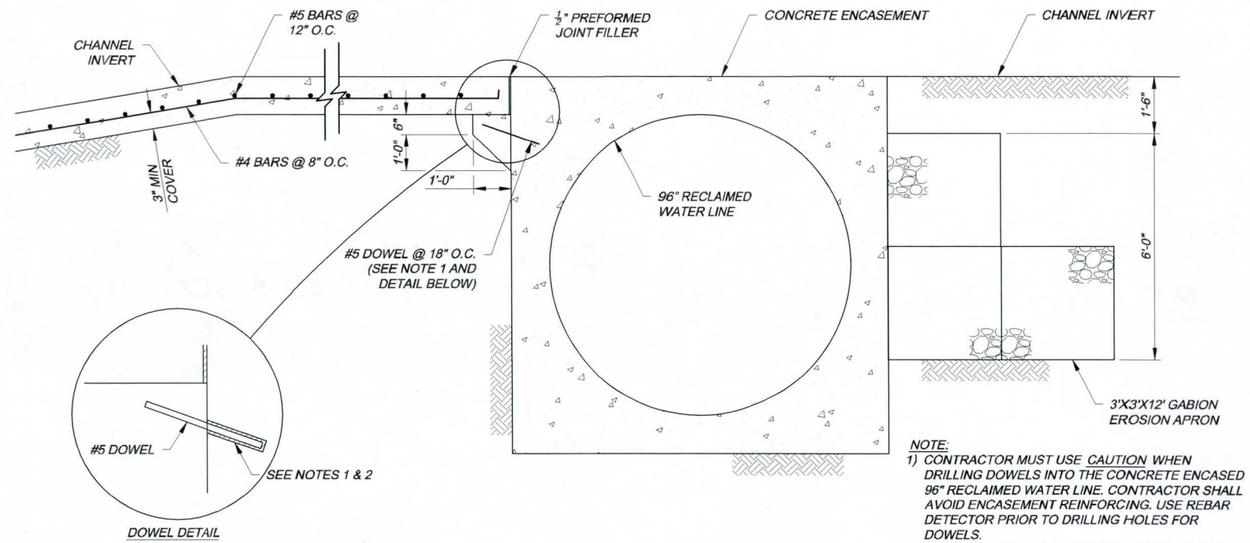
Dibble Engineering
7500 N. Dreamy Draw Drive
Suite 200
Phoenix, AZ 85020
P 602.957.1155

DRAWING NO. C1.10
PLAN AND PROFILE
SHEET 15 OF 80



JUNCTION OF CONCRETE BANK LINING TO GABION MATTRESS BANK LINING

(10) SCALE 1"=20'

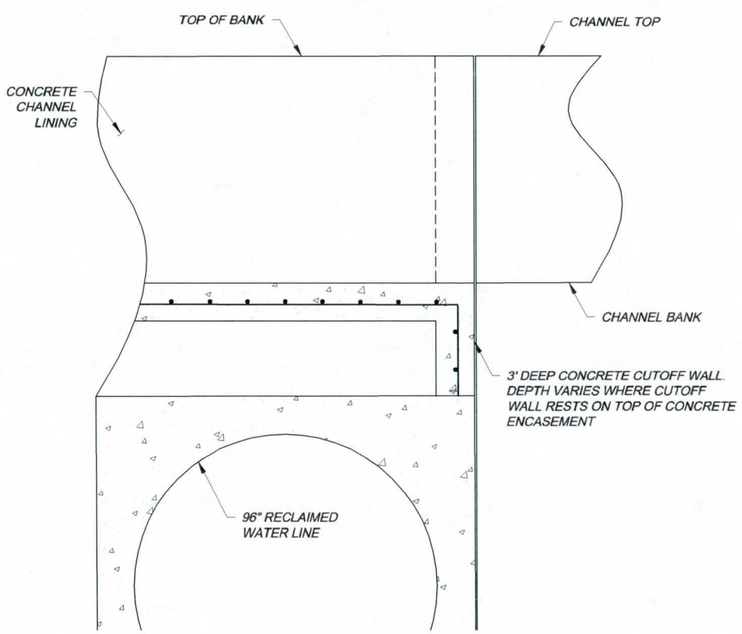


NOTE:

1) CONTRACTOR MUST USE CAUTION WHEN DRILLING DOWELS INTO THE CONCRETE ENCASED 96" RECLAIMED WATER LINE. CONTRACTOR SHALL AVOID ENCASEMENT REINFORCING. USE REBAR DETECTOR PRIOR TO DRILLING HOLES FOR DOWELS.
2) DRILL 1" Ø HOLE, 8" DEEP FOR #5 DOWEL. EPOXY DOWEL IN HOLE WITH APPROVED EPOXY ADHESIVE.
3) PLACE 2 LAYERS OF 40 LB ROOFING FELT.

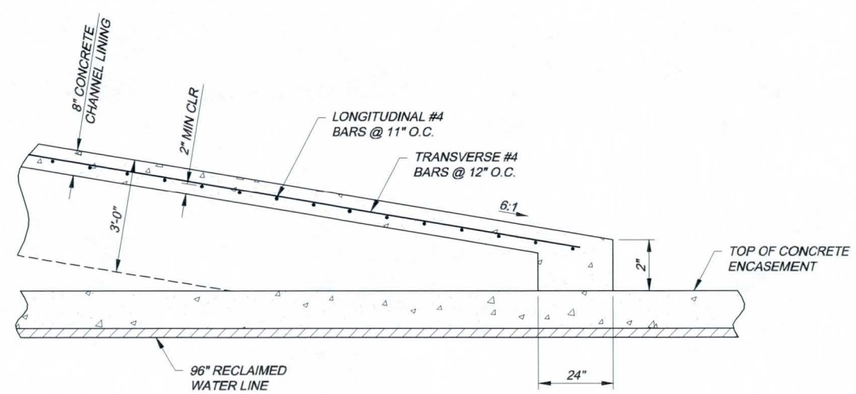
GABION EROSION APRON

(A) SCALE 1"=2'



CUTOFF WALL

(B) SCALE 1"=2'



CONCRETE BANK LINING OVER 96" ENCASEMENT

(C) NOT TO SCALE

NO.	REVISION	BY	DATE
3			
2			
1			

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY
ENGINEERING DIVISION

WATSON DRAINAGE SYSTEM
PRE-DESIGN
FCD NO. 2012-C003

PRELIMINARY SUBMITTAL
15%
NOT FOR CONSTRUCTION OR RECORDING

	BY	DATE
DESIGNED	J. Laipple	11/13
DRAWN	Staff	11/13
CHECKED	K. Roberts	11/13

Dibble Engineering
7500 N. Dreamy Draw Drive
Suite 200
Phoenix, AZ 85020
P 602.957.1155

DRAWING NO. XS1.04

TYPICAL CROSS SECTIONS

SHEET 72 OF 80

01206 \Trainag \CAD\ December 2013

Evergreen Discussion (Oct. 30, 2012)

Meeting Minutes

Project: Watson Drainage System Pre-Design
Date: October 30, 2012
Re: Watson Pre-Design / Evergreen
Contract: FCD 2012C003
Dibble Project: 101206

ATTENDEES:
Jeff Garrett (Garrett Development Corp)
Heather Personne (Evergreen Devco)
Gary Wesch (FCDMC)
Rob Sachs (FCDMC)
Kevin Roberts (Dibble)

PURPOSE OF MEEETING:
The purpose of this discussion was to discuss the potential impacts of the proposed Watson drainage system on the Evergreen development properties in the area, as well as the Watson Community Facilities District (CFD).

DISCUSSION:

- 18 Developers came together to form the Watson Road CFD and installed $30M in water infrastructure and sewer infrastructure. Each property within the CFD is encumbered by $24K in bond obligations. Every property within the CFD has a "final plat" with the Town. $49M in bonds were issued relying on these final plats. Seven of the properties in the CFD are Evergreen properties.

- An intergovernmental agreement (IGA) between FCDMC and the Town of Buckeye will follow the pre-design project. If FCDMC is the "lead" on the final design portions of the Watson project, then they will also take the lead on ROW acquisition.

- Evergreen Devco will meet with the Town to discuss implementation of the system. Woody Scoutten is the Engineer of Record for the CFD. Scott Ruby was the attorney.

- Plats for properties in the CFD are "approved", but not recorded. The clock is not yet ticking on the infrastructure implementation.

- Assessment obligations for the CFD properties may affect the alternatives for the Watson project.
    - Assessments are not broken out on a per lot basis, because plats are not yet recorded. Therefore, any take of property with an assessment obligation may come with the entire assessment for that property.

- Evergreen will provide G&D plans for the platted developments. Garrett will provide CFD information and water agreements.

BWCDD Discussion (Oct. 31, 2012)

Meeting Minutes

Project: Watson Drainage System Pre-Design
Date: October 31, 2012
Re: Watson Pre-Design / BWCDD
Contract: FCD 2012C003
Dibble Project: 101206

ATTENDEES:
Ed Gerak (BWCDD)
Melody Zyburt (Stantec)
Gary Wesch (FCDMC)
Gary Maiers (FCDMC)
Kevin Roberts (Dibble)

PURPOSE OF MEEETING:
The purpose of this discussion was to fully understand the functionality of the BWCDD irrigation system and the BWCDD requirements relocations or crossings required by the proposed Watson Drainage System.

DISCUSSION:

- The BWCDD main canal is designed to convey 400 cfs The maximum delivery rate now is approximately 300 cfs. The canal operates normally with approximate 1-1.5-feet of freeboard.
- There is no existing record or documentation of the profile of the canal. The last survey was performed in 1911. But, generally, the canal is typically 6'-8' deep from the normal operating water surface.
- Required improvement to the canal will include:
  - 4-inches of fiber mesh-reinforced concrete lining
  - Sideslopes could be vertical, if necessary, for 2:1 (H:V) is preferred. 1:1 could also be used.
  - 6" of reinforced concrete lining will be required at FCDMC crossing locations.
- Multi-use amenities along the canal is a concern. Liability is an issue. Who will be responsible for maintenance? The Town of Buckeye is currently developing a pilot project for a multi-use trail along the canal between Miller Road and Apache Road. The Town is assuming all liability for this reach.
- The canal cannot be siphoned. This is a big maintenance issue, particularly with respect to sediment deposition in the siphon.
- Proposed drainage facilities crossing the BWCDD canal will need to go UNDER the canal. Reconstruction of the canal (with 6" reinforced concrete lining) will be required for some distance upstream and downstream of the crossing location.
- The recent Loop 303 project required additional ROW for a canal shoofly, which was then conveyed to BWCDD.
- BWCDD prefers the location of the Watson system crossing to be approximately ½ mile east of Apache Road.
- Delivery laterals for the BWCDD system can be put into a pipe as long as the pipe is located on the "field side"

of the drainage channel to avoid siphon delivery to the fields.

- If a lateral needs to be relocated horizontally, then need to acquire easement. Current laterals may or may not be located within existing easements, but at minimum they have prescriptive rights to be where they are.

- Laterals proposed to be relocated into a pipe will require 30-inch diameter pipes, and will require a 24-foot wide easement.

- Existing Watson Drain:
    - BWCDD has existing easement
    - It is acceptable to BWCDD to have a joint-use facility
    - The Watson Drain will require a concrete lined low flow channel
    - Maintenance is currently performed from the maintenance road
    - If the Watson Drain is modified and incorporated into the Watson Drainage System, BWCDD would be looking to the town to take over maintenance of this reach.
    - The existing pipe culvert outlet to the Gila River restricts the flow to approximately 30 cfs. Combined flows from tail water and pumped dewatering is approximately 10-12 cfs.

- BWCDD has an agreement with the Town allowing BWCDD to capture tail water and pumped dewatering flow, and then pump it north for reuse in their system. These current "base flows" in the Watson Drain cannot be counted on to always be there in the future.

- BWCDD will require reimbursement for Ed's time. An agreement needs to be formalized with FCDMC for this reimbursement.

RID Discussion (October 31, 2012)

Meeting Minutes

Project: Watson Drainage System Pre-Design
Date: October 31, 2012
Re: Watson Pre-Design / RID
Contract: FCD 2012C003
Dibble Project: 101206

ATTENDEES:
Melody Zyburt (Stantec)
Gary Wesch (FCDMC)
Kevin Roberts (Dibble)

PURPOSE OF MEEETING:
The purpose of this discussion was to fully understand the functionality of the RID irrigation system and the RID requirements relocations or crossings required by the proposed Watson Drainage System.

DISCUSSION:

- The RID main canal has approximately a 6-foot bottom width with 2:1 (H:V) side slopes. The existing canal is concrete lined. It is located within a ROW corridor 80-feet to 100-feet wide, which is centered on the canal. There is an existing well facility located on Apache Road, approximately ½ mile north of Southern Avenue. The system includes a series of "partnership ditches", which are ditch facilities shared between the RID and the farmers.
- The canal cannot be siphoned. Proposed crossings of the canal will be required to go UNDER the canal.
- The location of the proposed "Apache Basin" conflicts with the Youngker pump facility. This basin design needs to be coordinated with the developers of the Monte Verde development.
- RID may be open to a multi-use trail system along the canal, but liability would need to be mitigated/transferred. This idea would need to be presented to the RID board.
- RID system laterals: laterals must be located on the "field side" of the drainage channel.
- RID currently holds "blanket easements" covering the entire parcels where delivery laterals are located. Laterals will require a minimum 24-foot wide easement. The remainder of the "blanket easements" may possibly be retired.
- May be able to replace existing well facilities, if necessary. If the Watson system proposed improvements impacts the "Napolitano Well", then the well site perimeter must be brought up to the standard dimension of 100-ft x100-ft.
- Flume crossings of the RID canal is possible if deliveries are required to both sides of the Watson drainage channel.
- RID is open to the drainage ditch west and south of the Wal-Mart facility being used as a shared, joint-use facility.

- The RID main canal carries approximately 360 cfs, and has approximately 12-inches of freeboard. 18-inches of freeboard is required at bridges and crossings.
- Box culverts crossing under the RID canal may require a "spreader basin" on the downstream side.
- Portions of the canal requiring reconstruction due to the Watson system will need to be lined with 4-inches of fiber mesh-reinforced concrete. 6-inch of fiber mesh-reinforced concrete may be required where the Watson drainage system crosses the main canal.
- RID has a restricted landscape plan.
- The proposed Globe Industrial Park will probably be looking for a railroad spur to their property. The globe property must maintain a delivery ditch corridor through the property.
- The RID system is manually operated. Zanjeros must have access to the canal and its appurtenances (gates, etc...)
- Bollards/fences/gates will be required at the Watson system crossing locations to restrict access to the RID canal.
- Well sites: minor electrical improvements to bring a site up to standard can cost $250K. If a well site needs to be reconfigured in any way, then the well site must be brought up to standards, including the perimeter ditch.
- If RID delivery laterals must be relocated as an open ditch, then a 24-foot maintenance road will be required on each side of the delivery ditch. If the delivery laterals are relocated into a pipe, then a single maintenance road above the pipe will suffice.
- The system experiences a 2-week dry up period each November.
- The RID system is supplied by the 23rd Avenue treatment plant and the Granite Reef Dam. The water flowing in the system is Class 'A' water.

APS Discussion (Nov. 6, 2012)

Meeting Minutes

Project: Watson Drainage System Pre-Design
Date: November 11, 2012
Re: Watson Pre-Design / APS Coordination
Contract: FCD 2012C003
Dibble Project: 101206

ATTENDEES:
Randy Butler (APS)
Mike Bouche (APS)
Dave Schlief (APS)
Gary Wesch (FCDMC)
Gary Maiers (FCDMC)
Kevin Roberts (Dibble)

PURPOSE OF MEEETING:
The purpose of this discussion was to fully understand the ANPP 96" waterline and the APS requirements to cross it with the proposed Watson Dainage System.

DISCUSSION:

- The internal diameter of the ANPP line is 96". It is made of PCCP, bell and spigot pipe, comprised of several "layers". They are:
  - A steel "can" lined with 2" of concrete mortar. The can is surrounded by:
  - 8"-12" of concrete, surrounded by:
  - High tension spiral reinforcing wires, surrounded by:
  - 1" of concrete mortar

- The ANPP line is designed for HS-20 loading.

- To cross UNDER the line, will need to jack and bore. This will require a steel casing first, and then the pipe to go through the casing. To date, the maximum size pip that has gone under the ANPP line is 36". Four feet of vertical separation will be required between the bottom of the ANPP line and the top of the steel casing. Jack and bore pits must be located outside of the ANPP ROW, which occupies 25-feet on either side of the pipe.

- The ANPP line is taken out of service twice annually for a duration of 2 weeks- once in April and once in October.

- The ANPP line will most likely be full of water during construction of the crossing. It is only dewatered once every 3 years for inspection.

- The ANPP pipeline is comprised of approximately 8,500 "spools" 24-feet in length.

- To go OVER the line, 12" of vertical clearance is required between the bottom of the drainage facility and the top of the ANPP line.

- The failure mechanism for the ANPP line seems to be as outlined below:
  - Mortar develops cracks
  - Moisture infiltrates

- High tension steel wire wrapping corrodes
- Cracks develop on the interior of the pipe at the spring line
- Moisture infiltrates to the inside of the pipe
- Interior steel can corrodes

- The ANPP line has experience 3 ruptures in history. APS has performed inspections on the pipe, and when a spool appears to be deteriorating, then reinforcement has been installed. The reinforcement used is post-tension cable encased in shotcrete. This reinforcement adds approximately 3" to the outer diameter of the ANPP line.

- All spools impacted by the proposed crossing will require this reinforcement. APS will do the work, to be reimbursed by the project.

- As an example, for the recent Cotton Lane project, 4 or 5 spools were impacted, requiring reinforcement. The cost of this reinforcement was approximately $750K.

- There is no anticipated easement fee.

- Reinforcement of the ANPP line will not be required if the Watson system crosses UNDER the line.

- Directional boring may be allowed as a method to construct the crossing, but we would need to convince APS that there is a compelling reason to use this method, AND that it is safe for the ANPP line.

- The proposed design needs to be presented to APS's consultant (SG&H) for review.

- A Temporary Construction Easement will need to be acquired in order to construct the crossing.

- The proposed crossing MUST avoid the sacrificial anode beds, which are fairly obvious in the field, as they are fence-enclosed manhole access points.

Walton Discussion (Nov. 15, 2012)

Meeting Minutes

Project: Watson Drainage System Pre-Design
Date: November 15, 2012
Re: Watson Pre-Design / Walton
Contract: FCD 2012C003
Dibble Project: 101206

ATTENDEES:
Barbara Rust (CVL)
Heidi Tilson (CVL)
Andrew Gasparro (Walton)
Gary Wesch (FCDMC)
Kevin Roberts (Dibble)

PURPOSE OF MEEETING:
The purpose of this discussion was to discuss the potential impacts of the proposed Watson drainage system on the Walton development properties in the area, as well as the Watson Community Facilities District (CFD).

DISCUSSION:

- Walton owns/controls several properties along the Apache Road corridor. Most are in the "final plat" stage (not yet recorded).
- The plats for these properties may have expired, but according to Walton, the Town has committed to "honoring" the plats, as long as they are "updated".
- The Monte Verde development is the exception:
  - This development was a Shea Homes development
  - Now, ownership is split into 2 ownership groups
  - Was rezoned in 2010, and it is about to be rezoned again
- A possibility for the Monte Verde development would be for storage and compensatory storage to be used to modify the size/volume of the proposed Apache Basin.
- Walton also owns the parcel east of Apache, north of Lower Buckeye Road. This parcel is zoned for mixed-use, possibly multi-family housing.
- CVL to provide PDFs and shapefiles for the Walton properties.

CFD Discussion (Dec. 11, 2012)

Meeting Minutes

Project: Watson Drainage System Pre-Design
Date: December 11, 2012
Re: Watson Pre-Design / Watson CFD
Contract: FCD 2012C003
Dibble Project: 101206

ATTENDEES:
Scott Zipprich (Town of Buckeye)
Woody Scoutten (WC Scoutten)
Scott Ruby (Gust Rosenfeld)
Jeff Garrett (Garrett Development Corp)
Heather Personne (Evergreen Devco)
Gary Wesch (FCDMC)
Kevin Roberts (Dibble)

PURPOSE OF MEEETING:
The purpose of this discussion was to discuss the potential impacts of the proposed Watson drainage system on the member properties of the Watson Community Facilities District (CFD).

DISCUSSION:

- CFD was formed in 2005.
- All assessments thus far for the CFD have been by acreage.
- As soon as plats are recorded, then the assessment maps and the assessments will be modified to reflect as much.
- The Buckeye ADMP, which the Town participated in, commenced in 2006 and was completed in 2009.
- The ADMP recommended projects were submitted by the Town for prioritization in the FCDMC system in December of 2010.
- Discussion was held regarding the possibility of replacing the open channels with a pipe. This is likely possible for certain reaches of the system, but generally, the flows are too large to make an complete underground system financially feasible.
- Discussion was held regarding the potential for CFD properties to contribute their on-site runoff flows directly to the Watson system. This will be up to the Town to decide what to allow, but the Watson system could accommodate some of these flows.
- Assessments for the CFD are based on benefit derived (from the water and sewer infrastructure).
- There is a 25-year bond, which was issued on December 29, 2005. This bond is not "callable" for 10 years (2015). The total bond issue was $49M.
- Scott Ruby will provide assessment/bond terms/CFD financial data to FCDMC

- Wingate East: Already accommodates the proposed Watson drainage system. May be able to avoid impacts on this parcel all together.

- There is some question regarding whether submitted plats for these CFD properties are still valid. The Town will investigate whether there is an expiration date for the plats.

- Scott Ruby reported that the assessments were done based on acreage because the Town did NOT want to guarantee density of developments.

- Wingate East is only assessed for sewer capacity, NOT sewer infrastructure.

- Wingate East plans were submitted for initial reviews, but Woody Scoutten does not believe redline comments were addressed or that the 2nd submittal was made.

- Existing plats accommodate "pass through" of the 100-yr, 6/24-hr flows.

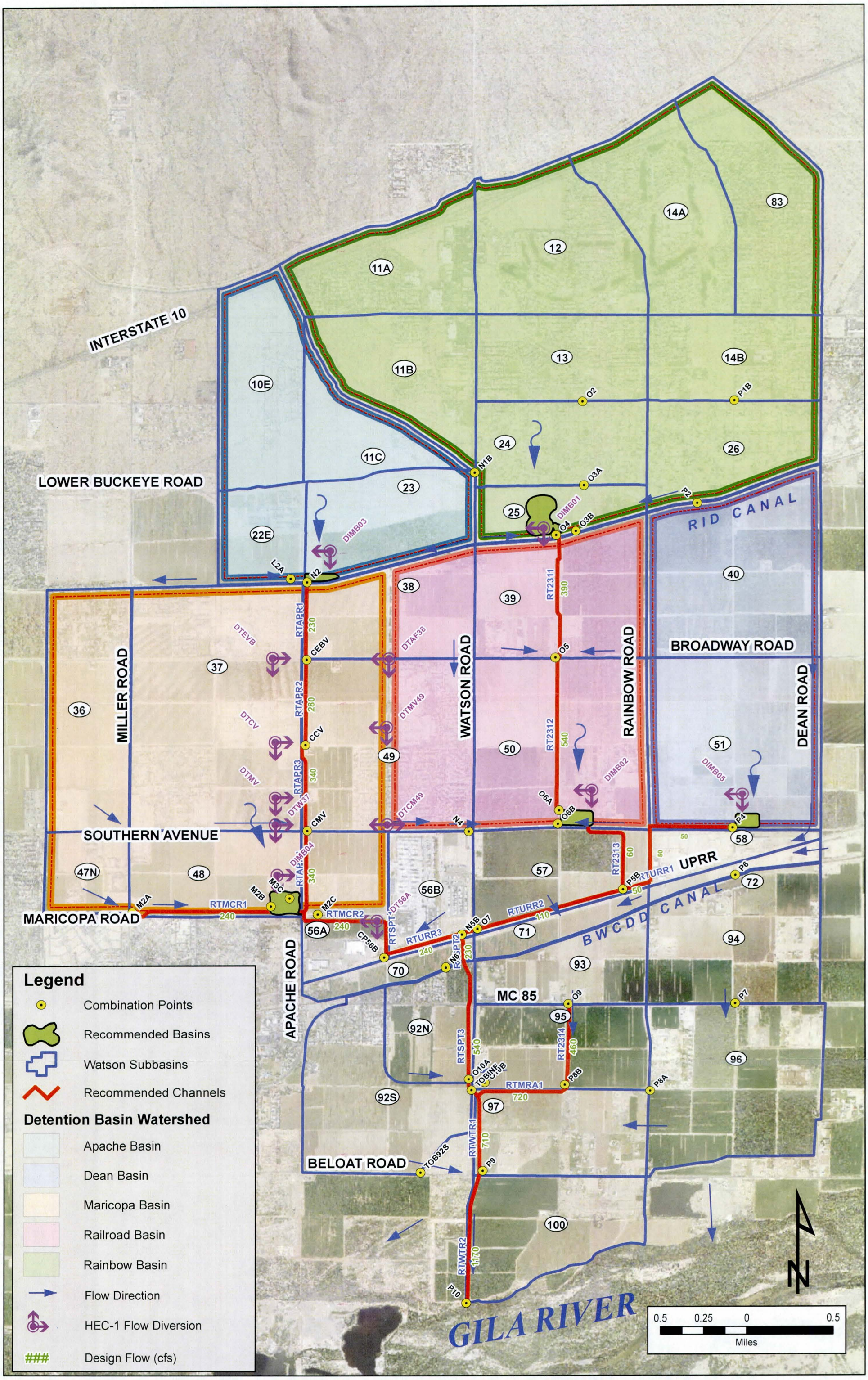
- Per Woody Scoutten, the Town does not want, for example, an 80-acre development with ALL of their required open space located along the perimeter of the development. Thus, the Town needs to develop some governing criteria for giving open space credits to developments for the Watson Drainage System channels, that may run adjacent to said developments, and require land dedications.

- As long as the integrity of the drainage system is maintained, and there are no adverse impacts to the downstream properties, then the Town can "horse trade" with the proposed developments regarding open space, on-site runoff direct contributions, etc...

- The proposed Maricopa Basin has significant impacts on the Watson CFD assessments, because it is proposed to occupy a significant portion of a CFD member property. This basin may need to be split between the east and west sides of Apache Road, or relocated entirely to the west side of the road.

Appendix C

Recommended Plan Hydrology


INTERSTATE 10
LOWER BUCKEYE ROAD
MILLER ROAD
SOUTHERN AVENUE
MARICOPA ROAD
APACHE ROAD
WATSON ROAD
RAINBOW ROAD
BROADWAY ROAD
DEAN ROAD
BELOAT ROAD
MC 85
UPRR
RID CANAL
BWCDD CANAL
GILA RIVER
Legend
Combination Points
Recommended Basins
Watson Subbasins
Recommended Channels
Detention Basin Watershed
Apache Basin
Dean Basin
Maricopa Basin
Railroad Basin
Rainbow Basin
Flow Direction
HEC-1 Flow Diversion
Design Flow (cfs)
0.5 0.25 0 0.5
Miles
N

Channel Design Flow Summary

HEC-1 Route ID	HEC-1 ID	Design Flow
RT2311	O5	390
RT2312	O6A	540
RT2313	MB02	60
RT2314	O9	460
RTAPR1	CEBV	230
RTAPR2	CCV	280
RTAPR3	CMV	340
RTAPR4	CMV	340
RTMCR1	M2B	240
RTMCR2	M2C	240
RTMRA1	P8B	720
RTSPT1	M2C	240
RTSPT2	N5B	230
RTSPT3	O10A	540
RTURR1	MB05	50
RTURR2	O7	110
RTURR3	M2C	240
RTWTR1	TOBINF	730
RTWTR2	P9	1170

ID	Method	Duration	2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
DEFAULT	NOAA14	5 MIN	0.261	0.356	0.428	0.523	0.595	0.668
	NOAA14	10 MIN	0.397	0.542	0.651	0.795	0.905	1.016
	NOAA14	15 MIN	0.492	0.672	0.807	0.986	1.122	1.260
	NOAA14	30 MIN	0.663	0.905	1.087	1.328	1.511	1.696
	NOAA14	1 HOUR	0.820	1.120	1.345	1.643	1.870	2.099
	NOAA14	2 HOUR	0.914	1.232	1.475	1.807	2.061	2.327
	NOAA14	3 HOUR	0.957	1.272	1.519	1.869	2.148	2.442
	NOAA14	6 HOUR	1.098	1.425	1.687	2.048	2.335	2.636
	NOAA14	12 HOUR	1.200	1.543	1.813	2.181	2.466	2.764
	NOAA14	24 HOUR	1.506	1.957	2.312	2.807	3.195	3.605

FCDMC
Drainage Design Management System
SUB BASINS
Project Reference: WATSON PD 24H RECPLN

Area ID	Sub Basin Parameters								Rainfall Losses				
	Area (sq mi)	Length (mi)	Slope (ft/mi)	S-Graph	Lca (mi)	Lag (min)	Velocity (f/s)	Kn	IA (in)	DTHETA	PSIF (in)	XKSAT (in/hr)	RTIMP (%)
Major Basin ID: 01													
10E	0.592	1.41	56.9	VALLEY	0.72	31.60	3.92	0.047	0.24	0.25	4.10	0.556	35
36	0.684	1.85	36.6	VALLEY	0.93	42.90	3.80	0.048	0.25	0.25	3.95	0.576	28
22E	0.286	0.70	39.8	VALLEY	0.42	22.50	2.75	0.050	0.25	0.25	3.95	0.572	30
93	0.377	1.21	17.4	VALLEY	0.60	25.20	4.23	0.034	0.17	0.25	4.90	0.379	57
37	1.421	2.36	30.1	VALLEY	1.18	52.30	3.97	0.047	0.24	0.25	4.10	0.554	34
94	0.719	1.30	22.4	VALLEY	0.65	35.20	3.25	0.047	0.24	0.15	7.30	0.134	35
38	0.542	1.40	20.7	VALLEY	0.70	40.20	3.07	0.050	0.25	0.25	3.95	0.573	30
95	0.522	1.66	7.8	VALLEY	0.83	47.30	3.09	0.043	0.21	0.15	8.00	0.104	42
11A	0.571	0.57	84.0	VALLEY	0.33	13.80	3.63	0.042	0.22	0.25	5.60	0.267	41
39	0.725	1.63	25.2	VALLEY	0.82	43.50	3.29	0.050	0.25	0.25	4.30	0.487	30
96	0.914	1.32	4.5	VALLEY	0.66	51.30	2.26	0.050	0.29	0.15	7.30	0.135	18
11B	0.581	1.39	41.8	VALLEY	0.62	33.50	3.65	0.050	0.25	0.25	4.30	0.487	30
40	0.976	1.83	31.3	VALLEY	0.91	45.40	3.54	0.050	0.25	0.25	4.20	0.514	30
97	0.500	1.32	6.1	VALLEY	0.66	48.50	2.40	0.050	0.28	0.17	6.80	0.158	22
11C	0.343	0.99	54.3	VALLEY	0.31	21.50	4.05	0.050	0.25	0.25	3.95	0.569	30
12	0.736	0.96	83.0	VALLEY	0.41	18.30	4.61	0.042	0.21	0.25	4.65	0.407	41
13	0.501	0.52	71.2	VALLEY	0.26	13.50	3.40	0.045	0.24	0.25	5.10	0.323	34
48	0.500	1.10	16.5	VALLEY	0.55	34.20	2.83	0.049	0.24	0.25	4.35	0.480	32
100	0.582	1.70	18.8	VALLEY	0.85	47.40	3.15	0.050	0.29	0.23	6.20	0.196	18
14A	0.692	1.33	67.9	VALLEY	0.71	31.60	3.70	0.050	0.26	0.25	4.35	0.467	27
49	1.009	1.96	23.5	VALLEY	0.98	50.60	3.41	0.050	0.25	0.25	3.95	0.576	30

* Non default value

Area ID	Sub Basin Parameters								Rainfall Losses				
	Area (sq mi)	Length (mi)	Slope (ft/mi)	S-Graph	Lca (mi)	Lag (min)	Velocity (f/s)	Kn	IA (in)	DTHETA	PSIF (in)	XKSAT (in/hr)	RTIMP (%)
Major Basin ID: 01													
14B	0.502	0.59	54.1	VALLEY	0.30	17.50	2.97	0.050	0.26	0.25	4.15	0.527	27
50	1.002	1.98	26.7	VALLEY	0.99	49.80	3.50	0.050	0.25	0.25	4.20	0.521	30
51	1.004	1.96	23.0	VALLEY	0.98	50.90	3.39	0.050	0.25	0.25	4.40	0.458	30
56A	0.411	1.19	30.3	VALLEY	0.59	13.20	7.95	0.020	0.15	0.25	3.95	0.619	55
47N	0.233	0.93	21.6	VALLEY	0.69	33.90	2.41	0.050	0.25	0.25	3.95	0.576	30
56B	0.334	0.73	43.7	VALLEY	0.37	8.50	7.52	0.020	0.15	0.25	4.00	0.610	55
57	0.489	0.68	19.1	VALLEY	0.34	9.40	6.35	0.020	0.15	0.25	4.25	0.551	55
23	0.524	1.32	15.9	VALLEY	0.66	40.40	2.88	0.050	0.25	0.25	3.95	0.572	30
58	0.190	0.50	16.0	VALLEY	0.25	7.70	5.70	0.020	0.15	0.25	4.30	0.526	55
24	0.489	0.53	56.2	VALLEY	0.27	16.00	2.92	0.050	0.29	0.25	4.60	0.405	18
25	0.274	1.05	10.5	VALLEY	0.52	36.60	2.52	0.050	0.29	0.25	4.15	0.531	18
26	0.524	0.76	39.3	VALLEY	0.38	22.40	2.99	0.050	0.29	0.25	4.00	0.557	18
92N	0.327	0.86	32.6	VALLEY	0.54	17.20	4.40	0.031	0.16	0.15	8.40	0.100	68
83	0.675	1.72	64.7	VALLEY	0.93	39.00	3.88	0.050	0.25	0.25	5.40	0.263	28
92S	0.687	1.31	26.0	VALLEY	0.70	27.70	4.15	0.037	0.19	0.15	8.80	0.082	56
70	0.141	0.68	1.5	VALLEY	0.34	15.30	3.92	0.020	0.15	0.25	4.45	0.487	55
71	0.155	0.34	14.4	VALLEY	0.17	5.90	5.09	0.020	0.15	0.25	4.80	0.390	55
72	0.086	0.13	7.7	VALLEY	0.06	3.10	3.70	0.020	0.15	0.25	4.45	0.476	55

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Basin          12
Divert          .-------> 12RET
Hydrograph     12-O
Route          O1-O2
Basin           .     13
Divert          .     .-------> 13RET
Hydrograph      .    13-O
Combine         O2............
Route          O2-O3A
Basin           .     24
Divert          .     .-------> 24RET
Hydrograph      .    24-O
Combine         O3A...........
Route          O3AO3B
Basin           .     25
Divert          .     .-------> 25RET
Hydrograph      .    25-O
Combine         O3B...........
Basin           .    14A
Divert          .     .-------> 14ARET
Hydrograph      .   14A-O
Route           .   P1AP1B
Basin           .     .     83
Divert          .     .     .-------> 83RET
Hydrograph      .     .    83-O
Basin           .     .     .    14B
Divert          .     .     .     .-------> 14BRET
Hydrograph      .     .     .   14B-O
Combine         .   P1B.......................
Route           .   P1B-P2
Basin           .     .     26
Divert          .     .     .-------> 26RET
Hydrograph      .     .    26-O
Combine         .   P2............
Route           .   P2-O4
Basin           .     .    11A
Divert          .     .     .-------> 11ARET
Hydrograph      .     .   11A-O
Route           .     .   N1A-1B
Basin           .     .     .    11B
Divert          .     .     .     .-------> 11BRET
Hydrograph      .     .     .   11B-O
Combine         .     .    N1B............
Route           .     .    N1BO4
Combine         O4........................
Divert          .-------> DIMB01
Hydrograph     MB01
Route          RT2311
Basin           .     39
Divert          .     .-------> 39RET
Hydrograph      .    39-O
Combine         O5............
Route          RT2312
Basin           .     50
Divert          .     .-------> 50RET
Hydrograph      .    50-O
Combine         O6A...........
Basin           .     38
Divert          .     .-------> 38RET
Hydrograph      .    38-O
Divert          .     .-------> DTAF38
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Hydrograph      .   DVAF38
Route           .   N3-N4
Basin           .   .   49
Divert          .   .   .-------> 49RET
Hydrograph      .   .   49-O
Divert          .   .   .-------> DTCM49
Hydrograph      .   .   DVCM49
Divert          .   .   .-------> DTMV49
Hydrograph      .   .   DVMV49
Combine         .   N4..........
Route           .   N4-O6
Combine         O6B..........
Divert          .-------> DIMB02
Hydrograph      MB02
Route           RT2313
Basin           .   40
Divert          .   .-------> 40RET
Hydrograph      .   40-O
Route           .   P3-P4
Basin           .   .   51
Divert          .   .   .-------> 51RET
Hydrograph      .   .   51-O
Combine         .   P4..........
Divert          .   .-------> DIMB05
Hydrograph      .   MB05
Route           .   RTURR1
Combine         P5B..........
Route           RTURR2
Basin           .   57
Divert          .   .-------> 57RET
Hydrograph      .   57-O
Combine         O7..........
Basin           .   10E
Divert          .   .-------> 10ERET
Hydrograph      .   10E-O
Route           .   L1AL2A
Basin           .   .   22E
Divert          .   .   .-------> 22ERET
Hydrograph      .   .   22E-O
Combine         .   L2A..........
Basin           .   .   11C
Divert          .   .   .-------> 11CRET
Hydrograph      .   .   11C-O
Route           .   .   N1C-N2
Basin           .   .   .   23
Divert          .   .   .   .-------> 23RET
Hydrograph      .   .   .   23-O
Combine         .   N2..........
Divert          .   .-------> DIMB03
Hydrograph      .   MB03
Route           .   RTAPR1
Basin           .   .   37
Divert          .   .   .-------> 37RET
Hydrograph      .   .   37-O
Divert          .   .   .-------> DTEVB
Hydrograph      .   .   DVEVB
Divert          .   .   .-------> DTCV
Hydrograph      .   .   DVCV
Divert          .   .   .-------> DTMV
Hydrograph      .   .   DVMV
Divert          .   .   .-------> DTW37
Hydrograph      .   .   DVW37
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Retrieve          .   .   .   .<-------  DTEVB
Hydrograph        .   .   .   DVEVB
Retrieve          .   .   .   .   .<-------  DTAF38
Hydrograph        .   .   .   .   DVAF38
Route             .   V
Basin             .   RTAPR2
Retrieve          .   .   .<-------  DTCV
Hydrograph        .   .   DVCV
Retrieve          .   .   .   .<-------  DTMV49
Hydrograph        .   .   .   DVMV49
Route             .   V
Basin             .   RTAPR3
Retrieve          .   .   .<-------  DTMV
Hydrograph        .   .   DVMV
Retrieve          .   .   .   .<-------  DTCM49
Hydrograph        .   .   .   DVCM49
Route             .   V
Basin             .   RTAPR4
Basin             .   .   36
Divert            .   .   .------->  36RET
Hydrograph        .   .   36-O
Route             .   .   L3-M2A
Basin             .   .   .   47N
Divert            .   .   .   .------->  47NRET
Hydrograph        .   .   .   47N-O
Combine           .   .   M2A.........
Route             .   .   RTMCR1
Retrieve          .   .   .   .<-------  DTW37
Hydrograph        .   .   .   DVW37
Route             .   .   .   37-M2B
Basin             .   .   .   .   48
Divert            .   .   .   .   .------->  48RET
Hydrograph        .   .   .   .   48-O
Combine           .   .   M2B.......................
Combine           .   M3C.........
Divert            .   .------->  DIMB04
Hydrograph        .   MB04
Basin             .   .   56A
Divert            .   .   .------->  56ARET
Hydrograph        .   .   56A-O
Divert            .   .   .------->  DT56A
Hydrograph        .   .   DV56A
Combine           .   M2C.........
Route             .   RTMCR2
Route             .   RTSPT1
Basin             .   .   56B
Divert            .   .   .------->  56BRET
Hydrograph        .   .   56B-O
Combine           .   CP56B.........
Route             .   RTURR3
Combine           N5B.........
Route             RTSPT2
Basin             .   70
Divert            .   .------->  70RET
Hydrograph        .   70-O
Retrieve          .   .   <-------  DT56A
Hydrograph        .   .   DV56A
Combine           N6.......................
Route             RTSPT3
Basin             .   92N
Divert            .   .------->  92NRET
Hydrograph        .   92N-O
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Combine          O10A.........
Basin              .     71
Divert             .       .-------> 71RET
Hydrograph         .    71-O
Basin              .       .     93
Divert             .       .       .-------> 93RET
Hydrograph         .       .    93-O
Combine            .       O9.........
Route              .    RT2314
Basin              .       .     95
Divert             .       .       .-------> 95RET
Hydrograph         .       .    95-O
Combine            .       P8B........
Route              .    RTMRA1
Combine          O10B.........
Basin              .    DET24
Combine        TOBINF.........
Route          RTWTR1
Basin              .    DRAN24
Basin              .       .     92S
Divert             .       .       .-------> 92SRET
Hydrograph         .       .    92S-O
Combine            .    TOB92S.........
Basin              .       .     58
Divert             .       .       .-------> 58RET
Hydrograph         .       .    58-O
Basin              .       .       .     72
Divert             .       .       .       .-------> 72RET
Hydrograph         .       .       .    72-O
Combine            .       .     P6.........
Basin              .       .       .     94
Divert             .       .       .       .-------> 94RET
Hydrograph         .       .       .    94-O
Combine            .       .     P7.........
Route              .       .  94-P8A
Basin              .       .       .     96
Divert             .       .       .       .-------> 96RET
Hydrograph         .       .       .    96-O
Combine            .       .     P8A........
Route              .       .  P8A-P9
Basin              .       .       .     97
Divert             .       .       .       .-------> 97RET
Hydrograph         .       .       .    97-O
Combine        P9.............................
Route          RTWTR2
Basin              .    100
Divert             .       .-------> 100RET
Hydrograph         .    100-O
Combine        P10.........
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Major Basin ID	Type	Area		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
Major Basin 01									
12	Hydrograph	0.7400	Flow (cfs)						1,151
			Volume (Inches)						2.003
			Volume (Ac-Ft)						78.62
			Ac-Ft/Sq Mi						106.24
			Time to Peak (Hrs)						12.25
12RET	Diversion	0.7400	Flow (cfs)						1,151
			Volume (Inches)						2.003
			Volume (Ac-Ft)						78.62
			Ac-Ft/Sq Mi						106.24
			Time to Peak (Hrs)						12.25
12-O	Hydrograph	0.7400	Flow (cfs)						
			Volume (Inches)						
			Volume (Ac-Ft)						
			Ac-Ft/Sq Mi						
			Time to Peak (Hrs)						
O1-O2	Routed	0.7400	Flow (cfs)						
			Volume (Inches)						
			Volume (Ac-Ft)						
			Ac-Ft/Sq Mi						
			Time to Peak (Hrs)						
13	Hydrograph	0.5000	Flow (cfs)						923
			Volume (Inches)						1.872
			Volume (Ac-Ft)						50.03
			Ac-Ft/Sq Mi						100.06
			Time to Peak (Hrs)						12.17
13RET	Diversion	0.5000	Flow (cfs)						923
			Volume (Inches)						1.872
			Volume (Ac-Ft)						50.03
			Ac-Ft/Sq Mi						100.06
			Time to Peak (Hrs)						12.17
13-O	Hydrograph	0.5000	Flow (cfs)						
			Volume (Inches)						
			Volume (Ac-Ft)						
			Ac-Ft/Sq Mi						
			Time to Peak (Hrs)						
O2	Combined	1.2400	Flow (cfs)						
			Volume (Inches)						
			Volume (Ac-Ft)						
			Ac-Ft/Sq Mi						
			Time to Peak (Hrs)						
O2-O3A	Routed	1.2400	Flow (cfs)						
			Volume (Inches)						
			Volume (Ac-Ft)						
			Ac-Ft/Sq Mi						
			Time to Peak (Hrs)						
24	Hydrograph	0.4900	Flow (cfs)						742
			Volume (Inches)						1.385
			Volume (Ac-Ft)						36.12

Major Basin ID	Type	Area		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
			Ac-Ft/Sq Mi						73.71
			Time to Peak (Hrs)						12.17
24RET	Diversion	0.4900	Flow (cfs)						2
			Volume (Inches)						0.012
			Volume (Ac-Ft)						0.30
			Ac-Ft/Sq Mi						0.61
			Time to Peak (Hrs)						1.08
24-O	Hydrograph	0.4900	Flow (cfs)						742
			Volume (Inches)						1.374
			Volume (Ac-Ft)						35.82
			Ac-Ft/Sq Mi						73.10
			Time to Peak (Hrs)						12.17
O3A	Combined	1.7300	Flow (cfs)						734
			Volume (Inches)						0.385
			Volume (Ac-Ft)						35.46
			Ac-Ft/Sq Mi						20.50
			Time to Peak (Hrs)						12.17
O3AO3	Routed	1.7300	Flow (cfs)						667
			Volume (Inches)						0.385
			Volume (Ac-Ft)						35.46
			Ac-Ft/Sq Mi						20.50
			Time to Peak (Hrs)						12.33
25	Hydrograph	0.2700	Flow (cfs)						235
			Volume (Inches)						1.315
			Volume (Ac-Ft)						19.22
			Ac-Ft/Sq Mi						71.19
			Time to Peak (Hrs)						12.58
25RET	Diversion	0.2700	Flow (cfs)						235
			Volume (Inches)						1.136
			Volume (Ac-Ft)						16.60
			Ac-Ft/Sq Mi						61.48
			Time to Peak (Hrs)						12.58
25-O	Hydrograph	0.2700	Flow (cfs)						18
			Volume (Inches)						0.179
			Volume (Ac-Ft)						2.62
			Ac-Ft/Sq Mi						9.70
			Time to Peak (Hrs)						13.42
O3B	Combined	2.0000	Flow (cfs)						667
			Volume (Inches)						0.355
			Volume (Ac-Ft)						37.86
			Ac-Ft/Sq Mi						18.93
			Time to Peak (Hrs)						12.33
14A	Hydrograph	0.6900	Flow (cfs)						712
			Volume (Inches)						1.599
			Volume (Ac-Ft)						59.00
			Ac-Ft/Sq Mi						85.51
			Time to Peak (Hrs)						12.50

Major Basin ID	Type	Area		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
14ARET	Diversion	0.6900	Flow (cfs)						712
			Volume (Inches)						1.374
			Volume (Ac-Ft)						50.70
			Ac-Ft/Sq Mi						73.48
			Time to Peak (Hrs)						12.50
14A-O	Hydrograph	0.6900	Flow (cfs)						31
			Volume (Inches)						0.225
			Volume (Ac-Ft)						8.30
			Ac-Ft/Sq Mi						12.03
			Time to Peak (Hrs)						13.58
P1AP1B	Routed	0.6900	Flow (cfs)						24
			Volume (Inches)						0.225
			Volume (Ac-Ft)						8.30
			Ac-Ft/Sq Mi						12.03
			Time to Peak (Hrs)						14.00
83	Hydrograph	0.6800	Flow (cfs)						678
			Volume (Inches)						1.767
			Volume (Ac-Ft)						63.60
			Ac-Ft/Sq Mi						93.53
			Time to Peak (Hrs)						12.58
83RET	Diversion	0.6800	Flow (cfs)						678
			Volume (Inches)						1.339
			Volume (Ac-Ft)						48.20
			Ac-Ft/Sq Mi						70.88
			Time to Peak (Hrs)						12.58
83-O	Hydrograph	0.6800	Flow (cfs)						206
			Volume (Inches)						0.428
			Volume (Ac-Ft)						15.40
			Ac-Ft/Sq Mi						22.65
			Time to Peak (Hrs)						13.08
14B	Hydrograph	0.5000	Flow (cfs)						729
			Volume (Inches)						1.567
			Volume (Ac-Ft)						41.97
			Ac-Ft/Sq Mi						83.94
			Time to Peak (Hrs)						12.25
14BRET	Diversion	0.5000	Flow (cfs)						729
			Volume (Inches)						1.567
			Volume (Ac-Ft)						41.97
			Ac-Ft/Sq Mi						83.94
			Time to Peak (Hrs)						12.25
14B-O	Hydrograph	0.5000	Flow (cfs)						
			Volume (Inches)						
			Volume (Ac-Ft)						
			Ac-Ft/Sq Mi						
			Time to Peak (Hrs)						
P1B	Combined	1.8700	Flow (cfs)						206
			Volume (Inches)						0.237
			Volume (Ac-Ft)						23.67
			Ac-Ft/Sq Mi						12.66

Major Basin ID	Type	Area		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
			Time to Peak (Hrs)						13.08
P1B-P2	Routed	1.8700	Flow (cfs)						110
			Volume (Inches)						0.225
			Volume (Ac-Ft)						22.41
			Ac-Ft/Sq Mi						11.98
			Time to Peak (Hrs)						13.33
26	Hydrograph	0.5200	Flow (cfs)						621
			Volume (Inches)						1.300
			Volume (Ac-Ft)						36.33
			Ac-Ft/Sq Mi						69.87
			Time to Peak (Hrs)						12.33
26RET	Diversion	0.5200	Flow (cfs)						9
			Volume (Inches)						0.125
			Volume (Ac-Ft)						3.50
			Ac-Ft/Sq Mi						6.73
			Time to Peak (Hrs)						10.67
26-O	Hydrograph	0.5200	Flow (cfs)						621
			Volume (Inches)						1.175
			Volume (Ac-Ft)						32.83
			Ac-Ft/Sq Mi						63.13
			Time to Peak (Hrs)						12.33
P2	Combined	2.3900	Flow (cfs)						610
			Volume (Inches)						0.424
			Volume (Ac-Ft)						54.13
			Ac-Ft/Sq Mi						22.65
			Time to Peak (Hrs)						12.33
P2-O4	Routed	2.3900	Flow (cfs)						479
			Volume (Inches)						0.424
			Volume (Ac-Ft)						54.13
			Ac-Ft/Sq Mi						22.65
			Time to Peak (Hrs)						12.67
11A	Hydrograph	0.5700	Flow (cfs)						1,075
			Volume (Inches)						2.081
			Volume (Ac-Ft)						63.37
			Ac-Ft/Sq Mi						111.18
			Time to Peak (Hrs)						12.17
11ARET	Diversion	0.5700	Flow (cfs)						1,075
			Volume (Inches)						2.039
			Volume (Ac-Ft)						62.10
			Ac-Ft/Sq Mi						108.95
			Time to Peak (Hrs)						12.17
11A-O	Hydrograph	0.5700	Flow (cfs)						6
			Volume (Inches)						0.042
			Volume (Ac-Ft)						1.27
			Ac-Ft/Sq Mi						2.23
			Time to Peak (Hrs)						22.00
N1A-1B	Routed	0.5700	Flow (cfs)						6
			Volume (Inches)						0.042

Major Basin ID	Type	Area		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
			Volume (Ac-Ft)						1.27
			Ac-Ft/Sq Mi						2.23
			Time to Peak (Hrs)						23.92
11B	Hydrograph	0.5800	Flow (cfs)						586
			Volume (Inches)						1.677
			Volume (Ac-Ft)						51.96
			Ac-Ft/Sq Mi						89.59
			Time to Peak (Hrs)						12.50
11BRET	Diversion	0.5800	Flow (cfs)						586
			Volume (Inches)						1.507
			Volume (Ac-Ft)						46.70
			Ac-Ft/Sq Mi						80.52
			Time to Peak (Hrs)						12.50
11B-O	Hydrograph	0.5800	Flow (cfs)						12
			Volume (Inches)						0.170
			Volume (Ac-Ft)						5.26
			Ac-Ft/Sq Mi						9.07
			Time to Peak (Hrs)						15.33
N1B	Combined	1.1500	Flow (cfs)						11
			Volume (Inches)						0.102
			Volume (Ac-Ft)						6.25
			Ac-Ft/Sq Mi						5.43
			Time to Peak (Hrs)						15.33
N1BO4	Routed	1.1500	Flow (cfs)						11
			Volume (Inches)						0.102
			Volume (Ac-Ft)						6.25
			Ac-Ft/Sq Mi						5.43
			Time to Peak (Hrs)						24.25
O4	Combined	5.5500	Flow (cfs)						766
			Volume (Inches)						0.309
			Volume (Ac-Ft)						91.45
			Ac-Ft/Sq Mi						16.48
			Time to Peak (Hrs)						12.50
DIMB01	Diversion	5.5500	Flow (cfs)						716
			Volume (Inches)						0.161
			Volume (Ac-Ft)						47.68
			Ac-Ft/Sq Mi						8.59
			Time to Peak (Hrs)						12.50
MB01	Hydrograph	5.5500	Flow (cfs)						50
			Volume (Inches)						0.148
			Volume (Ac-Ft)						43.77
			Ac-Ft/Sq Mi						7.89
			Time to Peak (Hrs)						12.00
RT2311	Routed	5.5500	Flow (cfs)						50
			Volume (Inches)						0.148
			Volume (Ac-Ft)						43.77
			Ac-Ft/Sq Mi						7.89
			Time to Peak (Hrs)						13.33

Major Basin ID	Type	Area		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
39	Hydrograph	0.7300	Flow (cfs)						610
			Volume (Inches)						1.670
			Volume (Ac-Ft)						64.58
			Ac-Ft/Sq Mi						88.47
			Time to Peak (Hrs)						12.67
39RET	Diversion	0.7300	Flow (cfs)						610
			Volume (Inches)						1.130
			Volume (Ac-Ft)						43.70
			Ac-Ft/Sq Mi						59.86
			Time to Peak (Hrs)						12.67
39-O	Hydrograph	0.7300	Flow (cfs)						339
			Volume (Inches)						0.540
			Volume (Ac-Ft)						20.88
			Ac-Ft/Sq Mi						28.60
			Time to Peak (Hrs)						13.00
O5	Combined	0.7300	Flow (cfs)						389
			Volume (Inches)						1.769
			Volume (Ac-Ft)						68.41
			Ac-Ft/Sq Mi						93.71
			Time to Peak (Hrs)						13.00
RT2312	Routed	0.7300	Flow (cfs)						255
			Volume (Inches)						1.769
			Volume (Ac-Ft)						68.41
			Ac-Ft/Sq Mi						93.71
			Time to Peak (Hrs)						13.33
50	Hydrograph	1.0000	Flow (cfs)						758
			Volume (Inches)						1.658
			Volume (Ac-Ft)						88.59
			Ac-Ft/Sq Mi						88.59
			Time to Peak (Hrs)						12.75
50RET	Diversion	1.0000	Flow (cfs)						758
			Volume (Inches)						1.145
			Volume (Ac-Ft)						61.20
			Ac-Ft/Sq Mi						61.20
			Time to Peak (Hrs)						12.75
50-O	Hydrograph	1.0000	Flow (cfs)						402
			Volume (Inches)						0.513
			Volume (Ac-Ft)						27.39
			Ac-Ft/Sq Mi						27.39
			Time to Peak (Hrs)						13.17
O6A	Combined	1.7300	Flow (cfs)						534
			Volume (Inches)						1.013
			Volume (Ac-Ft)						93.35
			Ac-Ft/Sq Mi						53.96
			Time to Peak (Hrs)						13.25
38	Hydrograph	0.5400	Flow (cfs)						468
			Volume (Inches)						1.640
			Volume (Ac-Ft)						47.42
			Ac-Ft/Sq Mi						87.81

Major Basin ID	Type	Area		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
			Time to Peak (Hrs)						12.58
38RET	Diversion	0.5400	Flow (cfs)						468
			Volume (Inches)						1.152
			Volume (Ac-Ft)						33.30
			Ac-Ft/Sq Mi						61.67
			Time to Peak (Hrs)						12.58
38-O	Hydrograph	0.5400	Flow (cfs)						215
			Volume (Inches)						0.488
			Volume (Ac-Ft)						14.12
			Ac-Ft/Sq Mi						26.15
			Time to Peak (Hrs)						13.00
DTAF38	Diversion	0.5400	Flow (cfs)						95
			Volume (Inches)						0.435
			Volume (Ac-Ft)						12.58
			Ac-Ft/Sq Mi						23.30
			Time to Peak (Hrs)						13.00
DVAF38	Hydrograph	0.5400	Flow (cfs)						120
			Volume (Inches)						0.053
			Volume (Ac-Ft)						1.53
			Ac-Ft/Sq Mi						2.83
			Time to Peak (Hrs)						13.00
N3-N4	Routed	0.5400	Flow (cfs)						28
			Volume (Inches)						0.053
			Volume (Ac-Ft)						1.53
			Ac-Ft/Sq Mi						2.83
			Time to Peak (Hrs)						13.25
49	Hydrograph	1.0100	Flow (cfs)						737
			Volume (Inches)						1.633
			Volume (Ac-Ft)						87.88
			Ac-Ft/Sq Mi						87.01
			Time to Peak (Hrs)						12.75
49RET	Diversion	1.0100	Flow (cfs)						737
			Volume (Inches)						1.464
			Volume (Ac-Ft)						78.80
			Ac-Ft/Sq Mi						78.02
			Time to Peak (Hrs)						12.75
49-O	Hydrograph	1.0100	Flow (cfs)						21
			Volume (Inches)						0.169
			Volume (Ac-Ft)						9.08
			Ac-Ft/Sq Mi						8.99
			Time to Peak (Hrs)						15.58
DTCM4	Diversion	1.0100	Flow (cfs)						3
			Volume (Inches)						0.045
			Volume (Ac-Ft)						2.43
			Ac-Ft/Sq Mi						2.41
			Time to Peak (Hrs)						17.00
DVCM4	Hydrograph	1.0100	Flow (cfs)						18
			Volume (Inches)						0.124

Major Basin ID	Type	Area		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
			Volume (Ac-Ft)						6.65
			Ac-Ft/Sq Mi						6.58
			Time to Peak (Hrs)						15.58
DTMV49	Diversion	1.0100	Flow (cfs)						5
			Volume (Inches)						0.070
			Volume (Ac-Ft)						3.77
			Ac-Ft/Sq Mi						3.73
			Time to Peak (Hrs)						17.08
DVMV4	Hydrograph	1.0100	Flow (cfs)						13
			Volume (Inches)						0.053
			Volume (Ac-Ft)						2.87
			Ac-Ft/Sq Mi						2.84
			Time to Peak (Hrs)						15.58
N4	Combined	0.9100	Flow (cfs)						28
			Volume (Inches)						0.092
			Volume (Ac-Ft)						4.44
			Ac-Ft/Sq Mi						4.88
			Time to Peak (Hrs)						13.25
N4-O6	Routed	0.9100	Flow (cfs)						12
			Volume (Inches)						0.091
			Volume (Ac-Ft)						4.41
			Ac-Ft/Sq Mi						4.85
			Time to Peak (Hrs)						14.00
O6B	Combined	2.6400	Flow (cfs)						534
			Volume (Inches)						0.690
			Volume (Ac-Ft)						97.05
			Ac-Ft/Sq Mi						36.76
			Time to Peak (Hrs)						13.25
DIMB02	Diversion	2.6400	Flow (cfs)						458
			Volume (Inches)						0.239
			Volume (Ac-Ft)						33.58
			Ac-Ft/Sq Mi						12.72
			Time to Peak (Hrs)						13.25
MB02	Hydrograph	2.6400	Flow (cfs)						60
			Volume (Inches)						0.435
			Volume (Ac-Ft)						61.09
			Ac-Ft/Sq Mi						23.14
			Time to Peak (Hrs)						19.25
RT2313	Routed	2.6400	Flow (cfs)						60
			Volume (Inches)						0.435
			Volume (Ac-Ft)						61.09
			Ac-Ft/Sq Mi						23.14
			Time to Peak (Hrs)						19.33
40	Hydrograph	0.9800	Flow (cfs)						791
			Volume (Inches)						1.666
			Volume (Ac-Ft)						86.72
			Ac-Ft/Sq Mi						88.49
			Time to Peak (Hrs)						12.67

Major Basin ID	Type	Area		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
40RET	Diversion	0.9800	Flow (cfs)						791
			Volume (Inches)						1.183
			Volume (Ac-Ft)						61.60
			Ac-Ft/Sq Mi						62.86
			Time to Peak (Hrs)						12.67
40-O	Hydrograph	0.9800	Flow (cfs)						327
			Volume (Inches)						0.483
			Volume (Ac-Ft)						25.12
			Ac-Ft/Sq Mi						25.63
			Time to Peak (Hrs)						13.17
P3-P4	Routed	0.9800	Flow (cfs)						324
			Volume (Inches)						0.483
			Volume (Ac-Ft)						25.12
			Ac-Ft/Sq Mi						25.63
			Time to Peak (Hrs)						13.42
51	Hydrograph	1.0000	Flow (cfs)						765
			Volume (Inches)						1.689
			Volume (Ac-Ft)						90.42
			Ac-Ft/Sq Mi						90.42
			Time to Peak (Hrs)						12.75
51RET	Diversion	1.0000	Flow (cfs)						765
			Volume (Inches)						1.163
			Volume (Ac-Ft)						62.30
			Ac-Ft/Sq Mi						62.30
			Time to Peak (Hrs)						12.75
51-O	Hydrograph	1.0000	Flow (cfs)						394
			Volume (Inches)						0.525
			Volume (Ac-Ft)						28.12
			Ac-Ft/Sq Mi						28.12
			Time to Peak (Hrs)						13.17
P4	Combined	1.9800	Flow (cfs)						538
			Volume (Inches)						0.485
			Volume (Ac-Ft)						51.27
			Ac-Ft/Sq Mi						25.89
			Time to Peak (Hrs)						13.42
DIMB05	Diversion	1.9800	Flow (cfs)						488
			Volume (Inches)						0.218
			Volume (Ac-Ft)						23.06
			Ac-Ft/Sq Mi						11.65
			Time to Peak (Hrs)						13.42
MB05	Hydrograph	1.9800	Flow (cfs)						50
			Volume (Inches)						0.267
			Volume (Ac-Ft)						28.21
			Ac-Ft/Sq Mi						14.25
			Time to Peak (Hrs)						13.17
RTURR	Routed	1.9800	Flow (cfs)						50
			Volume (Inches)						0.267
			Volume (Ac-Ft)						28.21
			Ac-Ft/Sq Mi						14.25

Major Basin ID	Type	Area		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
			Time to Peak (Hrs)						13.92
P5B	Combined	0.1900	Flow (cfs)						110
			Volume (Inches)						8.960
			Volume (Ac-Ft)						90.79
			Ac-Ft/Sq Mi						477.84
			Time to Peak (Hrs)						15.17
RTURR	Routed	0.1900	Flow (cfs)						110
			Volume (Inches)						8.960
			Volume (Ac-Ft)						90.79
			Ac-Ft/Sq Mi						477.84
			Time to Peak (Hrs)						15.25
57	Hydrograph	0.4900	Flow (cfs)						1,008
			Volume (Inches)						2.325
			Volume (Ac-Ft)						60.65
			Ac-Ft/Sq Mi						123.78
			Time to Peak (Hrs)						12.08
57RET	Diversion	0.4900	Flow (cfs)						1,008
			Volume (Inches)						2.325
			Volume (Ac-Ft)						60.65
			Ac-Ft/Sq Mi						123.78
			Time to Peak (Hrs)						12.08
57-O	Hydrograph	0.4900	Flow (cfs)						
			Volume (Inches)						
			Volume (Ac-Ft)						
			Ac-Ft/Sq Mi						
			Time to Peak (Hrs)						
O7	Combined	0.6800	Flow (cfs)						110
			Volume (Inches)						2.511
			Volume (Ac-Ft)						90.79
			Ac-Ft/Sq Mi						133.51
			Time to Peak (Hrs)						15.25
10E	Hydrograph	0.5900	Flow (cfs)						615
			Volume (Inches)						1.774
			Volume (Ac-Ft)						56.02
			Ac-Ft/Sq Mi						94.95
			Time to Peak (Hrs)						12.50
10ERET	Diversion	0.5900	Flow (cfs)						615
			Volume (Inches)						1.229
			Volume (Ac-Ft)						38.80
			Ac-Ft/Sq Mi						65.76
			Time to Peak (Hrs)						12.50
10E-O	Hydrograph	0.5900	Flow (cfs)						241
			Volume (Inches)						0.546
			Volume (Ac-Ft)						17.23
			Ac-Ft/Sq Mi						29.20
			Time to Peak (Hrs)						12.83
L1AL2A	Routed	0.5900	Flow (cfs)						149
			Volume (Inches)						0.546

Major Basin ID	Type	Area		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
			Volume (Ac-Ft)						17.22
			Ac-Ft/Sq Mi						29.19
			Time to Peak (Hrs)						13.00
22E	Hydrograph	0.2900	Flow (cfs)						360
			Volume (Inches)						1.637
			Volume (Ac-Ft)						24.97
			Ac-Ft/Sq Mi						86.10
			Time to Peak (Hrs)						12.33
22ERET	Diversion	0.2900	Flow (cfs)						360
			Volume (Inches)						1.174
			Volume (Ac-Ft)						17.90
			Ac-Ft/Sq Mi						61.72
			Time to Peak (Hrs)						12.33
22E-O	Hydrograph	0.2900	Flow (cfs)						142
			Volume (Inches)						0.463
			Volume (Ac-Ft)						7.07
			Ac-Ft/Sq Mi						24.38
			Time to Peak (Hrs)						12.58
L2A	Combined	0.8800	Flow (cfs)						179
			Volume (Inches)						0.518
			Volume (Ac-Ft)						24.26
			Ac-Ft/Sq Mi						27.57
			Time to Peak (Hrs)						12.92
11C	Hydrograph	0.3400	Flow (cfs)						439
			Volume (Inches)						1.631
			Volume (Ac-Ft)						29.84
			Ac-Ft/Sq Mi						87.76
			Time to Peak (Hrs)						12.33
11CRET	Diversion	0.3400	Flow (cfs)						439
			Volume (Inches)						1.339
			Volume (Ac-Ft)						24.50
			Ac-Ft/Sq Mi						72.06
			Time to Peak (Hrs)						12.33
11C-O	Hydrograph	0.3400	Flow (cfs)						28
			Volume (Inches)						0.292
			Volume (Ac-Ft)						5.34
			Ac-Ft/Sq Mi						15.71
			Time to Peak (Hrs)						13.00
N1C-N2	Routed	0.3400	Flow (cfs)						16
			Volume (Inches)						0.292
			Volume (Ac-Ft)						5.34
			Ac-Ft/Sq Mi						15.71
			Time to Peak (Hrs)						13.42
23	Hydrograph	0.5200	Flow (cfs)						450
			Volume (Inches)						1.639
			Volume (Ac-Ft)						45.81
			Ac-Ft/Sq Mi						88.10
			Time to Peak (Hrs)						12.58

Major Basin ID	Type	Area		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
23RET	Diversion	0.5200	Flow (cfs)						450
			Volume (Inches)						1.192
			Volume (Ac-Ft)						33.30
			Ac-Ft/Sq Mi						64.04
			Time to Peak (Hrs)						12.58
23-O	Hydrograph	0.5200	Flow (cfs)						162
			Volume (Inches)						0.448
			Volume (Ac-Ft)						12.51
			Ac-Ft/Sq Mi						24.06
			Time to Peak (Hrs)						13.08
N2	Combined	1.7500	Flow (cfs)						303
			Volume (Inches)						0.436
			Volume (Ac-Ft)						40.62
			Ac-Ft/Sq Mi						23.21
			Time to Peak (Hrs)						13.08
DIMB03	Diversion	1.7500	Flow (cfs)						253
			Volume (Inches)						0.135
			Volume (Ac-Ft)						12.61
			Ac-Ft/Sq Mi						7.21
			Time to Peak (Hrs)						13.08
MB03	Hydrograph	1.7500	Flow (cfs)						50
			Volume (Inches)						0.301
			Volume (Ac-Ft)						28.01
			Ac-Ft/Sq Mi						16.01
			Time to Peak (Hrs)						12.58
RTAPR1	Routed	1.7500	Flow (cfs)						50
			Volume (Inches)						0.301
			Volume (Ac-Ft)						28.01
			Ac-Ft/Sq Mi						16.01
			Time to Peak (Hrs)						14.17
37	Hydrograph	1.4200	Flow (cfs)						1,036
			Volume (Inches)						1.747
			Volume (Ac-Ft)						132.39
			Ac-Ft/Sq Mi						93.23
			Time to Peak (Hrs)						12.75
37RET	Diversion	1.4200	Flow (cfs)						1,036
			Volume (Inches)						1.226
			Volume (Ac-Ft)						92.90
			Ac-Ft/Sq Mi						65.42
			Time to Peak (Hrs)						12.75
37-O	Hydrograph	1.4200	Flow (cfs)						455
			Volume (Inches)						0.521
			Volume (Ac-Ft)						39.49
			Ac-Ft/Sq Mi						27.81
			Time to Peak (Hrs)						13.33
DTEVB	Diversion	1.4200	Flow (cfs)						76
			Volume (Inches)						0.350
			Volume (Ac-Ft)						26.52
			Ac-Ft/Sq Mi						18.68

Major Basin ID	Type	Area		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
			Time to Peak (Hrs)						13.25
DVEVB	Hydrograph	1.4200	Flow (cfs)						379
			Volume (Inches)						0.171
			Volume (Ac-Ft)						12.97
			Ac-Ft/Sq Mi						9.13
			Time to Peak (Hrs)						13.33
DTCV	Diversion	1.4200	Flow (cfs)						76
			Volume (Inches)						0.070
			Volume (Ac-Ft)						5.29
			Ac-Ft/Sq Mi						3.73
			Time to Peak (Hrs)						13.33
DVCV	Hydrograph	1.4200	Flow (cfs)						303
			Volume (Inches)						0.101
			Volume (Ac-Ft)						7.69
			Ac-Ft/Sq Mi						5.42
			Time to Peak (Hrs)						13.33
DTMV	Diversion	1.4200	Flow (cfs)						76
			Volume (Inches)						0.042
			Volume (Ac-Ft)						3.18
			Ac-Ft/Sq Mi						2.24
			Time to Peak (Hrs)						13.33
DVMV	Hydrograph	1.4200	Flow (cfs)						227
			Volume (Inches)						0.060
			Volume (Ac-Ft)						4.51
			Ac-Ft/Sq Mi						3.18
			Time to Peak (Hrs)						13.33
DTW37	Diversion	1.4200	Flow (cfs)						227
			Volume (Inches)						0.060
			Volume (Ac-Ft)						4.51
			Ac-Ft/Sq Mi						3.18
			Time to Peak (Hrs)						13.33
DVW37	Hydrograph	1.4200	Flow (cfs)						
			Volume (Inches)						
			Volume (Ac-Ft)						
			Ac-Ft/Sq Mi						
			Time to Peak (Hrs)						
DVEVB	Hydrograph	1.4200	Flow (cfs)						76
			Volume (Inches)						0.350
			Volume (Ac-Ft)						26.52
			Ac-Ft/Sq Mi						18.68
			Time to Peak (Hrs)						13.25
DVAF38	Hydrograph	0.5400	Flow (cfs)						95
			Volume (Inches)						0.435
			Volume (Ac-Ft)						12.58
			Ac-Ft/Sq Mi						23.30
			Time to Peak (Hrs)						13.00
CEBV	Combined	0.4700	Flow (cfs)						221
			Volume (Inches)						2.660

Major Basin ID	Type	Area		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
			Volume (Ac-Ft)						67.37
			Ac-Ft/Sq Mi						143.34
			Time to Peak (Hrs)						13.25
RTAPR2	Routed	0.4700	Flow (cfs)						199
			Volume (Inches)						2.660
			Volume (Ac-Ft)						67.37
			Ac-Ft/Sq Mi						143.34
			Time to Peak (Hrs)						13.42
DVCV	Hydrograph	1.4200	Flow (cfs)						76
			Volume (Inches)						0.070
			Volume (Ac-Ft)						5.29
			Ac-Ft/Sq Mi						3.73
			Time to Peak (Hrs)						13.33
DVMV4	Hydrograph	1.0100	Flow (cfs)						5
			Volume (Inches)						0.070
			Volume (Ac-Ft)						3.77
			Ac-Ft/Sq Mi						3.73
			Time to Peak (Hrs)						17.08
CCV	Combined	0.9600	Flow (cfs)						275
			Volume (Inches)						1.486
			Volume (Ac-Ft)						76.47
			Ac-Ft/Sq Mi						79.66
			Time to Peak (Hrs)						13.42
RTAPR3	Routed	0.9600	Flow (cfs)						263
			Volume (Inches)						1.486
			Volume (Ac-Ft)						76.47
			Ac-Ft/Sq Mi						79.66
			Time to Peak (Hrs)						13.50
DVMV	Hydrograph	1.4200	Flow (cfs)						76
			Volume (Inches)						0.042
			Volume (Ac-Ft)						3.18
			Ac-Ft/Sq Mi						2.24
			Time to Peak (Hrs)						13.33
DVCM4	Hydrograph	1.0100	Flow (cfs)						3
			Volume (Inches)						0.045
			Volume (Ac-Ft)						2.43
			Ac-Ft/Sq Mi						2.41
			Time to Peak (Hrs)						17.00
CMV	Combined	1.3500	Flow (cfs)						338
			Volume (Inches)						1.130
			Volume (Ac-Ft)						81.56
			Ac-Ft/Sq Mi						60.41
			Time to Peak (Hrs)						13.50
RTAPR4	Routed	1.3500	Flow (cfs)						329
			Volume (Inches)						1.130
			Volume (Ac-Ft)						81.56
			Ac-Ft/Sq Mi						60.41
			Time to Peak (Hrs)						13.58

Major Basin ID	Type	Area		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
36	Hydrograph	0.6800	Flow (cfs)						553
			Volume (Inches)						1.575
			Volume (Ac-Ft)						57.46
			Ac-Ft/Sq Mi						84.50
			Time to Peak (Hrs)						12.67
36RET	Diversion	0.6800	Flow (cfs)						553
			Volume (Inches)						1.190
			Volume (Ac-Ft)						43.40
			Ac-Ft/Sq Mi						63.82
			Time to Peak (Hrs)						12.67
36-O	Hydrograph	0.6800	Flow (cfs)						184
			Volume (Inches)						0.385
			Volume (Ac-Ft)						14.06
			Ac-Ft/Sq Mi						20.68
			Time to Peak (Hrs)						13.17
L3-M2A	Routed	0.6800	Flow (cfs)						105
			Volume (Inches)						0.385
			Volume (Ac-Ft)						14.06
			Ac-Ft/Sq Mi						20.68
			Time to Peak (Hrs)						13.42
47N	Hydrograph	0.2300	Flow (cfs)						225
			Volume (Inches)						1.633
			Volume (Ac-Ft)						20.30
			Ac-Ft/Sq Mi						88.26
			Time to Peak (Hrs)						12.50
47NRET	Diversion	0.2300	Flow (cfs)						225
			Volume (Inches)						1.143
			Volume (Ac-Ft)						14.20
			Ac-Ft/Sq Mi						61.74
			Time to Peak (Hrs)						12.50
47N-O	Hydrograph	0.2300	Flow (cfs)						107
			Volume (Inches)						0.491
			Volume (Ac-Ft)						6.10
			Ac-Ft/Sq Mi						26.52
			Time to Peak (Hrs)						12.83
M2A	Combined	0.9200	Flow (cfs)						125
			Volume (Inches)						0.412
			Volume (Ac-Ft)						20.12
			Ac-Ft/Sq Mi						21.87
			Time to Peak (Hrs)						13.33
RTMCR	Routed	0.9200	Flow (cfs)						93
			Volume (Inches)						0.412
			Volume (Ac-Ft)						20.12
			Ac-Ft/Sq Mi						21.87
			Time to Peak (Hrs)						14.17
DVW37	Hydrograph	1.4200	Flow (cfs)						227
			Volume (Inches)						0.060
			Volume (Ac-Ft)						4.51
			Ac-Ft/Sq Mi						3.18

Major Basin ID	Type	Area		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
			Time to Peak (Hrs)						13.33
37-M2B	Routed	1.4200	Flow (cfs)						148
			Volume (Inches)						0.060
			Volume (Ac-Ft)						4.51
			Ac-Ft/Sq Mi						3.18
			Time to Peak (Hrs)						13.42
48	Hydrograph	0.5000	Flow (cfs)						505
			Volume (Inches)						1.734
			Volume (Ac-Ft)						46.25
			Ac-Ft/Sq Mi						92.50
			Time to Peak (Hrs)						12.50
48RET	Diversion	0.5000	Flow (cfs)						505
			Volume (Inches)						1.185
			Volume (Ac-Ft)						31.60
			Ac-Ft/Sq Mi						63.20
			Time to Peak (Hrs)						12.50
48-O	Hydrograph	0.5000	Flow (cfs)						245
			Volume (Inches)						0.549
			Volume (Ac-Ft)						14.65
			Ac-Ft/Sq Mi						29.30
			Time to Peak (Hrs)						12.83
M2B	Combined	2.1300	Flow (cfs)						239
			Volume (Inches)						0.328
			Volume (Ac-Ft)						37.17
			Ac-Ft/Sq Mi						17.45
			Time to Peak (Hrs)						12.83
M3C	Combined	3.4800	Flow (cfs)						437
			Volume (Inches)						0.620
			Volume (Ac-Ft)						115.07
			Ac-Ft/Sq Mi						33.07
			Time to Peak (Hrs)						13.50
DIMB04	Diversion	3.4800	Flow (cfs)						339
			Volume (Inches)						0.181
			Volume (Ac-Ft)						33.52
			Ac-Ft/Sq Mi						9.63
			Time to Peak (Hrs)						13.50
MB04	Hydrograph	3.4800	Flow (cfs)						100
			Volume (Inches)						0.439
			Volume (Ac-Ft)						81.55
			Ac-Ft/Sq Mi						23.43
			Time to Peak (Hrs)						16.42
56A	Hydrograph	0.4100	Flow (cfs)						761
			Volume (Inches)						2.307
			Volume (Ac-Ft)						50.57
			Ac-Ft/Sq Mi						123.34
			Time to Peak (Hrs)						12.17
56ARET	Diversion	0.4100	Flow (cfs)						761
			Volume (Inches)						1.378

Major Basin ID	Type	Area		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
			Volume (Ac-Ft)						30.20
			Ac-Ft/Sq Mi						73.66
			Time to Peak (Hrs)						12.17
56A-O	Hydrograph	0.4100	Flow (cfs)						392
			Volume (Inches)						0.929
			Volume (Ac-Ft)						20.37
			Ac-Ft/Sq Mi						49.68
			Time to Peak (Hrs)						12.33
DT56A	Diversion	0.4100	Flow (cfs)						157
			Volume (Inches)						0.372
			Volume (Ac-Ft)						8.15
			Ac-Ft/Sq Mi						19.88
			Time to Peak (Hrs)						12.33
DV56A	Hydrograph	0.4100	Flow (cfs)						235
			Volume (Inches)						0.558
			Volume (Ac-Ft)						12.22
			Ac-Ft/Sq Mi						29.80
			Time to Peak (Hrs)						12.33
M2C	Combined	0.2500	Flow (cfs)						235
			Volume (Inches)						7.252
			Volume (Ac-Ft)						95.15
			Ac-Ft/Sq Mi						380.60
			Time to Peak (Hrs)						12.33
RTMCR	Routed	0.2500	Flow (cfs)						129
			Volume (Inches)						7.252
			Volume (Ac-Ft)						95.15
			Ac-Ft/Sq Mi						380.60
			Time to Peak (Hrs)						12.58
RTSPT1	Routed	0.2500	Flow (cfs)						124
			Volume (Inches)						7.252
			Volume (Ac-Ft)						95.15
			Ac-Ft/Sq Mi						380.60
			Time to Peak (Hrs)						13.33
56B	Hydrograph	0.3300	Flow (cfs)						708
			Volume (Inches)						2.328
			Volume (Ac-Ft)						41.47
			Ac-Ft/Sq Mi						125.67
			Time to Peak (Hrs)						12.08
56BRET	Diversion	0.3300	Flow (cfs)						708
			Volume (Inches)						2.328
			Volume (Ac-Ft)						41.47
			Ac-Ft/Sq Mi						125.67
			Time to Peak (Hrs)						12.08
56B-O	Hydrograph	0.3300	Flow (cfs)						
			Volume (Inches)						
			Volume (Ac-Ft)						
			Ac-Ft/Sq Mi						
			Time to Peak (Hrs)						

Major Basin ID	Type	Area		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
CP56B	Combined	0.5800	Flow (cfs)						124
			Volume (Inches)						3.076
			Volume (Ac-Ft)						95.15
			Ac-Ft/Sq Mi						164.05
			Time to Peak (Hrs)						13.33
RTURR	Routed	0.5800	Flow (cfs)						122
			Volume (Inches)						3.075
			Volume (Ac-Ft)						95.12
			Ac-Ft/Sq Mi						164.00
			Time to Peak (Hrs)						13.50
N5B	Combined	1.2600	Flow (cfs)						225
			Volume (Inches)						2.758
			Volume (Ac-Ft)						185.05
			Ac-Ft/Sq Mi						146.87
			Time to Peak (Hrs)						14.00
RTSPT2	Routed	1.2600	Flow (cfs)						225
			Volume (Inches)						2.758
			Volume (Ac-Ft)						185.05
			Ac-Ft/Sq Mi						146.87
			Time to Peak (Hrs)						14.08
70	Hydrograph	0.1400	Flow (cfs)						248
			Volume (Inches)						2.366
			Volume (Ac-Ft)						17.79
			Ac-Ft/Sq Mi						127.07
			Time to Peak (Hrs)						12.17
70RET	Diversion	0.1400	Flow (cfs)						248
			Volume (Inches)						1.636
			Volume (Ac-Ft)						12.30
			Ac-Ft/Sq Mi						87.86
			Time to Peak (Hrs)						12.17
70-O	Hydrograph	0.1400	Flow (cfs)						61
			Volume (Inches)						0.730
			Volume (Ac-Ft)						5.49
			Ac-Ft/Sq Mi						39.21
			Time to Peak (Hrs)						12.42
DV56A	Hydrograph	0.4100	Flow (cfs)						157
			Volume (Inches)						0.372
			Volume (Ac-Ft)						8.15
			Ac-Ft/Sq Mi						19.88
			Time to Peak (Hrs)						12.33
N6	Combined	1.5600	Flow (cfs)						241
			Volume (Inches)						2.372
			Volume (Ac-Ft)						197.77
			Ac-Ft/Sq Mi						126.78
			Time to Peak (Hrs)						14.00
RTSPT3	Routed	1.5600	Flow (cfs)						240
			Volume (Inches)						2.372
			Volume (Ac-Ft)						197.77
			Ac-Ft/Sq Mi						126.78

Major Basin ID	Type	Area		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
			Time to Peak (Hrs)						14.33
92N	Hydrograph	0.3300	Flow (cfs)						609
			Volume (Inches)						2.905
			Volume (Ac-Ft)						50.66
			Ac-Ft/Sq Mi						153.52
			Time to Peak (Hrs)						12.25
92NRET	Diversion	0.3300	Flow (cfs)						598
			Volume (Inches)						1.485
			Volume (Ac-Ft)						25.90
			Ac-Ft/Sq Mi						78.48
			Time to Peak (Hrs)						12.17
92N-O	Hydrograph	0.3300	Flow (cfs)						524
			Volume (Inches)						1.420
			Volume (Ac-Ft)						24.76
			Ac-Ft/Sq Mi						75.03
			Time to Peak (Hrs)						12.33
O10A	Combined	1.8900	Flow (cfs)						531
			Volume (Inches)						2.196
			Volume (Ac-Ft)						221.39
			Ac-Ft/Sq Mi						117.14
			Time to Peak (Hrs)						12.33
71	Hydrograph	0.1600	Flow (cfs)						357
			Volume (Inches)						2.374
			Volume (Ac-Ft)						19.62
			Ac-Ft/Sq Mi						122.63
			Time to Peak (Hrs)						12.08
71RET	Diversion	0.1600	Flow (cfs)						357
			Volume (Inches)						1.645
			Volume (Ac-Ft)						13.60
			Ac-Ft/Sq Mi						85.00
			Time to Peak (Hrs)						12.08
71-O	Hydrograph	0.1600	Flow (cfs)						69
			Volume (Inches)						0.729
			Volume (Ac-Ft)						6.02
			Ac-Ft/Sq Mi						37.63
			Time to Peak (Hrs)						12.17
93	Hydrograph	0.3800	Flow (cfs)						527
			Volume (Inches)						2.453
			Volume (Ac-Ft)						49.33
			Ac-Ft/Sq Mi						129.82
			Time to Peak (Hrs)						12.33
93RET	Diversion	0.3800	Flow (cfs)						527
			Volume (Inches)						1.293
			Volume (Ac-Ft)						26.00
			Ac-Ft/Sq Mi						68.42
			Time to Peak (Hrs)						12.33
93-O	Hydrograph	0.3800	Flow (cfs)						422
			Volume (Inches)						1.160

Major Basin ID	Type	Area		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
			Volume (Ac-Ft)						23.33
			Ac-Ft/Sq Mi						61.39
			Time to Peak (Hrs)						12.42
O9	Combined	0.5300	Flow (cfs)						451
			Volume (Inches)						1.032
			Volume (Ac-Ft)						29.33
			Ac-Ft/Sq Mi						55.34
			Time to Peak (Hrs)						12.42
RT2314	Routed	0.5300	Flow (cfs)						328
			Volume (Inches)						1.032
			Volume (Ac-Ft)						29.33
			Ac-Ft/Sq Mi						55.34
			Time to Peak (Hrs)						12.67
95	Hydrograph	0.5200	Flow (cfs)						536
			Volume (Inches)						2.351
			Volume (Ac-Ft)						65.46
			Ac-Ft/Sq Mi						125.88
			Time to Peak (Hrs)						12.67
95RET	Diversion	0.5200	Flow (cfs)						536
			Volume (Inches)						1.160
			Volume (Ac-Ft)						32.30
			Ac-Ft/Sq Mi						62.12
			Time to Peak (Hrs)						12.67
95-O	Hydrograph	0.5200	Flow (cfs)						487
			Volume (Inches)						1.191
			Volume (Ac-Ft)						33.16
			Ac-Ft/Sq Mi						63.77
			Time to Peak (Hrs)						12.83
P8B	Combined	1.0500	Flow (cfs)						718
			Volume (Inches)						1.108
			Volume (Ac-Ft)						62.33
			Ac-Ft/Sq Mi						59.36
			Time to Peak (Hrs)						12.83
RTMRA	Routed	1.0500	Flow (cfs)						573
			Volume (Inches)						1.108
			Volume (Ac-Ft)						62.33
			Ac-Ft/Sq Mi						59.36
			Time to Peak (Hrs)						13.08
O10B	Combined	2.9400	Flow (cfs)						706
			Volume (Inches)						1.782
			Volume (Ac-Ft)						279.89
			Ac-Ft/Sq Mi						95.20
			Time to Peak (Hrs)						13.08
DET24	Hydrograph	0.1600	Flow (cfs)						153
			Volume (Inches)						6.043
			Volume (Ac-Ft)						51.57
			Ac-Ft/Sq Mi						322.31
			Time to Peak (Hrs)						36.50

Major Basin ID	Type	Area		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
TOBINF	Combined	3.1100	Flow (cfs)						706
			Volume (Inches)						2.000
			Volume (Ac-Ft)						331.14
			Ac-Ft/Sq Mi						106.48
			Time to Peak (Hrs)						13.08
RTWTR	Routed	3.1100	Flow (cfs)						681
			Volume (Inches)						2.000
			Volume (Ac-Ft)						331.14
			Ac-Ft/Sq Mi						106.48
			Time to Peak (Hrs)						13.25
DRAN24	Hydrograph	0.7500	Flow (cfs)						535
			Volume (Inches)						3.236
			Volume (Ac-Ft)						129.44
			Ac-Ft/Sq Mi						172.59
			Time to Peak (Hrs)						37.50
92S	Hydrograph	0.6900	Flow (cfs)						1,004
			Volume (Inches)						2.684
			Volume (Ac-Ft)						98.33
			Ac-Ft/Sq Mi						142.51
			Time to Peak (Hrs)						12.42
92SRET	Diversion	0.6900	Flow (cfs)						990
			Volume (Inches)						1.411
			Volume (Ac-Ft)						51.70
			Ac-Ft/Sq Mi						74.93
			Time to Peak (Hrs)						12.33
92S-O	Hydrograph	0.6900	Flow (cfs)						907
			Volume (Inches)						1.273
			Volume (Ac-Ft)						46.63
			Ac-Ft/Sq Mi						67.58
			Time to Peak (Hrs)						12.50
TOB92S	Combined	1.4400	Flow (cfs)						907
			Volume (Inches)						2.290
			Volume (Ac-Ft)						175.54
			Ac-Ft/Sq Mi						121.90
			Time to Peak (Hrs)						12.50
58	Hydrograph	0.1900	Flow (cfs)						416
			Volume (Inches)						2.330
			Volume (Ac-Ft)						23.61
			Ac-Ft/Sq Mi						124.26
			Time to Peak (Hrs)						12.08
58RET	Diversion	0.1900	Flow (cfs)						416
			Volume (Inches)						1.638
			Volume (Ac-Ft)						16.60
			Ac-Ft/Sq Mi						87.37
			Time to Peak (Hrs)						12.08
58-O	Hydrograph	0.1900	Flow (cfs)						72
			Volume (Inches)						0.692
			Volume (Ac-Ft)						7.01
			Ac-Ft/Sq Mi						36.89

Major Basin ID	Type	Area		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
			Time to Peak (Hrs)						12.25
72	Hydrograph	0.0900	Flow (cfs)						175
			Volume (Inches)						2.102
			Volume (Ac-Ft)						9.64
			Ac-Ft/Sq Mi						107.11
			Time to Peak (Hrs)						12.08
72RET	Diversion	0.0900	Flow (cfs)						175
			Volume (Inches)						1.635
			Volume (Ac-Ft)						7.50
			Ac-Ft/Sq Mi						83.33
			Time to Peak (Hrs)						12.08
72-O	Hydrograph	0.0900	Flow (cfs)						9
			Volume (Inches)						0.467
			Volume (Ac-Ft)						2.14
			Ac-Ft/Sq Mi						23.78
			Time to Peak (Hrs)						12.67
P6	Combined	0.2800	Flow (cfs)						72
			Volume (Inches)						0.621
			Volume (Ac-Ft)						9.14
			Ac-Ft/Sq Mi						32.64
			Time to Peak (Hrs)						12.25
94	Hydrograph	0.7200	Flow (cfs)						875
			Volume (Inches)						2.142
			Volume (Ac-Ft)						82.13
			Ac-Ft/Sq Mi						114.07
			Time to Peak (Hrs)						12.50
94RET	Diversion	0.7200	Flow (cfs)						875
			Volume (Inches)						1.119
			Volume (Ac-Ft)						42.90
			Ac-Ft/Sq Mi						59.58
			Time to Peak (Hrs)						12.50
94-O	Hydrograph	0.7200	Flow (cfs)						712
			Volume (Inches)						1.023
			Volume (Ac-Ft)						39.23
			Ac-Ft/Sq Mi						54.49
			Time to Peak (Hrs)						12.67
P7	Combined	0.8100	Flow (cfs)						746
			Volume (Inches)						1.126
			Volume (Ac-Ft)						48.34
			Ac-Ft/Sq Mi						59.68
			Time to Peak (Hrs)						12.67
94-P8A	Routed	0.8100	Flow (cfs)						571
			Volume (Inches)						1.126
			Volume (Ac-Ft)						48.34
			Ac-Ft/Sq Mi						59.68
			Time to Peak (Hrs)						12.92
96	Hydrograph	0.9100	Flow (cfs)						824
			Volume (Inches)						1.725

Major Basin ID	Type	Area		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
			Volume (Ac-Ft)						84.08
			Ac-Ft/Sq Mi						92.40
			Time to Peak (Hrs)						12.75
96RET	Diversion	0.9100	Flow (cfs)						824
			Volume (Inches)						1.118
			Volume (Ac-Ft)						54.50
			Ac-Ft/Sq Mi						59.89
			Time to Peak (Hrs)						12.75
96-O	Hydrograph	0.9100	Flow (cfs)						551
			Volume (Inches)						0.607
			Volume (Ac-Ft)						29.58
			Ac-Ft/Sq Mi						32.51
			Time to Peak (Hrs)						13.08
P8A	Combined	1.7200	Flow (cfs)						978
			Volume (Inches)						0.831
			Volume (Ac-Ft)						76.23
			Ac-Ft/Sq Mi						44.32
			Time to Peak (Hrs)						13.08
P8A-P9	Routed	1.7200	Flow (cfs)						617
			Volume (Inches)						0.831
			Volume (Ac-Ft)						76.23
			Ac-Ft/Sq Mi						44.32
			Time to Peak (Hrs)						13.67
97	Hydrograph	0.5000	Flow (cfs)						463
			Volume (Inches)						1.769
			Volume (Ac-Ft)						47.18
			Ac-Ft/Sq Mi						94.36
			Time to Peak (Hrs)						12.75
97RET	Diversion	0.5000	Flow (cfs)						463
			Volume (Inches)						1.054
			Volume (Ac-Ft)						28.10
			Ac-Ft/Sq Mi						56.20
			Time to Peak (Hrs)						12.75
97-O	Hydrograph	0.5000	Flow (cfs)						369
			Volume (Inches)						0.716
			Volume (Ac-Ft)						19.08
			Ac-Ft/Sq Mi						38.16
			Time to Peak (Hrs)						12.92
P9	Combined	6.7600	Flow (cfs)						1,166
			Volume (Inches)						1.613
			Volume (Ac-Ft)						581.63
			Ac-Ft/Sq Mi						86.04
			Time to Peak (Hrs)						12.50
RTWTR	Routed	6.7600	Flow (cfs)						1,076
			Volume (Inches)						1.613
			Volume (Ac-Ft)						581.63
			Ac-Ft/Sq Mi						86.04
			Time to Peak (Hrs)						13.83

Major Basin ID	Type	Area		2 Yr	5 Yr	10 Yr	25 Yr	50 Yr	100 Yr
100	Hydrograph	0.5800	Flow (cfs)						506
			Volume (Inches)						1.577
			Volume (Ac-Ft)						48.96
			Ac-Ft/Sq Mi						84.41
			Time to Peak (Hrs)						12.67
100RET	Diversion	0.5800	Flow (cfs)						506
			Volume (Inches)						1.121
			Volume (Ac-Ft)						34.80
			Ac-Ft/Sq Mi						60.00
			Time to Peak (Hrs)						12.67
100-O	Hydrograph	0.5800	Flow (cfs)						279
			Volume (Inches)						0.456
			Volume (Ac-Ft)						14.16
			Ac-Ft/Sq Mi						24.41
			Time to Peak (Hrs)						13.08
P10	Combined	7.3400	Flow (cfs)						1,093
			Volume (Inches)						1.508
			Volume (Ac-Ft)						590.51
			Ac-Ft/Sq Mi						80.45
			Time to Peak (Hrs)						13.83

Diversion ID/ DT Card ID	Maximum Volume (ac-ft)	Maximum Diversion (cfs)		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
100-O	35		**Inflow (cfs)**		10,000								
100RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
10E-O	39		**Inflow (cfs)**		10,000								
10ERET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
11A-O	62		**Inflow (cfs)**		10,000								
11ARET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
11B-O	47		**Inflow (cfs)**		10,000								
11BRET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
11C-O	25		**Inflow (cfs)**		10,000								
11CRET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
12-O	80		**Inflow (cfs)**		10,000								
12RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
13-O	78		**Inflow (cfs)**		10,000								
13RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
14A-O	51		**Inflow (cfs)**		10,000								
14ARET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
14B-O	62		**Inflow (cfs)**		10,000								
14BRET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
22E-O	18		**Inflow (cfs)**		10,000								
22ERET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													

Diversion ID/ DT Card ID	Maximum Volume (ac-ft)	Maximum Diversion (cfs)		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
23-O	33		**Inflow (cfs)**		10,000								
23RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
24-O	-		**Inflow (cfs)**		10,000								
24RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
25-O	17		**Inflow (cfs)**		10,000								
25RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
26-O	4		**Inflow (cfs)**		10,000								
26RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
36-O	43		**Inflow (cfs)**		10,000								
36RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
37-O	93		**Inflow (cfs)**		10,000								
37RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
38-O	33		**Inflow (cfs)**		10,000								
38RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
39-O	44		**Inflow (cfs)**		10,000								
39RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
40-O	62		**Inflow (cfs)**		10,000								
40RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
47N-O	14		**Inflow (cfs)**		10,000								
47NRET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													

Diversion ID/ DT Card ID	Maximum Volume (ac-ft)	Maximum Diversion (cfs)		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
48-O	32		**Inflow (cfs)**		10,000								
48RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
49-O	79		**Inflow (cfs)**		10,000								
49RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
50-O	61		**Inflow (cfs)**		10,000								
50RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
51-O	62		**Inflow (cfs)**		10,000								
51RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
56A-O	30		**Inflow (cfs)**		10,000								
56ARET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
56B-O	69		**Inflow (cfs)**		10,000								
56BRET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
changed from original 29.1 value used in Base Model. Uses existing volume from WalMart site.													
57-O	69		**Inflow (cfs)**		10,000								
57RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
changed from original 27.4 value used in Base Model.													
58-O	17		**Inflow (cfs)**		10,000								
58RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
70-O	12		**Inflow (cfs)**		10,000								
70RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
71-O	14		**Inflow (cfs)**		10,000								
71RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													

Diversion ID/ DT Card ID	Maximum Volume (ac-ft)	Maximum Diversion (cfs)		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
72-O	8		**Inflow (cfs)**		10,000								
72RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
83-O	48		**Inflow (cfs)**		10,000								
83RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
93-O	26		**Inflow (cfs)**		10,000								
93RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
94-O	43		**Inflow (cfs)**		10,000								
94RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
95-O	32		**Inflow (cfs)**		10,000								
95RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
96-O	55		**Inflow (cfs)**		10,000								
96RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
97-O	28		**Inflow (cfs)**		10,000								
97RET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
92N-O	26		**Inflow (cfs)**		10,000								
92NRET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
92S-O	52		**Inflow (cfs)**		10,000								
92SRET			**Diversion (cfs)**		10,000								
Planned/Existing Development Retention													
MB01			**Inflow (cfs)**		50	51	10,000						
DIMB01			**Diversion (cfs)**			1	9,950						
RAINBOW BASIN													

Diversion ID/ DT Card ID	Maximum Volume (ac-ft)	Maximum Diversion (cfs)		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
MB02			**Inflow (cfs)**		60	61	10,000						
DIMB02			**Diversion (cfs)**			1	9,950						
RAILROAD BASIN													
MB03			**Inflow (cfs)**		50	51	10,000						
DIMB03			**Diversion (cfs)**			1	9,950						
APACHE BASIN													
MB04			**Inflow (cfs)**		100	101	10,000						
DIMB04			**Diversion (cfs)**			1	9,950						
MARICOPA BASIN													
MB05			**Inflow (cfs)**		50	51	10,000						
DIMB05			**Diversion (cfs)**			1	9,950						
DEAN BASIN													
DV56A			**Inflow (cfs)**		100	200	500	1,000	2,000	4,000	10,000	20,000	50,000
DT56A			**Diversion (cfs)**		40	80	200	400	800	1,600	4,000	8,000	20,000
DVEVB		76	**Inflow (cfs)**		10,000								
DTEVB			**Diversion (cfs)**		10,000								
ESTRELLA VISTA @ BUCKEYE DIVERSION FROM SUBBASIN 37													
DVCV		76	**Inflow (cfs)**		10,000								
DTCV			**Diversion (cfs)**		10,000								
BROADWAY ESTATES/CRYSTAL VISTA DIVERSION FROM SUBBASIN 37													
DVMV		76	**Inflow (cfs)**		10,000								
DTMV			**Diversion (cfs)**		10,000								
MYSTIC VISTA DIVERSION FROM SUBBASIN 37													
DVW37		1,000	**Inflow (cfs)**		10,000								
DTW37			**Diversion (cfs)**		10,000								
WEST HALF OF SUBBASIN 37													
DVAF38		95	**Inflow (cfs)**		10,000								
DTAF38			**Diversion (cfs)**		10,000								
APACHE FARMS DIVERSION FROM SUBBASIN 38													

Diversion ID/ DT Card ID	Maximum Volume (ac-ft)	Maximum Diversion (cfs)		1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
DVMV49		5	**Inflow (cfs)**		10,000								
DTMV49			**Diversion (cfs)**		10,000								
MONTANA VISTA DIVERSION FROM SUBBASIN 49													
DVCM49		3	**Inflow (cfs)**		10,000								
DTCM49			**Diversion (cfs)**		10,000								
COTTON MEADOWS DIVERSION FROM SUBBASIN 49													

Route ID	LOB N	Chan N	ROB N	Length (ft)	Slope (ft/ft)	Max Elev (ft)		1.	2.	3.	4.	5.	6.	7.	8.
NORMAL DEPTH															
Major Basin 01															
37-M2B	0.030	0.030	0.030	2,443.00	0.0074	-	X:	-	2.00	10.00	18.00	47.00	55.00	63.00	65.00
							Y:	4.50	4.00	2.00	-	-	2.00	4.00	4.50
94-P8A	0.030	0.030	0.030	6,356.60	0.0080	-	X:	-	2.00	10.00	18.00	54.50	62.50	70.50	72.50
							Y:	4.50	4.00	2.00	-	-	2.00	4.00	4.50
L1AL2A	0.030	0.030	0.030	3,239.80	0.0080	-	X:	-	2.00	10.00	18.00	44.70	52.70	60.70	62.70
							Y:	4.50	4.00	2.00	-	-	2.00	4.00	4.50
L3-M2A	0.030	0.030	0.030	2,443.00	0.0074	-	X:	-	2.00	10.00	18.00	47.00	55.00	63.00	65.00
							Y:	4.50	4.00	2.00	-	-	2.00	4.00	4.50
N1A-1B	0.030	0.030	0.030	6,236.10	0.0090	-	X:	-	2.00	10.00	18.00	27.90	35.90	43.90	45.90
							Y:	4.50	4.00	2.00	-	-	2.00	4.00	4.50
N1BO4	0.030	0.030	0.030	3,958.80	0.0030	-	X:	-	2.00	10.00	18.00	24.40	32.40	40.40	42.40
							Y:	4.50	4.00	2.00	-	-	2.00	4.00	4.50
N1C-N2	0.030	0.030	0.030	3,029.50	0.0100	-	X:	-	2.00	10.00	18.00	32.30	40.30	48.30	50.30
							Y:	4.50	4.00	2.00	-	-	2.00	4.00	4.50
N3-N4	0.030	0.030	0.030	5,206.40	0.0087	-	X:	-	2.00	10.00	18.00	34.00	42.00	50.00	52.00
							Y:	4.50	4.00	2.00	-	-	2.00	4.00	4.50
N4-O6	0.030	0.030	0.030	2,653.50	0.0010	-	X:	-	2.00	10.00	18.00	66.90	74.90	82.90	84.90
							Y:	4.50	4.00	2.00	-	-	2.00	4.00	4.50
O1-O2	0.030	0.030	0.030	2,743.80	0.0130	-	X:	-	2.00	10.20	18.40	39.70	47.90	56.10	58.10
							Y:	4.60	4.10	2.05	-	-	2.05	4.10	4.60
O2-O3A	0.030	0.030	0.030	2,815.00	0.0110	-	X:	-	2.00	10.10	18.10	35.50	43.50	51.60	53.60
							Y:	4.53	4.03	2.02	-	-	2.02	4.03	4.53

Route ID	LOB N	Chan N	ROB N	Length (ft)	Slope (ft/ft)	Max Elev (ft)		1.	2.	3.	4.	5.	6.	7.	8.
O3AO3B	0.030	0.030	0.030	2,510.20	0.0020	-	X:	-	2.00	10.00	18.00	74.30	82.30	90.30	92.30
							Y:	4.50	4.00	2.00	-	-	2.00	4.00	4.50
P1AP1B	0.030	0.030	0.030	3,128.60	0.0100	-	X:	-	2.00	10.00	18.00	22.00	30.00	38.00	40.00
							Y:	4.50	4.00	2.00	-	-	2.00	4.00	4.50
P1B-P2	0.030	0.030	0.030	4,031.60	0.0070	-	X:	-	2.00	10.00	18.00	45.90	53.90	61.90	63.90
							Y:	4.50	4.00	2.00	-	-	2.00	4.00	4.50
P2-O4	0.030	0.030	0.030	4,430.20	0.0010	-	X:	-	2.00	10.00	18.00	85.30	93.30	101.30	103.30
							Y:	4.50	4.00	2.00	-	-	2.00	4.00	4.50
P3-P4	0.030	0.030	0.030	5,240.90	0.0080	-	X:	-	2.00	10.00	18.00	22.00	30.00	38.00	40.00
							Y:	4.50	4.00	2.00	-	-	2.00	4.00	4.50
P4-P5	0.030	0.030	0.030	2,651.50	0.0080	-	X:	-	2.00	10.00	18.00	37.10	45.10	53.10	55.10
							Y:	4.50	4.00	2.00	-	-	2.00	4.00	4.50
P8A-P9	0.030	0.030	0.030	5,738.60	0.0010	-	X:	-	2.00	10.00	18.00	175.30	183.30	191.30	193.30
							Y:	4.50	4.00	2.00	-	-	2.00	4.00	4.50
RT2311	0.035	0.035	0.035	3,818.70	0.0070	-	X:	-	40.00	62.00	69.00	76.00	97.00	117.00	137.00
							Y:	100.00	100.00	96.40	96.40	96.40	100.00	100.00	100.00
RT2312	0.035	0.035	0.035	5,991.00	0.0070	-	X:	-	40.00	63.00	72.00	80.00	104.00	124.00	144.00
							Y:	100.00	100.00	96.10	96.10	96.10	100.00	100.00	100.00
RT2313	0.035	0.016	0.035	2,899.00	0.0040	-	X:	-	20.00	39.00	47.00	51.00	55.00	63.00	73.00
							Y:	100.00	100.00	100.00	98.00	98.00	98.00	100.00	100.00
RT2314	0.035	0.035	0.035	2,879.90	0.0040	-	X:	-	40.00	64.00	73.00	81.00	106.00	126.00	146.00
							Y:	100.00	100.00	95.90	95.90	95.90	100.00	100.00	100.00
RTAPR1	0.032	0.022	0.032	2,354.30	0.0055	-	X:	-	60.00	66.00	72.00	81.00	87.00	94.00	109.00
							Y:	100.00	100.00	98.40	96.90	96.90	95.40	100.00	100.00

Route ID	LOB N	Chan N	ROB N	Length (ft)	Slope (ft/ft)	Max Elev (ft)		1.	2.	3.	4.	5.	6.	7.	8.
RTAPR2	0.032	0.022	0.032	2,613.50	0.0055	-	X:	-	60.00	66.00	73.00	83.00	90.00	96.00	111.00
							Y:	100.00	100.00	98.40	96.80	96.80	95.20	100.00	100.00
RTAPR3	0.032	0.022	0.032	2,798.70	0.0055	-	X:	-	60.00	67.00	73.00	85.00	91.00	99.00	114.00
							Y:	100.00	100.00	98.30	96.70	96.70	95.10	100.00	100.00
RTAPR4	0.032	0.022	0.032	2,748.40	0.0055	-	X:	-	60.00	67.00	73.00	85.00	91.00	99.00	114.00
							Y:	100.00	100.00	98.30	96.70	96.70	95.10	100.00	100.00
RTMCR1	0.033	0.033	0.033	5,521.20	0.0008	-	X:	-	10.00	36.00	43.00	50.00	76.00	96.00	116.00
							Y:	100.00	100.00	96.70	96.70	96.70	100.00	100.00	100.00
RTMCR2	0.033	0.033	0.033	2,512.70	0.0015	-	X:	-	10.00	34.00	41.00	47.00	71.00	91.00	111.00
							Y:	100.00	100.00	95.60	95.60	95.60	100.00	100.00	100.00
RTMRA1	0.035	0.035	0.035	2,669.60	0.0008	-	X:	-	40.00	76.00	91.00	106.00	142.00	162.00	182.00
							Y:	100.00	100.00	94.00	94.00	94.00	100.00	100.00	100.00
RTSPT1	0.035	0.035	0.035	986.90	0.0045	-	X:	-	40.00	61.00	67.00	72.00	92.00	112.00	132.00
							Y:	100.00	100.00	96.50	96.50	96.50	100.00	100.00	100.00
RTSPT2	0.035	0.035	0.035	879.40	0.0010	-	X:	-	40.00	65.00	72.00	79.00	105.00	125.00	145.00
							Y:	100.00	100.00	95.80	95.80	95.80	100.00	100.00	100.00
RTSPT3	0.035	0.035	0.035	4,340.90	0.0056	-	X:	-	40.00	64.00	73.00	82.00	106.00	126.00	146.00
							Y:	100.00	100.00	96.00	96.00	96.00	100.00	100.00	100.00
RTURR1	0.035	0.016	0.035	926.10	0.0010	-	X:	-	20.00	39.00	48.00	52.00	56.00	66.00	76.00
							Y:	100.00	100.00	100.00	97.70	97.70	97.70	100.00	100.00
RTURR2	0.035	0.016	0.035	5,087.70	0.0010	-	X:	-	20.00	39.00	51.00	55.00	59.00	71.00	81.00
							Y:	100.00	100.00	100.00	97.00	97.00	97.00	100.00	100.00
RTURR3	0.035	0.016	0.035	2,363.40	0.0010	-	X:	-	20.00	39.00	54.00	58.00	62.00	78.00	88.00
							Y:	100.00	100.00	100.00	96.10	96.10	96.10	100.00	100.00

Route ID	LOB N	Chan N	ROB N	Length (ft)	Slope (ft/ft)	Max Elev (ft)		1.	2.	3.	4.	5.	6.	7.	8.
RTWTR1	0.032	0.022	0.032	2,380.20	0.0011	-	X:	-	60.00	70.00	80.00	105.00	115.00	125.00	140.00
							Y:	100.00	100.00	97.50	95.00	95.00	92.50	100.00	100.00
RTWTR2	0.032	0.020	0.032	4,011.40	0.0010	-	X:	-	54.00	92.00	107.00	112.00	117.00	131.00	169.00
							Y:	100.00	100.00	93.70	93.70	92.70	93.70	93.70	100.00

FCDMC
Drainage Design Management System
LAND USE
Project Reference: WATSON PD 24H RECPLN

Sub Basin	Land Use Code	Area (sq mi)	Area (%)	Initial Loss (IA)	Percent Impervious (RTIMP)	Vegetation Cover (%)	DTHETA	Kn	Description
Major Basin ID: 01									
100	134	0.5731	98.5	0.29	18	50.0	NORMAL	0.050	LDR CUSTOM 80% LLR (130) & 20% MDR (140)
	150	0.0085	1.5	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
		0.5816	**100.0**						
10E	134	0.0368	6.2	0.29	18	50.0	NORMAL	0.050	LDR CUSTOM 80% LLR (130) & 20% MDR (140)
	150	0.4918	83.1	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
	234	0.0005	0.1	0.10	80	72.0	NORMAL	0.020	RC CUSTOM 33% (220), 33% (230), & 33% (240)
	810	0.0628	10.6	0.10	80	75.0	NORMAL	0.020	Business Park (enclosed industrial, office or retail)
		0.5919	**100.0**						
11A	134	0.1367	23.9	0.29	18	50.0	NORMAL	0.050	LDR CUSTOM 80% LLR (130) & 20% MDR (140)
	150	0.2768	48.5	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
	234	0.1449	25.4	0.10	80	72.0	NORMAL	0.020	RC CUSTOM 33% (220), 33% (230), & 33% (240)
	810	0.0128	2.2	0.10	80	75.0	NORMAL	0.020	Business Park (enclosed industrial, office or retail)
		0.5712	**100.0**						
11B	150	0.5791	99.7	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
	234	0.0016	0.3	0.10	80	72.0	NORMAL	0.020	RC CUSTOM 33% (220), 33% (230), & 33% (240)
		0.5807	**100.0**						
11C	150	0.3432	100.0	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
		0.3432	**100.0**						
12	120	0.0594	8.1	0.30	5	30.0	NORMAL	0.050	Estate Residential (1/5 du per acre to 1 du per acre)
	134	0.0025	0.3	0.29	18	50.0	NORMAL	0.050	LDR CUSTOM 80% LLR (130) & 20% MDR (140)
	150	0.4790	65.0	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)

* Non default value

FCDMC
Drainage Design Management System
LAND USE
Project Reference: WATSON PD 24H RECPLN

Sub Basin	Land Use Code	Area (sq mi)	Area (%)	Initial Loss (IA)	Percent Impervious (RTIMP)	Vegetation Cover (%)	DTHETA	Kn	Description
Major Basin ID: 01									
12	234	0.1957	26.6	0.10	80	72.0	NORMAL	0.020	RC CUSTOM 33% (220), 33% (230), & 33% (240)
		0.7366	**100.0**						
13	134	0.1366	27.2	0.29	18	50.0	NORMAL	0.050	LDR CUSTOM 80% LLR (130) & 20% MDR (140)
	150	0.2895	57.7	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
	234	0.0752	15.0	0.10	80	72.0	NORMAL	0.020	RC CUSTOM 33% (220), 33% (230), & 33% (240)
		0.5013	**99.9**						
14A	120	0.0805	11.6	0.30	5	30.0	NORMAL	0.050	Estate Residential (1/5 du per acre to 1 du per acre)
	150	0.6118	88.4	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
		0.6923	**100.0**						
14B	134	0.1349	26.9	0.29	18	50.0	NORMAL	0.050	LDR CUSTOM 80% LLR (130) & 20% MDR (140)
	150	0.3666	73.1	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
		0.5015	**100.0**						
22E	150	0.2862	100.0	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
		0.2862	**100.0**						
23	150	0.5238	100.0	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
		0.5238	**100.0**						
24	134	0.4890	100.0	0.29	18	50.0	NORMAL	0.050	LDR CUSTOM 80% LLR (130) & 20% MDR (140)
	150	0.0001		0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
		0.4891	**100.0**						
25	134	0.2731	99.6	0.29	18	50.0	NORMAL	0.050	LDR CUSTOM 80% LLR (130) & 20% MDR (140)
	150	0.0011	0.4	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)

* Non default value

FCDMC
Drainage Design Management System
LAND USE
Project Reference: WATSON PD 24H RECPLN

Sub Basin	Land Use Code	Area (sq mi)	Area (%)	Initial Loss (IA)	Percent Impervious (RTIMP)	Vegetation Cover (%)	DTHETA	Kn	Description
Major Basin ID: 01									
		0.2742	**100.0**						
26	134	0.5192	99.0	0.29	18	50.0	NORMAL	0.050	LDR CUSTOM 80% LLR (130) & 20% MDR (140)
	150	0.0053	1.0	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
		0.5245	**100.0**						
36	134	0.2012	29.4	0.29	18	50.0	NORMAL	0.050	LDR CUSTOM 80% LLR (130) & 20% MDR (140)
	150	0.4356	63.7	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
	320	0.0470	6.9	0.15	55	60.0	NORMAL	0.020	Industrial
		0.6838	**100.0**						
37	150	1.2995	91.4	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
	210	0.1216	8.6	0.10	80	75.0	NORMAL	0.020	Specialty Commercial (<=50,000 sq. ft.)
		1.4211	**100.0**						
38	150	0.5420	100.0	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
		0.5420	**100.0**						
39	150	0.7254	100.0	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
		0.7254	**100.0**						
40	150	0.9761	100.0	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
		0.9761	**100.0**						
47N	150	0.2326	100.0	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
		0.2326	**100.0**						
48	150	0.4755	95.1	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
	550	0.0243	4.9	0.10	80	75.0	NORMAL	0.020	Public Facilities (comm centers, libraries, sub-stations)

* Non default value

FCDMC
Drainage Design Management System
LAND USE
Project Reference: WATSON PD 24H RECPLN

Major Basin ID: 01

Sub Basin	Land Use Code	Area (sq mi)	Area (%)	Initial Loss (IA)	Percent Impervious (RTIMP)	Vegetation Cover (%)	DTHETA	Kn	Description
		0.4998	**100.0**						
49	150	1.0089	100.0	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
	320	0.0005		0.15	55	60.0	NORMAL	0.020	Industrial
		1.0094	**100.0**						
50	150	1.0012	99.9	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
	320	0.0007	0.1	0.15	55	60.0	NORMAL	0.020	Industrial
		1.0019	**100.0**						
51	150	1.0035	100.0	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
	320	0.0005		0.15	55	60.0	NORMAL	0.020	Industrial
		1.0040	**100.0**						
56A	150	0.0001		0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
	320	0.4103	100.0	0.15	55	60.0	NORMAL	0.020	Industrial
	550	0.0001		0.10	80	75.0	NORMAL	0.020	Public Facilities (comm centers, libraries, sub-stations)
		0.4105	**100.0**						
56B	320	0.3335	100.0	0.15	55	60.0	NORMAL	0.020	Industrial
		0.3335	**100.0**						
57	320	0.4886	100.0	0.15	55	60.0	NORMAL	0.020	Industrial
		0.4886	**100.0**						
58	320	0.1898	100.0	0.15	55	60.0	NORMAL	0.020	Industrial
		0.1898	**100.0**						
70	320	0.1406	100.0	0.15	55	60.0	NORMAL	0.020	Industrial

* Non default value

FCDMC
Drainage Design Management System
LAND USE
Project Reference: WATSON PD 24H RECPLN

Sub Basin	Land Use Code	Area (sq mi)	Area (%)	Initial Loss (IA)	Percent Impervious (RTIMP)	Vegetation Cover (%)	DTHETA	Kn	Description
Major Basin ID: 01									
		0.1406	**100.0**						
71	320	0.1553	100.0	0.15	55	60.0	NORMAL	0.020	Industrial
		0.1553	**100.0**						
72	320	0.0856	100.0	0.15	55	60.0	NORMAL	0.020	Industrial
		0.0856	**100.0**						
83	120	0.0656	9.7	0.30	5	30.0	NORMAL	0.050	Estate Residential (1/5 du per acre to 1 du per acre)
	150	0.6096	90.3	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
		0.6752	**100.0**						
92N	218	0.2347	71.8	0.18	63	63.0	NORMAL	0.035	Mixed Use CUSTOM 50% (210) & 50% HDR (180)
	234	0.0866	26.5	0.10	80	72.0	NORMAL	0.020	RC CUSTOM 33% (220), 33% (230), & 33% (240)
	320	0.0002	0.1	0.15	55	60.0	NORMAL	0.020	Industrial
	550	0.0053	1.6	0.10	80	75.0	NORMAL	0.020	Public Facilities (comm centers, libraries, sub-stations)
		0.3268	**100.0**						
92S	150	0.1889	27.5	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
	218	0.3952	57.5	0.18	63	63.0	NORMAL	0.035	Mixed Use CUSTOM 50% (210) & 50% HDR (180)
	234	0.0096	1.4	0.10	80	72.0	NORMAL	0.020	RC CUSTOM 33% (220), 33% (230), & 33% (240)
	320	0.0050	0.7	0.15	55	60.0	NORMAL	0.020	Industrial
	550	0.0885	12.9	0.10	80	75.0	NORMAL	0.020	Public Facilities (comm centers, libraries, sub-stations)
		0.6872	**100.0**						
93	150	0.1721	45.6	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
	210	0.0562	14.9	0.10	80	75.0	NORMAL	0.020	Specialty Commercial (<=50,000 sq. ft.)

* Non default value

Sub Basin	Land Use Code	Area (sq mi)	Area (%)	Initial Loss (IA)	Percent Impervious (RTIMP)	Vegetation Cover (%)	DTHETA	Kn	Description
Major Basin ID: 01									
93	234	0.1480	39.2	0.10	80	72.0	NORMAL	0.020	RC CUSTOM 33% (220), 33% (230), & 33% (240)
	810	0.0012	0.3	0.10	80	75.0	NORMAL	0.020	Business Park (enclosed industrial, office or retail)
		0.3775	**100.0**						
94	134	0.0010	0.1	0.29	18	50.0	NORMAL	0.050	LDR CUSTOM 80% LLR (130) & 20% MDR (140)
	150	0.6501	90.3	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
	210	0.0685	9.5	0.10	80	75.0	NORMAL	0.020	Specialty Commercial (<=50,000 sq. ft.)
		0.7196	**99.9**						
95	134	0.0290	5.6	0.29	18	50.0	NORMAL	0.050	LDR CUSTOM 80% LLR (130) & 20% MDR (140)
	150	0.3628	69.5	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
	210	0.0332	6.4	0.10	80	75.0	NORMAL	0.020	Specialty Commercial (<=50,000 sq. ft.)
	218	0.0001		0.18	63	63.0	NORMAL	0.035	Mixed Use CUSTOM 50% (210) & 50% HDR (180)
	810	0.0971	18.6	0.10	80	75.0	NORMAL	0.020	Business Park (enclosed industrial, office or retail)
		0.5222	**100.1**						
96	134	0.9110	99.6	0.29	18	50.0	NORMAL	0.050	LDR CUSTOM 80% LLR (130) & 20% MDR (140)
	150	0.0033	0.4	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
		0.9143	**100.0**						
97	134	0.3458	69.1	0.29	18	50.0	NORMAL	0.050	LDR CUSTOM 80% LLR (130) & 20% MDR (140)
	150	0.1545	30.9	0.25	30	50.0	NORMAL	0.050	Small Lot Residential - Single Family (4-6 du per acre)
		0.5003	**100.0**						

Area ID	Book Number	Map Unit	Soil ID	Area (sq mi)	Area (%)	XKSAT	Rock Percent (%)	Effective Rock (%)	Comments
Major Basin ID: 01									
100	651	Ao	6512049	0.114	19.60	0.040	-	100	
	651	Ap	6512051	0.042	7.30	0.040	-	100	
	651	Br	6512255	0.003	0.50	1.050	-	100	
	651	Cn	6512447	0.012	2.00	0.010	-	100	
	651	Gh	6513235	0.210	36.10	0.240	-	100	
	651	Gt	6513259	0.014	2.50	0.040	-	100	
	651	GgA	651323320	0.186	32.00	0.250	-	100	
10E	651	AL	6512042	0.347	58.70	0.400	-	100	
	651	Cp	6512451	0.019	3.30	0.400	-	100	
	651	CV	6512462	0.035	5.90	0.390	-	100	
	651	Ma	6514421	0.004	0.60	0.400	-	100	
	651	LEVEE	6228622828	0.007	1.10	0.010	-	100	
	651	AbA	651202320	0.010	1.70	0.380	-	100	
	651	AGB	651203222	0.150	25.30	0.400	-	100	
	651	GYD	651326826	0.020	3.40	0.260	-	100	
11A	651	LEVEE	6228622828	0.031	5.40	0.010	-	100	
	651	AGB	651203222	0.135	23.60	0.400	-	100	
	651	GYD	651326826	0.115	20.20	0.260	-	100	
	651	TSC	651585624	0.290	50.80	0.140	-	100	
11B	651	Cp	6512451	0.001	0.10	0.400	-	100	
	651	Ma	6514421	0.001	0.10	0.400	-	100	
	651	Pa	6515021	0.022	3.70	0.400	-	100	
	651	AGB	651203222	0.351	60.40	0.400	-	100	
	651	GYD	651326826	0.141	24.30	0.260	-	100	
	651	HLC	651344224	0.019	3.20	0.140	-	100	
	651	RaA	651542120	0.027	4.60	0.390	-	100	
	651	TSC	651585624	0.021	3.60	0.140	-	100	
11C	651	AL	6512042	0.160	46.50	0.400	-	100	
	651	Cp	6512451	0.017	4.90	0.400	-	100	
	651	Ma	6514421	0.006	1.80	0.400	-	100	
	651	AbA	651202320	0.015	4.50	0.380	-	100	
	651	AGB	651203222	0.129	37.50	0.400	-	100	
	651	GYD	651326826	0.009	2.50	0.260	-	100	
	651	RaA	651542120	0.008	2.20	0.390	-	100	
12	651	AL	6512042	0.033	4.50	0.400	-	100	
	651	CV	6512462	0.043	5.80	0.390	-	100	
	651	TB	6515822	0.005	0.60	0.400	-	100	
	651	Vh	6516235	0.001	0.10	0.270	-	100	
	651	LEVEE	6228622828	0.018	2.50	0.010	-	100	
	651	AGB	651203222	0.243	33.00	0.400	-	100	
	651	GYD	651326826	0.288	39.10	0.260	-	100	
	651	HLC	651344224	0.020	2.70	0.140	-	100	
	651	PYD	651506826	0.064	8.70	0.200	-	100	
	651	TSC	651585624	0.022	3.00	0.140	-	100	
13	651	Cp	6512451	0.009	1.80	0.400	-	100	
	651	CV	6512462	0.057	11.30	0.390	-	100	
	651	Vh	6516235	0.002	0.40	0.270	-	100	
	651	AbA	651202320	0.012	2.50	0.380	-	100	
	651	AGB	651203222	0.064	12.70	0.400	-	100	
	651	GYD	651326826	0.060	11.90	0.260	-	100	
	651	HLC	651344224	0.239	47.70	0.140	-	100	
	651	PRB	651505422	0.050	10.00	0.280	-	100	
	651	TSC	651585624	0.009	1.70	0.140	-	100	
14A	651	AL	6512042	0.168	24.20	0.400	-	100	
	651	Cb	6512423	0.014	2.10	0.400	-	100	
	651	Cp	6512451	0.016	2.30	0.400	-	100	
	651	Vh	6516235	0.018	2.50	0.270	-	100	
	651	LEVEE	6228622828	0.010	1.50	0.010	-	100	
	651	AGB	651203222	0.321	46.40	0.400	-	100	
	651	GYD	651326826	0.101	14.50	0.260	-	100	
	651	HLC	651344224	0.045	6.50	0.140	-	100	
14B	651	Cb	6512423	0.009	1.70	0.400	-	100	
	651	Cp	6512451	0.312	62.30	0.400	-	100	

Area ID	Book Number	Map Unit	Soil ID	Area (sq mi)	Area (%)	XKSAT	Rock Percent (%)	Effective Rock (%)	Comments
Major Basin ID: 01									
14B	651	Pa	6515021	0.043	8.50	0.400	-	100	
	651	Vh	6516235	0.113	22.60	0.270	-	100	
	651	AbA	651202320	0.023	4.50	0.380	-	100	
	651	AdA	651202720	0.002	0.30	0.400	-	100	
22E	651	Cp	6512451	0.166	58.10	0.400	-	100	
	651	Lb	6514223	0.003	1.00	0.400	-	100	
	651	Ma	6514421	0.044	15.50	0.400	-	100	
	651	Mo	6514449	0.022	7.50	0.390	-	100	
	651	AbA	651202320	0.030	10.30	0.380	-	100	
	651	RaA	651542120	0.022	7.60	0.390	-	100	
23	651	AL	6512042	0.006	1.10	0.400	-	100	
	651	Cp	6512451	0.285	54.30	0.400	-	100	
	651	Ma	6514421	0.110	21.00	0.400	-	100	
	651	Pa	6515021	0.002	0.40	0.400	-	100	
	651	AbA	651202320	0.035	6.70	0.380	-	100	
	651	RaA	651542120	0.086	16.50	0.390	-	100	
24	651	AL	6512042	0.010	2.10	0.400	-	100	
	651	Cp	6512451	0.010	2.00	0.400	-	100	
	651	CV	6512462	0.082	16.70	0.390	-	100	
	651	Ma	6514421	0.053	10.90	0.400	-	100	
	651	Pa	6515021	0.044	9.10	0.400	-	100	
	651	AbA	651202320	0.037	7.60	0.380	-	100	
	651	AGB	651203222	0.019	3.80	0.400	-	100	
	651	HLC	651344224	0.123	25.20	0.140	-	100	
	651	LcA	651422520	0.013	2.60	0.250	-	100	
	651	PRB	651505422	0.098	19.90	0.280	-	100	
25	651	Cp	6512451	0.002	0.50	0.400	-	100	
	651	CV	6512462	0.001	0.50	0.390	-	100	
	651	Ma	6514421	0.060	21.80	0.400	-	100	
	651	Pa	6515021	0.124	45.10	0.400	-	100	
	651	AbA	651202320	0.025	9.20	0.380	-	100	
	651	LcA	651422520	0.042	15.40	0.250	-	100	
	651	PeA	651502920	0.020	7.40	0.370	-	100	
26	651	Cp	6512451	0.401	76.40	0.400	-	100	
	651	Ma	6514421	0.001	0.20	0.400	-	100	
	651	Pa	6515021	0.076	14.50	0.400	-	100	
	651	Vh	6516235	0.010	2.00	0.270	-	100	
	651	AbA	651202320	0.002	0.40	0.380	-	100	
	651	LcA	651422520	0.030	5.60	0.250	-	100	
	651	PeA	651502920	0.004	0.80	0.370	-	100	
36	651	Ae	6512029	0.120	17.50	0.390	-	100	
	651	Cp	6512451	0.469	68.50	0.400	-	100	
	651	Lb	6514223	0.039	5.70	0.400	-	100	
	651	AbA	651202320	0.057	8.30	0.380	-	100	
37	651	Cp	6512451	0.773	54.20	0.400	-	100	
	651	Lb	6514223	0.210	14.70	0.400	-	100	
	651	Ma	6514421	0.050	3.50	0.400	-	100	
	651	Pa	6515021	0.007	0.50	0.400	-	100	
	651	AbA	651202320	0.113	7.90	0.380	-	100	
	651	LcA	651422520	0.167	11.70	0.250	-	100	
	651	RaA	651542120	0.105	7.40	0.390	-	100	
38	651	Cp	6512451	0.195	35.90	0.400	-	100	
	651	Lb	6514223	0.078	14.30	0.400	-	100	
	651	Ma	6514421	0.090	16.60	0.400	-	100	
	651	Pa	6515021	0.063	11.70	0.400	-	100	
	651	AbA	651202320	0.021	3.90	0.380	-	100	
	651	RaA	651542120	0.096	17.60	0.390	-	100	
39	651	Bs	6512257	0.008	1.10	0.390	-	100	
	651	Lb	6514223	0.076	10.50	0.400	-	100	
	651	Ma	6514421	0.200	27.50	0.400	-	100	
	651	Pa	6515021	0.098	13.50	0.400	-	100	
	651	AbA	651202320	0.062	8.50	0.380	-	100	

Area ID	Book Number	Map Unit	Soil ID	Area (sq mi)	Area (%)	XKSAT	Rock Percent (%)	Effective Rock (%)	Comments
Major Basin ID: 01									
39	651	LcA	651422520	0.249	34.30	0.250	-	100	
	651	PeA	651502920	0.034	4.70	0.370	-	100	
40	651	Cp	6512451	0.202	20.70	0.400	-	100	
	651	Lb	6514223	0.076	7.80	0.400	-	100	
	651	Ma	6514421	0.127	13.00	0.400	-	100	
	651	Pa	6515021	0.007	0.70	0.400	-	100	
	651	Va	6516221	0.040	4.10	0.390	-	100	
	651	AbA	651202320	0.045	4.60	0.380	-	100	
	651	LcA	651422520	0.179	18.40	0.250	-	100	
	651	PeA	651502920	0.301	30.80	0.370	-	100	
47N	651	Cp	6512451	0.077	33.10	0.400	-	100	
	651	Lb	6514223	0.156	66.90	0.400	-	100	
48	651	Cp	6512451	0.062	12.40	0.400	-	100	
	651	Lb	6514223	0.227	45.50	0.400	-	100	
	651	LcA	651422520	0.211	42.10	0.250	-	100	
49	651	Bs	6512257	0.026	2.50	0.390	-	100	
	651	Lb	6514223	0.444	43.80	0.400	-	100	
	651	Ma	6514421	0.101	9.90	0.400	-	100	
	651	Pa	6515021	0.400	39.50	0.400	-	100	
	651	AbA	651202320	0.027	2.60	0.380	-	100	
	651	RaA	651542120	0.016	1.60	0.390	-	100	
50	651	Bs	6512257	0.222	22.20	0.390	-	100	
	651	Lb	6514223	0.093	9.30	0.400	-	100	
	651	Ma	6514421	0.271	27.10	0.400	-	100	
	651	Pa	6515021	0.211	21.00	0.400	-	100	
	651	GgA	651323320	0.014	1.40	0.250	-	100	
	651	LcA	651422520	0.191	19.00	0.250	-	100	
51	651	Lb	6514223	0.001	0.10	0.400	-	100	
	651	Ma	6514421	0.062	6.20	0.400	-	100	
	651	AbA	651202320	0.244	24.30	0.380	-	100	
	651	GgA	651323320	0.111	11.10	0.250	-	100	
	651	LcA	651422520	0.321	32.00	0.250	-	100	
	651	PeA	651502920	0.089	8.80	0.370	-	100	
	651	PeB	651502922	0.175	17.40	0.380	-	100	
56A	651	Lb	6514223	0.295	71.80	0.400	-	100	
	651	Ma	6514421	0.016	3.90	0.400	-	100	
	651	Pa	6515021	0.023	5.60	0.400	-	100	
	651	AbA	651202320	0.077	18.70	0.380	-	100	
56B	651	Lb	6514223	0.102	30.70	0.400	-	100	
	651	Ma	6514421	0.022	6.70	0.400	-	100	
	651	Pa	6515021	0.061	18.10	0.400	-	100	
	651	AbA	651202320	0.149	44.50	0.380	-	100	
57	651	Bs	6512257	0.095	19.40	0.390	-	100	
	651	Lb	6514223	0.118	24.20	0.400	-	100	
	651	Ma	6514421	0.073	14.90	0.400	-	100	
	651	Pa	6515021	0.012	2.50	0.400	-	100	
	651	AbA	651202320	0.070	14.40	0.380	-	100	
	651	GgA	651323320	0.120	24.50	0.250	-	100	
58	651	Ma	6514421	0.041	21.60	0.400	-	100	
	651	AbA	651202320	0.062	32.50	0.380	-	100	
	651	GgA	651323320	0.055	29.20	0.250	-	100	
	651	LcA	651422520	0.004	2.30	0.250	-	100	
	651	PeB	651502922	0.027	14.40	0.380	-	100	
70	651	Ao	6512049	0.012	8.60	0.040	-	100	
	651	Lb	6514223	0.015	10.50	0.400	-	100	
	651	Ma	6514421	0.024	17.20	0.400	-	100	
	651	AbA	651202320	0.083	59.10	0.380	-	100	
	651	GgA	651323320	0.007	4.70	0.250	-	100	
71	651	Ao	6512049	0.015	9.90	0.040	-	100	
	651	Lb	6514223	0.006	3.80	0.400	-	100	
	651	Ma	6514421	0.014	9.00	0.400	-	100	

Area ID	Book Number	Map Unit	Soil ID	Area (sq mi)	Area (%)	XKSAT	Rock Percent (%)	Effective Rock (%)	Comments
Major Basin ID: 01									
71	651	AbA	651202320	0.045	28.90	0.380	-	100	
	651	GgA	651323320	0.075	48.40	0.250	-	100	
72	651	Ao	6512049	0.001	0.90	0.040	-	100	
	651	Ma	6514421	0.039	45.30	0.400	-	100	
	651	GgA	651323320	0.046	53.70	0.250	-	100	
83	651	AL	6512042	0.091	13.50	0.400	-	100	
	651	Cp	6512451	0.055	8.20	0.400	-	100	
	651	LEVEE	651228622828	0.006	0.90	0.010	-	100	
	651	AdA	651202720	0.008	1.20	0.400	-	100	
	651	AGB	651203222	0.035	5.10	0.400	-	100	
	651	GYD	651326826	0.005	0.70	0.260	-	100	
	651	HLC	651344224	0.475	70.40	0.140	-	100	
92N	651	Aa	6512021	0.011	3.20	0.260	-	100	
	651	An	6512047	0.109	33.40	0.050	-	100	
	651	Ao	6512049	0.157	47.90	0.040	-	100	
	651	Ma	6514421	0.007	2.10	0.400	-	100	
	651	GgA	651323320	0.044	13.40	0.250	-	100	
92S	651	An	6512047	0.215	31.30	0.050	-	100	
	651	Ao	6512049	0.240	34.90	0.040	-	100	
	651	Ap	6512051	0.061	8.80	0.040	-	100	
	651	Cn	6512447	0.060	8.70	0.010	-	100	
	651	Gh	6513235	0.052	7.50	0.240	-	100	
	651	Ma	6514421	0.000	0.10	0.400	-	100	
	651	AbA	651202320	0.002	0.20	0.380	-	100	
	651	GgA	651323320	0.059	8.50	0.250	-	100	
93	651	Ao	6512049	0.028	7.30	0.040	-	100	
	651	Ma	6514421	0.031	8.10	0.400	-	100	
	651	AbA	651202320	0.046	12.30	0.380	-	100	
	651	GgA	651323320	0.273	72.30	0.250	-	100	
94	651	Ao	6512049	0.374	52.00	0.040	-	100	
	651	Gt	6513259	0.040	5.50	0.040	-	100	
	651	Ma	6514421	0.061	8.50	0.400	-	100	
	651	GgA	651323320	0.245	34.10	0.250	-	100	
95	651	An	6512047	0.002	0.30	0.050	-	100	
	651	Ao	6512049	0.288	55.10	0.040	-	100	
	651	Cn	6512447	0.047	9.00	0.010	-	100	
	651	Gh	6513235	0.001	0.10	0.240	-	100	
	651	Ma	6514421	0.007	1.40	0.400	-	100	
	651	GgA	651323320	0.178	34.10	0.250	-	100	
96	651	Ao	6512049	0.268	29.40	0.040	-	100	
	651	Cn	6512447	0.126	13.80	0.010	-	100	
	651	Gf	6513231	0.084	9.10	0.240	-	100	
	651	Gt	6513259	0.001	0.10	0.040	-	100	
	651	GgA	651323320	0.435	47.50	0.250	-	100	
97	651	Ao	6512049	0.151	30.20	0.040	-	100	
	651	Ap	6512051	0.017	3.30	0.040	-	100	
	651	Cn	6512447	0.031	6.20	0.010	-	100	
	651	Gh	6513235	0.109	21.80	0.240	-	100	
	651	GgA	651323320	0.192	38.50	0.250	-	100	

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                 SCHEMATIC DIAGRAM OF STREAM NETWORK
INPUT
 LINE       (V) ROUTING          (--->) DIVERSION OR PUMP FLOW

  NO.       (.) CONNECTOR        (<---) RETURN OF DIVERTED OR PUMPED FLOW

   27          12
                .
                .
   37           .-------> 12RET
   35        12-O
                V
                V
   40       O1-O2
                .
                .
   46           .          13
                .           .
                .           .
   56           .           .-------> 13RET
   54           .        13-O
                .           .
                .           .
   59          O2............
                V
                V
   62      O2-O3A
                .
                .
   68           .          24
                .           .
                .           .
   78           .           .-------> 24RET
   76           .        24-O
                .           .
                .           .
   81         O3A............
                V
                V
   84      O3AO3B
                .
                .
   90           .          25
                .           .
                .           .
  100           .           .-------> 25RET
   98           .        25-O
                .           .
                .           .
  103         O3B............
                .
                .
  106           .         14A
                .           .
                .           .
  116           .           .-------> 14ARET
  114           .       14A-O
                .           V
                .           V
  119           .      P1AP1B
                .           .
                .           .
  125           .           .          83
                .           .           .
                .           .           .
  135           .           .           .-------> 83RET
  133           .           .        83-O
                .           .           .
                .           .           .
  138           .           .           .         14B
                .           .           .           .
                .           .           .           .
  148           .           .           .           .-------> 14BRET
  146           .           .           .       14B-O
                .           .           .           .
                .           .           .           .
  151           .         P1B........................
                .           V
                .           V
  154           .      P1B-P2
                .           .
                .           .
  160           .           .          26
                .           .           .
                .           .           .
  170           .           .           .-------> 26RET
  168           .           .        26-O
                .           .           .
                .           .           .
  173           .          P2............
                .           V
                .           V
  176           .       P2-O4
                .           .
                .           .
  182           .           .         11A
```

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            .           .           .
            .           .           .
192         .           .           .-------> 11ARET
190         .           .      11A-O
            .           .           V
            .           .           V
195         .           .     N1A-1B
            .           .           .
            .           .           .
201         .           .           .        11B
            .           .           .          .
            .           .           .          .
211         .           .           .          .-------> 11BRET
209         .           .           .      11B-O
            .           .           .          .
            .           .           .          .
214         .           .        N1B............
            .           .           V
            .           .           V
217         .           .      N1BO4
            .           .           .
            .           .           .
223        O4........................
            .
            .
229         .-------> DIMB01
226       MB01
            V
            V
232      RT2311
            .
            .
239         .          39
            .           .
            .           .
249         .           .------->   39RET
247         .        39-O
            .           .
            .           .
252        O5............
            V
            V
255      RT2312
            .
            .
262         .          50
            .           .
            .           .
272         .           .------->   50RET
270         .        50-O
            .           .
            .           .
275       O6A............
            .
            .
278         .          38
            .           .
            .           .
288         .           .------->   38RET
286         .        38-O
            .           .
            .           .
292         .           .-------> DTAF38
291         .      DVAF38
            .           V
            .           V
295         .       N3-N4
            .           .
            .           .
301         .           .          49
            .           .           .
            .           .           .
311         .           .           .------->   49RET
309         .           .        49-O
            .           .           .
            .           .           .
315         .           .           .-------> DTCM49
314         .           .      DVCM49
            .           .           .
            .           .           .
319         .           .           .-------> DTMV49
318         .           .      DVMV49
            .           .           .
            .           .           .
322         .          N4............
            .           V
            .           V
325         .       N4-O6
            .           .
            .           .
331       O6B............
            .
            .
337         .-------> DIMB02
334       MB02
            V
```

```
                V
340        RT2313
                .
                .
347             .          40
                .           .
                .           .
357             .           .-------->   40RET
355             .        40-O
                .           V
                .           V
360             .       P3-P4
                .           .
                .           .
366             .           .          51
                .           .           .
                .           .           .
376             .           .           .-------->   51RET
374             .           .        51-O
                .           .           .
                .           .           .
379             .          P4............
                .           .
                .           .
385             .           .-------->  DIMB05
382             .        MB05
                .           V
                .           V
388             .      RTURR1
                .           .
                .           .
395           P5B............
                V
                V
397        RTURR2
                .
                .
404             .          57
                .           .
                .           .
414             .           .-------->   57RET
412             .        57-O
                .           .
                .           .
417           O7............
                .
                .
420             .         10E
                .           .
                .           .
430             .           .-------->  10ERET
428             .       10E-O
                .           V
                .           V
433             .      L1AL2A
                .           .
                .           .
439             .           .         22E
                .           .           .
                .           .           .
449             .           .           .-------->  22ERET
447             .           .       22E-O
                .           .           .
                .           .           .
452             .         L2A............
                .           .
                .           .
455             .           .         11C
                .           .           .
                .           .           .
465             .           .           .-------->  11CRET
463             .           .       11C-O
                .           .           V
                .           .           V
468             .           .      N1C-N2
                .           .           .
                .           .           .
474             .           .           .          23
                .           .           .           .
                .           .           .           .
484             .           .           .           .-------->   23RET
482             .           .           .        23-O
                .           .           .           .
                .           .           .           .
487             .          N2........................
                .           .
                .           .
493             .           .-------->  DIMB03
490             .        MB03
                .           V
                .           V
496             .      RTAPR1
                .           .
                .           .
503             .           .          37
                .           .           .
```

```
513                 .-------> 37RET
511              37-O
                    .
                    .
517                 .-------> DTEVB
516            DVEVB
                    .
                    .
521                 .-------> DTCV
520              DVCV
                    .
                    .
525                 .-------> DTMV
524              DVMV
                    .
                    .
529                 .-------> DTW37
528            DVW37
                    .
                    .
534                 .                .<------- DTEVB
532                 .          DVEVB
                    .                .
                    .                .
537                 .                .          .<------- DTAF38
535                 .                .     DVAF38
                    .                .          .
                    .                .          .
538          CEBV.....................................
                V
                V
541        RTAPR2
                .
                .
550                 .<------- DTCV
548              DVCV
                    .
                    .
553                 .                .<------- DTMV49
551                 .          DVMV49
                    .                .
                    .                .
554           CCV........................
                V
                V
557        RTAPR3
                .
                .
566                 .<------- DTMV
564              DVMV
                    .
                    .
569                 .                .<------- DTCM49
567                 .          DVCM49
                    .                .
                    .                .
570           CMV........................
                V
                V
573        RTAPR4
                .
                .
580                36
                    .
                    .
590                 .-------> 36RET
588              36-O
                    V
                    V
593            L3-M2A
                    .
                    .
599                 .             47N
                    .                .
                    .                .
609                 .                .-------> 47NRET
607                 .          47N-O
                    .                .
                    .                .
612                M2A............
                    V
                    V
615            RTMCR1
                    .
                    .
623                 .                .<------- DTW37
622                 .          DVW37
                    .                V
                    .                V
624                 .          37-M2B
                    .                .
                    .                .
630                 .                .          48
                    .                .          .
                    .                .          .
```

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640          .           .           .           .         .-------->   48RET
638          .           .           .           .      48-O
             .           .           .           .         .
             .           .           .           .         .
643          .           .        M2B.......................
             .           .           .
             .           .           .
646          .        M3C............
             .           .
             .           .
652          .           .-------->  DIMB04
649          .       MB04
             .           .
             .           .
655          .           .        56A
             .           .           .
             .           .           .
665          .           .           .-------->  56ARET
663          .           .      56A-O
             .           .           .
             .           .           .
670          .           .           .-------->   DT56A
668          .           .      DV56A
             .           .           .
             .           .           .
673          .        M2C............
             .           V
             .           V
676          .      RTMCR2
             .           V
             .           V
683          .      RTSPT1
             .           .
             .           .
690          .           .        56B
             .           .           .
             .           .           .
700          .           .           .-------->  56BRET
698          .           .      56B-O
             .           .           .
             .           .           .
703          .      CP56B............
             .           V
             .           V
706          .      RTURR3
             .           .
             .           .
713        N5B............
             V
             V
716     RTSPT2
             .
             .
723          .          70
             .           .
             .           .
733          .           .-------->   70RET
731          .        70-O
             .           .
             .           .
738          .           .           .<--------   DT56A
736          .           .      DV56A
             .           .           .
             .           .           .
739         N6........................
             V
             V
742     RTSPT3
             .
             .
749          .         92N
             .           .
             .           .
759          .           .-------->  92NRET
757          .      92N-O
             .           .
             .           .
762       O10A............
             .
             .
765          .          71
             .           .
             .           .
775          .           .-------->   71RET
773          .        71-O
             .           .
             .           .
778          .           .          93
             .           .           .
             .           .           .
788          .           .           .-------->   93RET
786          .           .       93-O
             .           .           .
             .           .           .
791          .          O9............
             .           V
```

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                .          V
 794            .      RT2314
                .          .
                .          .
 801            .          .          95
                .          .           .
                .          .           .
 811            .          .           .-------->   95RET
 809            .          .        95-O
                .          .           .
                .          .           .
 814            .        P8B............
                .          V
                .          V
 817            .      RTMRA1
                .          .
                .          .
 824        O10B............
                .
                .
 827            .       DET24
                .          .
                .          .
 866      TOBINF............
              V
              V
 869      RTWTR1
                .
                .
 876            .      DRAN24
                .          .
                .          .
 932            .          .         92S
                .          .           .
                .          .           .
 942            .          .           .-------->  92SRET
 940            .          .       92S-O
                .          .           .
                .          .           .
 945            .      TOB92S............
                .          .
                .          .
 948            .          .          58
                .          .           .
                .          .           .
 958            .          .           .-------->   58RET
 956            .          .        58-O
                .          .           .
                .          .           .
 961            .          .           .          72
                .          .           .           .
                .          .           .           .
 971            .          .           .           .-------->   72RET
 969            .          .           .        72-O
                .          .           .           .
                .          .           .           .
 974            .          .          P6............
                .          .           .
                .          .           .
 977            .          .           .          94
                .          .           .           .
                .          .           .           .
 987            .          .           .           .-------->   94RET
 985            .          .           .        94-O
                .          .           .           .
                .          .           .           .
 990            .          .          P7............
                .          .           V
                .          .           V
 993            .          .      94-P8A
                .          .           .
                .          .           .
 999            .          .           .          96
                .          .           .           .
                .          .           .           .
1009            .          .           .           .-------->   96RET
1007            .          .           .        96-O
                .          .           .           .
                .          .           .           .
1012            .          .         P8A............
                .          .           V
                .          .           V
1015            .          .      P8A-P9
                .          .           .
                .          .           .
1021            .          .           .          97
                .          .           .           .
                .          .           .           .
1031            .          .           .           .-------->   97RET
1029            .          .           .        97-O
                .          .           .           .
                .          .           .           .
1034            .       P9.................................
                .        V
                .        V
1037      RTWTR2
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                .
                .
1044            .          100
                .            .
                .            .
1054            .            .-------> 100RET
1052            .        100-O
                .            .
                .            .
1057          P10............
```

Appendix D

Normal Depth Calculations

2+43 - 40+71

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00110	ft/ft
Discharge	1170.00	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+35	9.83
0+82	2.00
0+92	2.00
0+96	0.00
1+04	0.00
1+08	2.00
1+18	2.00
1+60	9.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+35, 9.83)	(0+92, 2.00)	0.032
(0+92, 2.00)	(1+08, 2.00)	0.016
(1+08, 2.00)	(1+60, 9.00)	0.032

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	6.56	ft
Elevation Range	0.00 to 9.83 ft	
Flow Area	312.92	ft²
Wetted Perimeter	92.43	ft
Hydraulic Radius	3.39	ft
Top Width	90.73	ft

2+43 - 40+71

Results

Normal Depth	6.56	ft
Critical Depth	4.31	ft
Critical Slope	0.01019	ft/ft
Velocity	3.74	ft/s
Velocity Head	0.22	ft
Specific Energy	6.78	ft
Froude Number	0.35	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	6.56	ft
Critical Depth	4.31	ft
Channel Slope	0.00110	ft/ft
Critical Slope	0.01019	ft/ft

42+23 - 54+62

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.022	
Channel Slope	0.00110	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	24.00	ft
Discharge	710.00	ft^3/s

Results

Normal Depth	3.99	ft
Flow Area	159.46	ft^2
Wetted Perimeter	56.91	ft
Hydraulic Radius	2.80	ft
Top Width	55.92	ft
Critical Depth	2.59	ft
Critical Slope	0.00572	ft/ft
Velocity	4.45	ft/s
Velocity Head	0.31	ft
Specific Energy	4.30	ft
Froude Number	0.46	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.99	ft
Critical Depth	2.59	ft
Channel Slope	0.00110	ft/ft
Critical Slope	0.00572	ft/ft

54+62 - 66+62

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.022	
Channel Slope	0.00250	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	24.00	ft
Discharge	710.00	ft^3/s

Results

Normal Depth	3.22	ft
Flow Area	118.91	ft^2
Wetted Perimeter	50.58	ft
Hydraulic Radius	2.35	ft
Top Width	49.78	ft
Critical Depth	2.59	ft
Critical Slope	0.00572	ft/ft
Velocity	5.97	ft/s
Velocity Head	0.55	ft
Specific Energy	3.78	ft
Froude Number	0.68	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.22	ft
Critical Depth	2.59	ft
Channel Slope	0.00250	ft/ft
Critical Slope	0.00572	ft/ft

69+67 - 94+64 (Earth)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.032	
Channel Slope	0.00560	ft/ft
Left Side Slope	6.00	ft/ft (H:V)
Right Side Slope	6.00	ft/ft (H:V)
Bottom Width	20.00	ft
Discharge	540.00	ft^3/s

Results

Normal Depth	2.77	ft
Flow Area	101.62	ft^2
Wetted Perimeter	53.74	ft
Hydraulic Radius	1.89	ft
Top Width	53.28	ft
Critical Depth	2.25	ft
Critical Slope	0.01289	ft/ft
Velocity	5.31	ft/s
Velocity Head	0.44	ft
Specific Energy	3.21	ft
Froude Number	0.68	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.77	ft
Critical Depth	2.25	ft
Channel Slope	0.00560	ft/ft
Critical Slope	0.01289	ft/ft

69+67 - 94+64 (Turf)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.00560	ft/ft
Left Side Slope	6.00	ft/ft (H:V)
Right Side Slope	6.00	ft/ft (H:V)
Bottom Width	20.00	ft
Discharge	540.00	ft^3/s

Results

Normal Depth	2.90	ft
Flow Area	108.45	ft^2
Wetted Perimeter	55.28	ft
Hydraulic Radius	1.96	ft
Top Width	54.80	ft
Critical Depth	2.25	ft
Critical Slope	0.01542	ft/ft
Velocity	4.98	ft/s
Velocity Head	0.39	ft
Specific Energy	3.29	ft
Froude Number	0.62	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.90	ft
Critical Depth	2.25	ft
Channel Slope	0.00560	ft/ft
Critical Slope	0.01542	ft/ft

109+10 - 114+60

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.016	
Channel Slope	0.00100	ft/ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	30.00	ft
Discharge	230.00	ft^3/s

Results

Normal Depth	1.75	ft
Flow Area	58.54	ft^2
Wetted Perimeter	37.82	ft
Hydraulic Radius	1.55	ft
Top Width	36.99	ft
Critical Depth	1.19	ft
Critical Slope	0.00368	ft/ft
Velocity	3.93	ft/s
Velocity Head	0.24	ft
Specific Energy	1.99	ft
Froude Number	0.55	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.75	ft
Critical Depth	1.19	ft
Channel Slope	0.00100	ft/ft
Critical Slope	0.00368	ft/ft

200+00 - 203+27

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.022	
Channel Slope	0.00080	ft/ft
Left Side Slope	4.00	ft/ft (H:V)
Right Side Slope	4.00	ft/ft (H:V)
Bottom Width	34.00	ft
Discharge	720.00	ft^3/s

Results

Normal Depth	3.80	ft
Flow Area	186.98	ft^2
Wetted Perimeter	65.34	ft
Hydraulic Radius	2.86	ft
Top Width	64.40	ft
Critical Depth	2.20	ft
Critical Slope	0.00585	ft/ft
Velocity	3.85	ft/s
Velocity Head	0.23	ft
Specific Energy	4.03	ft
Froude Number	0.40	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.80	ft
Critical Depth	2.20	ft
Channel Slope	0.00080	ft/ft
Critical Slope	0.00585	ft/ft

203+27 - 226+26

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00080	ft/ft
Discharge	720.00	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+35	9.83
0+82	2.00
0+92	2.00
0+96	0.00
1+04	0.00
1+08	2.00
1+18	2.00
1+60	9.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+35, 9.83)	(0+92, 2.00)	0.032
(0+92, 2.00)	(1+08, 2.00)	0.016
(1+08, 2.00)	(1+60, 9.00)	0.032

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	5.77	ft
Elevation Range	0.00 to 9.83 ft	
Flow Area	244.82	ft²
Wetted Perimeter	82.79	ft
Hydraulic Radius	2.96	ft
Top Width	81.22	ft

203+27 - 226+26

Results

Normal Depth	5.77	ft
Critical Depth	3.58	ft
Critical Slope	0.01080	ft/ft
Velocity	2.94	ft/s
Velocity Head	0.13	ft
Specific Energy	5.90	ft
Froude Number	0.30	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	5.77	ft
Critical Depth	3.58	ft
Channel Slope	0.00080	ft/ft
Critical Slope	0.01080	ft/ft

228+32 - 253+78 (Earth)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.032	
Channel Slope	0.00400	ft/ft
Left Side Slope	6.00	ft/ft (H:V)
Right Side Slope	6.00	ft/ft (H:V)
Bottom Width	20.00	ft
Discharge	460.00	ft^3/s

Results

Normal Depth	2.78	ft
Flow Area	102.21	ft^2
Wetted Perimeter	53.87	ft
Hydraulic Radius	1.90	ft
Top Width	53.41	ft
Critical Depth	2.06	ft
Critical Slope	0.01320	ft/ft
Velocity	4.50	ft/s
Velocity Head	0.31	ft
Specific Energy	3.10	ft
Froude Number	0.57	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.78	ft
Critical Depth	2.06	ft
Channel Slope	0.00400	ft/ft
Critical Slope	0.01320	ft/ft

228+32 - 253+78 (Turf)

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.00400	ft/ft
Left Side Slope	6.00	ft/ft (H:V)
Right Side Slope	6.00	ft/ft (H:V)
Bottom Width	20.00	ft
Discharge	460.00	ft^3/s

Results

Normal Depth	2.91	ft
Flow Area	109.08	ft^2
Wetted Perimeter	55.42	ft
Hydraulic Radius	1.97	ft
Top Width	54.94	ft
Critical Depth	2.06	ft
Critical Slope	0.01579	ft/ft
Velocity	4.22	ft/s
Velocity Head	0.28	ft
Specific Energy	3.19	ft
Froude Number	0.53	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.91	ft
Critical Depth	2.06	ft
Channel Slope	0.00400	ft/ft
Critical Slope	0.01579	ft/ft

300+80 - 352+62

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.016	
Channel Slope	0.00100	ft/ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	16.00	ft
Discharge	110.00	ft^3/s

Results

Normal Depth	1.61	ft
Flow Area	30.93	ft^2
Wetted Perimeter	23.20	ft
Hydraulic Radius	1.33	ft
Top Width	22.44	ft
Critical Depth	1.08	ft
Critical Slope	0.00390	ft/ft
Velocity	3.56	ft/s
Velocity Head	0.20	ft
Specific Energy	1.81	ft
Froude Number	0.53	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.61	ft
Critical Depth	1.08	ft
Channel Slope	0.00100	ft/ft
Critical Slope	0.00390	ft/ft

352+82 - 353+23

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.016	
Channel Slope	0.01460	ft/ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	16.00	ft
Discharge	60.00	ft^3/s

Results

Normal Depth	0.51	ft
Flow Area	8.75	ft^2
Wetted Perimeter	18.30	ft
Hydraulic Radius	0.48	ft
Top Width	18.06	ft
Critical Depth	0.74	ft
Critical Slope	0.00435	ft/ft
Velocity	6.86	ft/s
Velocity Head	0.73	ft
Specific Energy	1.24	ft
Froude Number	1.74	
Flow Type	Supercritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.51	ft
Critical Depth	0.74	ft
Channel Slope	0.01460	ft/ft
Critical Slope	0.00435	ft/ft

353+23 - 370+00

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.016	
Channel Slope	0.00280	ft/ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	8.00	ft
Discharge	60.00	ft^3/s

Results

Normal Depth	1.22	ft
Flow Area	12.69	ft^2
Wetted Perimeter	13.44	ft
Hydraulic Radius	0.94	ft
Top Width	12.86	ft
Critical Depth	1.09	ft
Critical Slope	0.00408	ft/ft
Velocity	4.73	ft/s
Velocity Head	0.35	ft
Specific Energy	1.56	ft
Froude Number	0.84	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.22	ft
Critical Depth	1.09	ft
Channel Slope	0.00280	ft/ft
Critical Slope	0.00408	ft/ft

370+00 - 379+07

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.016	
Channel Slope	0.00080	ft/ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	8.00	ft
Discharge	60.00	ft^3/s

Results

Normal Depth	1.72	ft
Flow Area	19.65	ft^2
Wetted Perimeter	15.68	ft
Hydraulic Radius	1.25	ft
Top Width	14.87	ft
Critical Depth	1.09	ft
Critical Slope	0.00408	ft/ft
Velocity	3.05	ft/s
Velocity Head	0.14	ft
Specific Energy	1.86	ft
Froude Number	0.47	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	1.72	ft
Critical Depth	1.09	ft
Channel Slope	0.00080	ft/ft
Critical Slope	0.00408	ft/ft

394+80 - 439+60

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.00550	ft/ft
Left Side Slope	6.00	ft/ft (H:V)
Right Side Slope	6.00	ft/ft (H:V)
Bottom Width	16.00	ft
Discharge	540.00	ft^3/s

Results

Normal Depth	3.11	ft
Flow Area	107.92	ft^2
Wetted Perimeter	53.86	ft
Hydraulic Radius	2.00	ft
Top Width	53.35	ft
Critical Depth	2.43	ft
Critical Slope	0.01530	ft/ft
Velocity	5.00	ft/s
Velocity Head	0.39	ft
Specific Energy	3.50	ft
Froude Number	0.62	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.11	ft
Critical Depth	2.43	ft
Channel Slope	0.00550	ft/ft
Critical Slope	0.01530	ft/ft

454+60 - 472+00

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.035	
Channel Slope	0.00700	ft/ft
Left Side Slope	6.00	ft/ft (H:V)
Right Side Slope	6.00	ft/ft (H:V)
Bottom Width	16.00	ft
Discharge	390.00	ft^3/s

Results

Normal Depth	2.51	ft
Flow Area	77.86	ft^2
Wetted Perimeter	46.51	ft
Hydraulic Radius	1.67	ft
Top Width	46.09	ft
Critical Depth	2.04	ft
Critical Slope	0.01605	ft/ft
Velocity	5.01	ft/s
Velocity Head	0.39	ft
Specific Energy	2.90	ft
Froude Number	0.68	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.51	ft
Critical Depth	2.04	ft
Channel Slope	0.00700	ft/ft
Critical Slope	0.01605	ft/ft

498+88 - 507+30

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.016	
Channel Slope	0.00100	ft/ft
Left Side Slope	6.00	ft/ft (H:V)
Right Side Slope	6.00	ft/ft (H:V)
Bottom Width	16.00	ft
Discharge	50.00	ft^3/s

Results

Normal Depth	0.95	ft
Flow Area	20.65	ft^2
Wetted Perimeter	27.57	ft
Hydraulic Radius	0.75	ft
Top Width	27.41	ft
Critical Depth	0.62	ft
Critical Slope	0.00466	ft/ft
Velocity	2.42	ft/s
Velocity Head	0.09	ft
Specific Energy	1.04	ft
Froude Number	0.49	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	0.95	ft
Critical Depth	0.62	ft
Channel Slope	0.00100	ft/ft
Critical Slope	0.00466	ft/ft

601+14 - 624+49

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.016	
Channel Slope	0.00100	ft/ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	16.00	ft
Discharge	240.00	ft^3/s

Results

Normal Depth	2.50	ft
Flow Area	52.63	ft^2
Wetted Perimeter	27.20	ft
Hydraulic Radius	1.93	ft
Top Width	26.02	ft
Critical Depth	1.77	ft
Critical Slope	0.00342	ft/ft
Velocity	4.56	ft/s
Velocity Head	0.32	ft
Specific Energy	2.83	ft
Froude Number	0.57	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.50	ft
Critical Depth	1.77	ft
Channel Slope	0.00100	ft/ft
Critical Slope	0.00342	ft/ft

625+27 - 635+00

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.016	
Channel Slope	0.00100	ft/ft
Left Side Slope	2.00	ft/ft (H:V)
Right Side Slope	2.00	ft/ft (H:V)
Bottom Width	8.00	ft
Discharge	240.00	ft^3/s

Results

Normal Depth	3.35	ft
Flow Area	49.19	ft^2
Wetted Perimeter	22.97	ft
Hydraulic Radius	2.14	ft
Top Width	21.39	ft
Critical Depth	2.46	ft
Critical Slope	0.00335	ft/ft
Velocity	4.88	ft/s
Velocity Head	0.37	ft
Specific Energy	3.72	ft
Froude Number	0.57	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.35	ft
Critical Depth	2.46	ft
Channel Slope	0.00100	ft/ft
Critical Slope	0.00335	ft/ft

635+66 - 659+03

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.033	
Channel Slope	0.00100	ft/ft
Left Side Slope	6.00	ft/ft (H:V)
Right Side Slope	6.00	ft/ft (H:V)
Bottom Width	8.00	ft
Discharge	240.00	ft^3/s

Results

Normal Depth	3.57	ft
Flow Area	104.79	ft^2
Wetted Perimeter	51.37	ft
Hydraulic Radius	2.04	ft
Top Width	50.78	ft
Critical Depth	1.95	ft
Critical Slope	0.01505	ft/ft
Velocity	2.29	ft/s
Velocity Head	0.08	ft
Specific Energy	3.65	ft
Froude Number	0.28	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.57	ft
Critical Depth	1.95	ft
Channel Slope	0.00100	ft/ft
Critical Slope	0.01505	ft/ft

669+66 - 673+69

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00150	ft/ft
Discharge	340.00	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+45	9.83
0+92	2.00
0+96	0.00
1+04	0.00
1+08	2.00
1+50	9.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+45, 9.83)	(0+92, 2.00)	0.032
(0+92, 2.00)	(1+08, 2.00)	0.016
(1+08, 2.00)	(1+50, 9.00)	0.032

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	4.42	ft
Elevation Range	0.00 to 9.83 ft	
Flow Area	97.92	ft²
Wetted Perimeter	46.41	ft
Hydraulic Radius	2.11	ft
Top Width	45.06	ft
Normal Depth	4.42	ft
Critical Depth	3.02	ft

669+66 - 673+69

Results

Critical Slope	0.00965	ft/ft
Velocity	3.47	ft/s
Velocity Head	0.19	ft
Specific Energy	4.61	ft
Froude Number	0.42	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	4.42	ft
Critical Depth	3.02	ft
Channel Slope	0.00150	ft/ft
Critical Slope	0.00965	ft/ft

673+89 - 684+09

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00550	ft/ft
Discharge	340.00	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+45	9.83
0+92	2.00
0+96	0.00
1+04	0.00
1+08	2.00
1+50	9.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+45, 9.83)	(0+92, 2.00)	0.032
(0+92, 2.00)	(1+08, 2.00)	0.016
(1+08, 2.00)	(1+50, 9.00)	0.032

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	3.29	ft
Elevation Range	0.00 to 9.83 ft	
Flow Area	54.73	ft²
Wetted Perimeter	32.68	ft
Hydraulic Radius	1.67	ft
Top Width	31.52	ft
Normal Depth	3.29	ft
Critical Depth	3.02	ft

673+89 - 684+09

Results

Critical Slope	0.00813	ft/ft
Velocity	6.21	ft/s
Velocity Head	0.60	ft
Specific Energy	3.89	ft
Froude Number	0.83	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.29	ft
Critical Depth	3.02	ft
Channel Slope	0.00550	ft/ft
Critical Slope	0.00813	ft/ft

684+29 - 686+28

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00200	ft/ft
Discharge	340.00	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+45	9.83
0+92	2.00
0+96	0.00
1+04	0.00
1+08	2.00
1+50	9.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+45, 9.83)	(0+92, 2.00)	0.032
(0+92, 2.00)	(1+08, 2.00)	0.016
(1+08, 2.00)	(1+50, 9.00)	0.032

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	4.16	ft
Elevation Range	0.00 to 9.83 ft	
Flow Area	86.59	ft²
Wetted Perimeter	43.24	ft
Hydraulic Radius	2.00	ft
Top Width	41.93	ft
Normal Depth	4.16	ft
Critical Depth	3.02	ft

684+29 - 686+28

Results

Critical Slope	0.00939	ft/ft
Velocity	3.93	ft/s
Velocity Head	0.24	ft
Specific Energy	4.40	ft
Froude Number	0.48	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	4.16	ft
Critical Depth	3.02	ft
Channel Slope	0.00200	ft/ft
Critical Slope	0.00939	ft/ft

688+44 - 695+63

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00410	ft/ft
Discharge	340.00	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+45	9.83
0+92	2.00
0+96	0.00
1+04	0.00
1+08	2.00
1+50	9.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+45, 9.83)	(0+92, 2.00)	0.032
(0+92, 2.00)	(1+08, 2.00)	0.016
(1+08, 2.00)	(1+50, 9.00)	0.032

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	3.54	ft
Elevation Range	0.00 to 9.83 ft	
Flow Area	62.90	ft²
Wetted Perimeter	35.69	ft
Hydraulic Radius	1.76	ft
Top Width	34.49	ft
Normal Depth	3.54	ft
Critical Depth	3.02	ft

688+44 - 695+63

Results

Critical Slope	0.00856	ft/ft
Velocity	5.41	ft/s
Velocity Head	0.45	ft
Specific Energy	3.99	ft
Froude Number	0.71	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.54	ft
Critical Depth	3.02	ft
Channel Slope	0.00410	ft/ft
Critical Slope	0.00856	ft/ft

698+78 - 710+32

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00460	ft/ft
Discharge	340.00	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+45	9.83
0+92	2.00
0+96	0.00
1+04	0.00
1+08	2.00
1+50	9.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+45, 9.83)	(0+92, 2.00)	0.032
(0+92, 2.00)	(1+08, 2.00)	0.016
(1+08, 2.00)	(1+50, 9.00)	0.032

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	3.44	ft
Elevation Range	0.00 to 9.83 ft	
Flow Area	59.60	ft²
Wetted Perimeter	34.51	ft
Hydraulic Radius	1.73	ft
Top Width	33.33	ft
Normal Depth	3.44	ft
Critical Depth	3.02	ft

698+78 - 710+32

Results

Critical Slope	0.00840	ft/ft
Velocity	5.70	ft/s
Velocity Head	0.51	ft
Specific Energy	3.95	ft
Froude Number	0.75	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.44	ft
Critical Depth	3.02	ft
Channel Slope	0.00460	ft/ft
Critical Slope	0.00840	ft/ft

715+96 - 728+60

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00540	ft/ft
Discharge	280.00	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+45	9.83
0+92	2.00
0+96	0.00
1+04	0.00
1+08	2.00
1+50	9.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+45, 9.83)	(0+92, 2.00)	0.032
(0+92, 2.00)	(1+08, 2.00)	0.016
(1+08, 2.00)	(1+50, 9.00)	0.032

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	2.98	ft
Elevation Range	0.00 to 9.83 ft	
Flow Area	45.37	ft²
Wetted Perimeter	28.83	ft
Hydraulic Radius	1.57	ft
Top Width	27.73	ft
Normal Depth	2.98	ft
Critical Depth	2.75	ft

715+96 - 728+60

Results

Critical Slope	0.00758	ft/ft
Velocity	6.17	ft/s
Velocity Head	0.59	ft
Specific Energy	3.57	ft
Froude Number	0.85	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.98	ft
Critical Depth	2.75	ft
Channel Slope	0.00540	ft/ft
Critical Slope	0.00758	ft/ft

728+80 - 740+65

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00400	ft/ft
Discharge	280.00	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+45	9.83
0+92	2.00
0+96	0.00
1+04	0.00
1+08	2.00
1+50	9.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+45, 9.83)	(0+92, 2.00)	0.032
(0+92, 2.00)	(1+08, 2.00)	0.016
(1+08, 2.00)	(1+50, 9.00)	0.032

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	3.23	ft
Elevation Range	0.00 to 9.83 ft	
Flow Area	52.89	ft²
Wetted Perimeter	31.96	ft
Hydraulic Radius	1.65	ft
Top Width	30.82	ft
Normal Depth	3.23	ft
Critical Depth	2.75	ft

728+80 - 740+65

Results

Critical Slope	0.00817	ft/ft
Velocity	5.29	ft/s
Velocity Head	0.44	ft
Specific Energy	3.67	ft
Froude Number	0.71	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.23	ft
Critical Depth	2.75	ft
Channel Slope	0.00400	ft/ft
Critical Slope	0.00817	ft/ft

742+45 - 755+75

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Channel Slope	0.00500	ft/ft
Discharge	230.00	ft³/s

Section Definitions

Station (ft)	Elevation (ft)
0+45	9.83
0+92	2.00
0+96	0.00
1+04	0.00
1+08	2.00
1+50	9.00

Roughness Segment Definitions

Start Station	Ending Station	Roughness Coefficient
(0+45, 9.83)	(0+92, 2.00)	0.032
(0+92, 2.00)	(1+08, 2.00)	0.016
(1+08, 2.00)	(1+50, 9.00)	0.032

Options

Current Roughness Weighted Method	Pavlovskii's Method
Open Channel Weighting Method	Pavlovskii's Method
Closed Channel Weighting Method	Pavlovskii's Method

Results

Normal Depth	2.69	ft
Elevation Range	0.00 to 9.83 ft	
Flow Area	37.80	ft²
Wetted Perimeter	25.29	ft
Hydraulic Radius	1.49	ft
Top Width	24.23	ft
Normal Depth	2.69	ft
Critical Depth	2.47	ft

742+45 - 755+75

Results

Critical Slope		0.00687	ft/ft
Velocity		6.09	ft/s
Velocity Head		0.58	ft
Specific Energy		3.26	ft
Froude Number		0.86	
Flow Type	Subcritical		

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	2.69	ft
Critical Depth	2.47	ft
Channel Slope	0.00500	ft/ft
Critical Slope	0.00687	ft/ft

813+73 - 851+11

Project Description

Friction Method	Manning Formula
Solve For	Normal Depth

Input Data

Roughness Coefficient	0.033	
Channel Slope	0.00080	ft/ft
Left Side Slope	6.00	ft/ft (H:V)
Right Side Slope	6.00	ft/ft (H:V)
Bottom Width	16.00	ft
Discharge	360.00	ft^3/s

Results

Normal Depth	3.94	ft
Flow Area	155.93	ft^2
Wetted Perimeter	63.88	ft
Hydraulic Radius	2.44	ft
Top Width	63.23	ft
Critical Depth	1.95	ft
Critical Slope	0.01443	ft/ft
Velocity	2.31	ft/s
Velocity Head	0.08	ft
Specific Energy	4.02	ft
Froude Number	0.26	
Flow Type	Subcritical	

GVF Input Data

Downstream Depth	0.00	ft
Length	0.00	ft
Number Of Steps	0	

GVF Output Data

Upstream Depth	0.00	ft
Profile Description		
Profile Headloss	0.00	ft
Downstream Velocity	Infinity	ft/s
Upstream Velocity	Infinity	ft/s
Normal Depth	3.94	ft
Critical Depth	1.95	ft
Channel Slope	0.00080	ft/ft
Critical Slope	0.01443	ft/ft

CHANNEL FREEBOARD - CALCULATION SHEET
WATSON DRAINAGE SYSTEM PRE-DESIGN
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY - FCD NO. 2012-C003

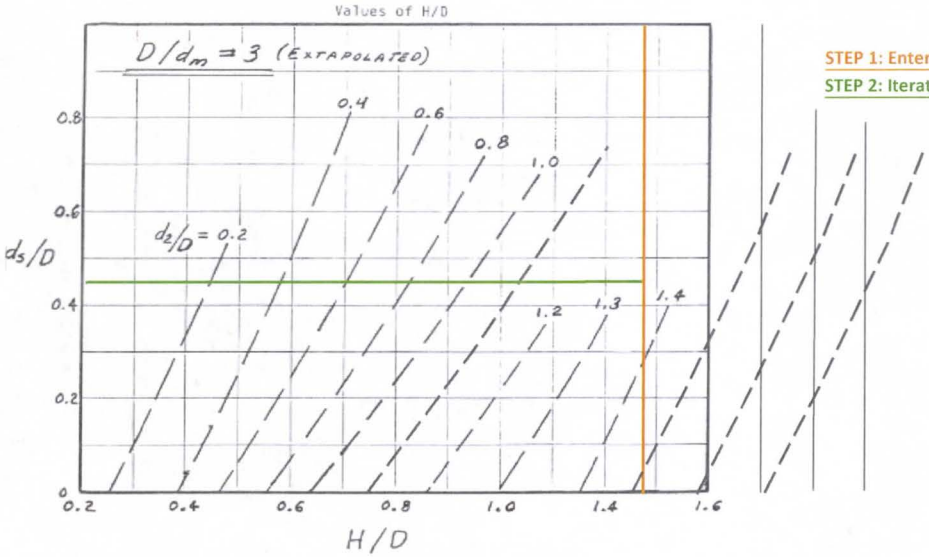
Label	Roughness Coefficient	Channel Slope (ft/ft)	Left Side Slope (ft/ft (H:V))	Right Side Slope (ft/ft (H:V))	Bottom Width (ft)	Discharge (ft^3/s)	Normal Depth (ft)	Velocity (ft/s)	Froude Number	Freeboard (ft)	Channel Depth (ft)
2+43 - 40+71	0.030	0.0011	-	-	-	1,170	6.56	3.74	0.35	1.69	8.25
42+23 - 54+62	0.022	0.0011	4.00	4.00	24.00	710	3.99	4.45	0.46	1.07	5.06
54+62 - 66+62	0.022	0.0025	4.0	4.0	24.00	710	3.22	5.97	0.68	1.00	4.22
69+67 - 94+64 (Earth)	0.032	0.0056	6.0	6.0	20.00	540	2.77	5.31	0.68	1.00	3.77
69+67 - 94+64 (Turf)	0.035	0.0056	6.0	6.0	20.00	540	2.90	4.98	0.62	1.00	3.90
109+10 - 114+60	0.016	0.0010	2.0	2.0	30.00	230	1.75	3.93	0.55	1.00	2.75
200+00 - 203+27	0.022	0.0008	4.0	4.0	34.00	720	3.80	3.85	0.40	1.01	4.81
203+27 - 226+26	0.029	0.0008	-	-	-	720	5.77	2.94	0.30	1.48	7.25
228+32 - 253+78 (Earth)	0.032	0.0040	6.0	6.0	20.00	460	2.78	4.50	0.57	1.00	3.78
228+32 - 253+78 (Turf)	0.035	0.0040	6.0	6.0	20.00	460	2.91	4.22	0.53	1.00	3.91
300+80 - 352+62	0.016	0.0010	2.0	2.0	16.00	110	1.61	3.56	0.53	1.00	2.61
352+82 - 353+23	0.016	0.0146	2.0	2.0	16.00	60	0.51	6.86	1.74	1.00	1.51
353+23 - 370+00	0.016	0.0028	2.0	2.0	8.00	60	1.22	4.73	0.84	1.00	2.22
370+00 - 379+07	0.016	0.0008	2.0	2.0	8.00	60	1.72	3.05	0.47	1.00	2.72
394+80 - 439+60	0.035	0.0055	6.0	6.0	16.00	540	3.11	5.00	0.62	1.00	4.11
454+60 - 472+00	0.035	0.0070	6.0	6.0	16.00	390	2.51	5.01	0.68	1.00	3.51
498+88 - 507+30	0.016	0.0010	2.0	2.0	16.00	50	0.95	2.42	0.49	1.00	1.95
601+14 - 624+49	0.016	0.0010	2.0	2.0	16.00	240	2.50	4.56	0.57	1.00	3.50
625+27 - 635+00	0.016	0.0010	2.0	2.0	8.00	240	3.35	4.88	0.57	1.00	4.35
635+66 - 659+03	0.033	0.0010	6.0	6.0	8.00	240	3.57	2.29	0.28	1.00	4.57
669+66 - 673+69	0.027	0.0015	-	-	-	340	4.42	3.47	0.42	1.15	5.57
673+89 - 684+09	0.025	0.0055	-	-	-	340	3.29	6.21	0.83	1.00	4.29
684+29 - 686+28	0.027	0.0020	-	-	-	340	4.16	3.93	0.48	1.10	5.26
688+44 - 695+63	0.026	0.0041	-	-	-	340	3.54	5.41	0.71	1.00	4.54
698+78 - 710+32	0.025	0.0046	-	-	-	340	3.44	5.70	0.75	1.00	4.44
715+96 - 728+60	0.024	0.0054	-	-	-	280	2.98	6.17	0.85	1.00	3.98
728+80 - 740+65	0.025	0.0040	-	-	-	280	3.23	5.29	0.71	1.00	4.23
742+45 - 755+75	0.023	0.0050	-	-	-	230	2.69	6.09	0.86	1.00	3.69
813+73 - 851+11	0.033	0.0008	6.0	6.0	16.00	360	3.94	2.31	0.26	1.01	4.95

Appendix E

Hydraulic Structure Calculations

VERTICAL DROP WITH RIPRAP STILLING BASIN - CALCULATION SHEET
WATSON DRAINAGE SYSTEM PRE-DESIGN
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY - FCD NO. 2012-C003

Drop ID	85+05	228+32 241+31	395+20 395+80 400+64 401+56 408+60 413+37 414+20 415+20 426+60 428+40 435+00	673+69	684+09	688+24 698+38 698+58	704+55	715+54 715+76	727+40 728+00 728+60	727+40 728+00 728+60 742+06	742+25 744+62 746+60 750+40 754+00		
D =	2.50	2.50	2.50	2.50	2.50		2.50		2.50	2.50	2.50	(ft)	Drop Height
y_c =	2.25	2.06	2.43	3.02	3.02		3.02		2.75	2.75	2.47	(ft)	Upstream Critical Depth
H =	3.38	3.09	3.65	4.53	4.53		4.53		4.13	4.13	3.71	(ft)	Upstream Energy Grade
D_r/d_{50} =	2.00	2.00	2.00	2.00	2.00	Drop structure is submerged in culvert entrance backwater	2.00	Drop structure is submerged in culvert entrance backwater	2.00	2.00	2.00		Thickness to Stone Size Ratio
$D_{r\text{-}min}$ =	1.67	1.67	1.67	1.67	1.67		1.67		1.67	1.67	1.67	(ft)	Minimum Thickness of Riprap Apron
d_{50} =	0.83	0.83	0.83	0.83	0.83		0.83		0.83	0.83	0.83	(ft)	Median Stone Size
y_2 =	2.90	2.91	3.11	4.42	3.29		3.44		2.93	3.23	2.59	(ft)	Downstream Normal Depth
d_2 =	3.35	3.30	3.50	4.50	4.08		4.11		3.73	3.85	3.34	(ft)	Depth of Flow in Basin
D/d_{50} =	3.0	3.0	3.0	3.0	3.0		3.0		3.0	3.0	3.0		Drop Height to Stone Size Ratio
H/D =	1.35	1.24	1.46	1.81	1.81		1.81		1.65	1.65	1.48		Energy Grade to Drop Height Ratio
d_2/D =	1.34	1.32	1.40	1.80	1.63		1.64		1.49	1.54	1.34		Flow Depth in Basin to Drop Height Ratio
d_s/D =	0.27	0.23	0.23	0.05	0.47		0.40		0.48	0.37	0.45		Scour Depth to Drop Height Ratio
d_s =	0.68	0.58	0.58	0.13	1.18		1.00		1.20	0.93	1.13	(ft)	Scour Depth
H_d =	2.05	2.11	2.11	2.42	1.71		1.83		1.70	1.88	1.75	(ft)	Effective Drop Height
L_b =	14.13	12.99	15.21	18.75	18.75		18.75		17.13	17.13	15.45	(ft)	Length of Basin
D_r =	1.67	1.67	1.67	1.67	1.76		1.67		1.80	1.67	1.69	(ft)	Thickness of Riprap Apron
h_1 =	9.04	8.76	9.31	10.20	10.20		10.20		9.79	9.79	9.37	(ft)	Upstream Wall Height
B =	0.45	0.39	0.39	0.08	0.79		0.67		0.80	0.62	0.75	(ft)	End Sill Height



STEP 1: Enter H/D

STEP 2: Iterate d_s/D until values for d_2/D and d_s/D match

Table 1 - Summary of Culvert Flows at Crossing: STA 10+25

Headwater Elevation (ft)	Total Discharge (cfs)	2-8X7 Discharge (cfs)	2-8X5 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
843.90	1000.00	588.61	412.68	0.00	10
843.93	1020.00	599.48	421.37	0.00	3
843.95	1040.00	611.22	429.50	0.00	3
843.98	1060.00	622.57	437.73	0.00	3
844.00	1080.00	634.12	445.89	0.00	3
844.03	1100.00	646.07	453.24	0.00	3
844.05	1120.00	657.83	462.39	0.00	3
844.08	1140.00	669.14	470.66	0.00	4
844.11	1160.00	681.19	479.22	0.00	3
844.13	1170.00	689.33	481.19	0.00	2
844.17	1200.00	709.11	490.89	0.00	4
852.00	3368.75	1981.05	1387.70	0.00	Overtopping

Site Data - 2-8X7

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 836.50 ft

Outlet Station: 150.00 ft

Outlet Elevation: 836.34 ft

Number of Barrels: 2

Culvert Data Summary - 2-8X7

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 7.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: 1:1 Bevel Headwall

Inlet Depression: NONE

Site Data - 2-8X5

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 838.50 ft

Outlet Station: 150.00 ft

Outlet Elevation: 838.34 ft

Number of Barrels: 2

Culvert Data Summary - 2-8X5

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 5.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: 1:1 Bevel Headwall

Inlet Depression: NONE

Table 2 - Downstream Channel Rating Curve (Crossing: STA 10+25)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
1000.00	843.30	6.96
1020.00	843.30	6.96
1040.00	843.30	6.96
1060.00	843.30	6.96
1080.00	843.30	6.96
1100.00	843.30	6.96
1120.00	843.30	6.96
1140.00	843.30	6.96
1160.00	843.30	6.96
1170.00	843.30	6.96
1200.00	843.30	6.96

Tailwater Channel Data - STA 10+25

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 843.30 ft

Roadway Data for Crossing: STA 10+25

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 852.00 ft

Roadway Surface: Paved

Roadway Top Width: 90.00 ft

Table 3 - Summary of Culvert Flows at Crossing: STA 27+30

Headwater Elevation (ft)	Total Discharge (cfs)	2-8X7 Discharge (cfs)	2-8X5 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
845.16	1000.00	592.60	411.22	0.00	10
845.17	1020.00	604.77	418.57	0.00	4
845.18	1040.00	617.74	419.49	0.00	3
845.18	1060.00	627.26	436.01	0.00	3
845.19	1080.00	639.38	443.55	0.00	4
845.20	1100.00	644.10	456.17	0.00	4
845.20	1120.00	650.62	459.63	0.00	4
845.21	1140.00	673.25	468.11	0.00	3
845.22	1160.00	686.26	475.70	0.00	3
845.22	1170.00	690.40	479.43	0.00	3
845.23	1200.00	709.08	491.88	0.00	3
852.00	6046.63	3562.90	2483.74	0.00	Overtopping

Site Data - 2-8X7

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 838.38 ft

Outlet Station: 150.00 ft

Outlet Elevation: 838.21 ft

Number of Barrels: 4

Culvert Data Summary - 2-8X7

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 7.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: 1:1 Bevel Headwall

Inlet Depression: NONE

Site Data - 2-8X5

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 840.38 ft

Outlet Station: 150.00 ft

Outlet Elevation: 840.21 ft

Number of Barrels: 4

Culvert Data Summary - 2-8X5

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 5.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: 1:1 Bevel Headwall

Inlet Depression: NONE

Table 4 - Downstream Channel Rating Curve (Crossing: STA 27+30)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
1000.00	845.00	6.79
1020.00	845.00	6.79
1040.00	845.00	6.79
1060.00	845.00	6.79
1080.00	845.00	6.79
1100.00	845.00	6.79
1120.00	845.00	6.79
1140.00	845.00	6.79
1160.00	845.00	6.79
1170.00	845.00	6.79
1200.00	845.00	6.79

Tailwater Channel Data - STA 27+30

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 845.00 ft

Roadway Data for Crossing: STA 27+30

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 852.00 ft

Roadway Surface: Paved

Roadway Top Width: 90.00 ft

Table 5 - Summary of Culvert Flows at Crossing: STA 40+71

Headwater Elevation (ft)	Total Discharge (cfs)	4-8X5 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
847.06	700.00	700.00	0.00	1
847.08	710.00	710.00	0.00	1
847.09	720.00	720.00	0.00	1
847.10	730.00	730.00	0.00	1
847.12	740.00	740.00	0.00	1
847.13	750.00	750.00	0.00	1
847.15	760.00	760.00	0.00	1
847.16	770.00	770.00	0.00	1
847.17	780.00	780.00	0.00	1
847.19	790.00	790.00	0.00	1
847.20	800.00	800.00	0.00	1
850.00	1896.97	1896.97	0.00	Overtopping

Site Data - 4-8X5

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 839.85 ft

Outlet Station: 152.00 ft

Outlet Elevation: 839.69 ft

Number of Barrels: 4

Culvert Data Summary - 4-8X5

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 5.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: 1:1 Bevel Headwall

Inlet Depression: NONE

Table 6 - Downstream Channel Rating Curve (Crossing: STA 40+71)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
700.00	846.60	6.91
710.00	846.60	6.91
720.00	846.60	6.91
730.00	846.60	6.91
740.00	846.60	6.91
750.00	846.60	6.91
760.00	846.60	6.91
770.00	846.60	6.91
780.00	846.60	6.91
790.00	846.60	6.91
800.00	846.60	6.91

Tailwater Channel Data - STA 40+71

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 846.60 ft

Roadway Data for Crossing: STA 40+71

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 850.00 ft

Roadway Surface: Paved

Roadway Top Width: 90.00 ft

Table 7 - Summary of Culvert Flows at Crossing: STA 66+62

Headwater Elevation (ft)	Total Discharge (cfs)	3-6x6 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
852.59	500.00	500.00	0.00	1
852.60	510.00	510.00	0.00	1
852.61	520.00	520.00	0.00	1
852.62	530.00	530.00	0.00	1
852.63	540.00	540.00	0.00	1
852.64	550.00	550.00	0.00	1
852.65	560.00	560.00	0.00	1
852.66	570.00	570.00	0.00	1
852.67	580.00	580.00	0.00	1
852.68	590.00	590.00	0.00	1
852.69	600.00	600.00	0.00	1
857.50	1678.15	1678.15	0.00	Overtopping

Site Data - 3-6x6

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 851.28 ft

Outlet Station: 305.00 ft

Outlet Elevation: 844.22 ft

Number of Barrels: 3

Culvert Data Summary - 3-6x6

Barrel Shape: Concrete Box

Barrel Span: 6.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: 1:1 Bevel Headwall

Inlet Depression: Yes

Table 8 - Downstream Channel Rating Curve (Crossing: STA 66+62)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
500.00	847.50	3.28
510.00	847.50	3.28
520.00	847.50	3.28
530.00	847.50	3.28
540.00	847.50	3.28
550.00	847.50	3.28
560.00	847.50	3.28
570.00	847.50	3.28
580.00	847.50	3.28
590.00	847.50	3.28
600.00	847.50	3.28

Tailwater Channel Data - STA 66+62

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 847.50 ft

Roadway Data for Crossing: STA 66+62

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 857.50 ft

Roadway Surface: Paved

Roadway Top Width: 300.00 ft

Table 9 - Summary of Culvert Flows at Crossing: STA 94+64

Headwater Elevation (ft)	Total Discharge (cfs)	1-6x6 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
880.18	200.00	200.00	0.00	1
880.19	205.00	205.00	0.00	1
880.21	210.00	210.00	0.00	1
880.22	215.00	215.00	0.00	1
880.24	220.00	220.00	0.00	1
880.25	225.00	225.00	0.00	1
880.26	230.00	230.00	0.00	1
880.28	235.00	235.00	0.00	1
880.29	240.00	240.00	0.00	1
880.30	245.00	245.00	0.00	1
880.32	250.00	250.00	0.00	1
888.00	524.72	524.72	0.00	Overtopping

Site Data - 1-6x6

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 879.06 ft

Outlet Station: 1421.00 ft

Outlet Elevation: 866.64 ft

Number of Barrels: 1

Culvert Data Summary - 1-6x6

Barrel Shape: Concrete Box

Barrel Span: 6.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: 1:1 Bevel Headwall

Inlet Depression: Yes

Table 10 - Downstream Channel Rating Curve (Crossing: STA 94+64)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
200.00	870.00	3.36
205.00	870.00	3.36
210.00	870.00	3.36
215.00	870.00	3.36
220.00	870.00	3.36
225.00	870.00	3.36
230.00	870.00	3.36
235.00	870.00	3.36
240.00	870.00	3.36
245.00	870.00	3.36
250.00	870.00	3.36

Tailwater Channel Data - STA 94+64

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 870.00 ft

Roadway Data for Crossing: STA 94+64

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 100.00 ft

Crest Elevation: 888.00 ft

Roadway Surface: Paved

Roadway Top Width: 1420.00 ft

Table 11 - Summary of Culvert Flows at Crossing: STA 114+60

Headwater Elevation (ft)	Total Discharge (cfs)	1-8x4 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
889.24	200.00	200.00	0.00	1
889.31	205.00	205.00	0.00	1
889.38	210.00	210.00	0.00	1
889.45	215.00	215.00	0.00	1
889.52	220.00	220.00	0.00	1
889.59	225.00	225.00	0.00	1
889.66	230.00	230.00	0.00	1
889.73	235.00	235.00	0.00	1
889.80	240.00	240.00	0.00	1
889.87	245.00	245.00	0.00	1
889.94	250.00	250.00	0.00	1
893.00	384.19	384.19	0.00	Overtopping

Site Data - 1-8x4

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 884.81 ft

Outlet Station: 280.00 ft

Outlet Elevation: 884.53 ft

Number of Barrels: 1

Culvert Data Summary - 1-8x4

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: 1:1 Bevel Headwall

Inlet Depression: NONE

Table 12 - Downstream Channel Rating Curve (Crossing: STA 114+60)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
200.00	886.50	1.97
205.00	886.50	1.97
210.00	886.50	1.97
215.00	886.50	1.97
220.00	886.50	1.97
225.00	886.50	1.97
230.00	886.50	1.97
235.00	886.50	1.97
240.00	886.50	1.97
245.00	886.50	1.97
250.00	886.50	1.97

Tailwater Channel Data - STA 114+60

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 886.50 ft

Roadway Data for Crossing: STA 114+60

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 893.00 ft

Roadway Surface: Paved

Roadway Top Width: 90.00 ft

Table 13 - Summary of Culvert Flows at Crossing: STA 226+26

Headwater Elevation (ft)	Total Discharge (cfs)	3-8x4 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
851.12	200.00	200.00	0.00	1
851.13	205.00	205.00	0.00	1
851.13	210.00	210.00	0.00	1
851.14	215.00	215.00	0.00	1
851.15	220.00	220.00	0.00	1
851.15	225.00	225.00	0.00	1
851.16	230.00	230.00	0.00	1
851.17	235.00	235.00	0.00	1
851.17	240.00	240.00	0.00	1
851.18	245.00	245.00	0.00	1
851.19	250.00	250.00	0.00	1
853.00	815.16	815.16	0.00	Overtopping

Site Data - 3-8x4

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 846.06 ft

Outlet Station: 206.00 ft

Outlet Elevation: 845.96 ft

Number of Barrels: 3

Culvert Data Summary - 3-8x4

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: 1:1 Bevel Headwall

Inlet Depression: NONE

Table 14 - Downstream Channel Rating Curve (Crossing: STA 226+26)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
200.00	851.00	5.04
205.00	851.00	5.04
210.00	851.00	5.04
215.00	851.00	5.04
220.00	851.00	5.04
225.00	851.00	5.04
230.00	851.00	5.04
235.00	851.00	5.04
240.00	851.00	5.04
245.00	851.00	5.04
250.00	851.00	5.04

Tailwater Channel Data - STA 226+26

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 851.00 ft

Roadway Data for Crossing: STA 226+26

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 853.00 ft

Roadway Surface: Paved

Roadway Top Width: 200.00 ft

Table 15 - Summary of Culvert Flows at Crossing: STA 253+78

Headwater Elevation (ft)	Total Discharge (cfs)	2-6x4 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
866.48	400.00	400.00	0.00	1
866.59	410.00	410.00	0.00	1
866.72	420.00	420.00	0.00	1
866.84	430.00	430.00	0.00	1
866.96	440.00	440.00	0.00	1
867.09	450.00	450.00	0.00	1
867.22	460.00	460.00	0.00	1
867.35	470.00	470.00	0.00	1
867.48	480.00	480.00	0.00	1
867.62	490.00	490.00	0.00	1
867.75	500.00	500.00	0.00	1
868.00	517.38	517.38	0.00	Overtopping

Site Data - 2-6x4

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 861.14 ft

Outlet Station: 140.00 ft

Outlet Elevation: 859.08 ft

Number of Barrels: 2

Culvert Data Summary - 2-6x4

Barrel Shape: Concrete Box

Barrel Span: 6.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: 1:1 Bevel Headwall

Inlet Depression: NONE

Table 16 - Downstream Channel Rating Curve (Crossing: STA 253+78)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
400.00	862.00	2.92
410.00	862.00	2.92
420.00	862.00	2.92
430.00	862.00	2.92
440.00	862.00	2.92
450.00	862.00	2.92
460.00	862.00	2.92
470.00	862.00	2.92
480.00	862.00	2.92
490.00	862.00	2.92
500.00	862.00	2.92

Tailwater Channel Data - STA 253+78

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 862.00 ft

Roadway Data for Crossing: STA 253+78

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 868.00 ft

Roadway Surface: Paved

Roadway Top Width: 135.00 ft

Table 17 - Summary of Culvert Flows at Crossing: STA 379+07

Headwater Elevation (ft)	Total Discharge (cfs)	1-48" SD Discharge (cfs)	Roadway Discharge (cfs)	Iterations
908.69	50.00	50.00	0.00	1
908.76	52.00	52.00	0.00	1
908.83	54.00	54.00	0.00	1
908.90	56.00	56.00	0.00	1
908.97	58.00	58.00	0.00	1
909.04	60.00	60.00	0.00	1
909.11	62.00	62.00	0.00	1
909.18	64.00	64.00	0.00	1
909.25	66.00	66.00	0.00	1
909.32	68.00	68.00	0.00	1
909.38	70.00	70.00	0.00	1
912.00	126.91	126.91	0.00	Overtopping

Site Data - 1-48" SD

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 905.56 ft

Outlet Station: 241.00 ft

Outlet Elevation: 904.78 ft

Number of Barrels: 1

Culvert Data Summary - 1-48" SD

Barrel Shape: Circular

Barrel Diameter: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Beveled Edge (1:1)

Inlet Depression: NONE

Table 18 - Downstream Channel Rating Curve (Crossing: STA 379+07)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
50.00	906.50	1.90
52.00	906.50	1.90
54.00	906.50	1.90
56.00	906.50	1.90
58.00	906.50	1.90
60.00	906.50	1.90
62.00	906.50	1.90
64.00	906.50	1.90
66.00	906.50	1.90
68.00	906.50	1.90
70.00	906.50	1.90

Tailwater Channel Data - STA 379+07

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 906.50 ft

Roadway Data for Crossing: STA 379+07

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 90.00 ft

Crest Elevation: 912.00 ft

Roadway Surface: Paved

Roadway Top Width: 240.00 ft

Table 19 - Summary of Culvert Flows at Crossing: STA 392+48

Headwater Elevation (ft)	Total Discharge (cfs)	2-6X6 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
917.71	500.00	500.00	0.00	1
917.79	510.00	510.00	0.00	1
917.88	520.00	520.00	0.00	1
917.96	530.00	530.00	0.00	1
918.05	540.00	540.00	0.00	1
918.14	550.00	550.00	0.00	1
918.22	560.00	560.00	0.00	1
918.31	570.00	570.00	0.00	1
918.40	580.00	580.00	0.00	1
918.49	590.00	590.00	0.00	1
918.57	600.00	600.00	0.00	1
920.00	753.56	753.56	0.00	Overtopping

Site Data - 2-6X6

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 911.84 ft

Outlet Station: 232.00 ft

Outlet Elevation: 906.44 ft

Number of Barrels: 2

Culvert Data Summary - 2-6X6

Barrel Shape: Concrete Box

Barrel Span: 6.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: 1:1 Bevel Headwall

Inlet Depression: NONE

Table 20 - Downstream Channel Rating Curve (Crossing: STA 392+48)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
500.00	910.50	4.06
510.00	910.50	4.06
520.00	910.50	4.06
530.00	910.50	4.06
540.00	910.50	4.06
550.00	910.50	4.06
560.00	910.50	4.06
570.00	910.50	4.06
580.00	910.50	4.06
590.00	910.50	4.06
600.00	910.50	4.06

Tailwater Channel Data - STA 392+48

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 910.50 ft

Roadway Data for Crossing: STA 392+48

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 920.00 ft

Roadway Surface: Paved

Roadway Top Width: 230.00 ft

Table 21 - Summary of Culvert Flows at Crossing: STA 439+60

Headwater Elevation (ft)	Total Discharge (cfs)	2-8X6 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
972.43	350.00	350.00	0.00	1
972.50	360.00	360.00	0.00	1
972.57	370.00	370.00	0.00	1
972.64	380.00	380.00	0.00	1
972.71	390.00	390.00	0.00	1
972.78	400.00	400.00	0.00	1
972.84	410.00	410.00	0.00	1
972.91	420.00	420.00	0.00	1
972.98	430.00	430.00	0.00	1
973.04	440.00	440.00	0.00	1
973.11	450.00	450.00	0.00	1
975.00	742.18	742.18	0.00	Overtopping

Site Data - 2-8X6

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 968.61 ft

Outlet Station: 1500.00 ft

Outlet Elevation: 951.77 ft

Number of Barrels: 2

Culvert Data Summary - 2-8X6

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: 1:1 Bevel Headwall

Inlet Depression: NONE

Table 22 - Downstream Channel Rating Curve (Crossing: STA 439+60)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
350.00	955.00	3.23
360.00	955.00	3.23
370.00	955.00	3.23
380.00	955.00	3.23
390.00	955.00	3.23
400.00	955.00	3.23
410.00	955.00	3.23
420.00	955.00	3.23
430.00	955.00	3.23
440.00	955.00	3.23
450.00	955.00	3.23

Tailwater Channel Data - STA 439+60

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 955.00 ft

Roadway Data for Crossing: STA 439+60

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 975.00 ft

Roadway Surface: Paved

Roadway Top Width: 1500.00 ft

Table 23 - Summary of Culvert Flows at Crossing: STA 466+51

Headwater Elevation (ft)	Total Discharge (cfs)	2-8X4 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
986.39	350.00	350.00	0.00	1
986.47	360.00	360.00	0.00	1
986.55	370.00	370.00	0.00	1
986.63	380.00	380.00	0.00	1
986.71	390.00	390.00	0.00	1
986.79	400.00	400.00	0.00	1
986.87	410.00	410.00	0.00	1
986.95	420.00	420.00	0.00	1
987.03	430.00	430.00	0.00	1
987.11	440.00	440.00	0.00	1
987.19	450.00	450.00	0.00	1
990.00	741.76	741.76	0.00	Overtopping

Site Data - 2-8X4

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 982.59 ft

Outlet Station: 110.00 ft

Outlet Elevation: 979.66 ft

Number of Barrels: 2

Culvert Data Summary - 2-8X4

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: 1:1 Bevel Headwall

Inlet Depression: NONE

Table 24 - Downstream Channel Rating Curve (Crossing: STA 466+51)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
350.00	982.50	2.84
360.00	982.50	2.84
370.00	982.50	2.84
380.00	982.50	2.84
390.00	982.50	2.84
400.00	982.50	2.84
410.00	982.50	2.84
420.00	982.50	2.84
430.00	982.50	2.84
440.00	982.50	2.84
450.00	982.50	2.84

Tailwater Channel Data - STA 466+51

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 982.50 ft

Roadway Data for Crossing: STA 466+51

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 990.00 ft

Roadway Surface: Paved

Roadway Top Width: 100.00 ft

Table 25 - Summary of Culvert Flows at Crossing: STA 466+75

Headwater Elevation (ft)	Total Discharge (cfs)	1-36" SD Discharge (cfs)	Roadway Discharge (cfs)	Iterations
995.54	50.00	50.00	0.00	1
995.68	52.00	52.00	0.00	1
995.83	54.00	54.00	0.00	1
995.98	56.00	56.00	0.00	1
996.15	58.00	58.00	0.00	1
996.31	60.00	60.00	0.00	1
996.49	62.00	62.00	0.00	1
996.67	64.00	64.00	0.00	1
996.85	66.00	66.00	0.00	1
997.04	68.00	68.00	0.00	1
997.24	70.00	70.00	0.00	1
998.00	75.80	75.80	0.00	Overtopping

Site Data - 1-36" SD

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 991.76 ft

Outlet Station: 1251.00 ft

Outlet Elevation: 979.69 ft

Number of Barrels: 1

Culvert Data Summary - 1-36" SD

Barrel Shape: Circular

Barrel Diameter: 3.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Beveled Edge (1:1)

Inlet Depression: NONE

Table 26 - Downstream Channel Rating Curve (Crossing: STA 466+75)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
50.00	982.50	2.81
52.00	982.50	2.81
54.00	982.50	2.81
56.00	982.50	2.81
58.00	982.50	2.81
60.00	982.50	2.81
62.00	982.50	2.81
64.00	982.50	2.81
66.00	982.50	2.81
68.00	982.50	2.81
70.00	982.50	2.81

Tailwater Channel Data - STA 466+75

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 982.50 ft

Roadway Data for Crossing: STA 466+75

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 90.00 ft

Crest Elevation: 998.00 ft

Roadway Surface: Paved

Roadway Top Width: 1250.00 ft

Table 27 - Summary of Culvert Flows at Crossing: STA 507+30

Headwater Elevation (ft)	Total Discharge (cfs)	1-48" SD Discharge (cfs)	Roadway Discharge (cfs)	Iterations
898.23	40.00	40.00	0.00	1
898.39	43.00	43.00	0.00	1
898.57	46.00	46.00	0.00	1
898.75	49.00	49.00	0.00	1
898.83	50.00	50.00	0.00	1
899.35	55.00	55.00	0.00	1
900.16	58.00	58.00	0.00	1
900.91	61.00	61.00	0.00	1
901.68	64.00	64.00	0.00	1
902.49	67.00	67.00	0.00	1
902.55	70.00	67.22	2.66	8
902.50	67.05	67.05	0.00	Overtopping

Site Data - 1-48" SD

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 895.13 ft

Outlet Station: 4425.00 ft

Outlet Elevation: 890.70 ft

Number of Barrels: 1

Culvert Data Summary - 1-48" SD

Barrel Shape: Circular

Barrel Diameter: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Beveled Edge (1:1)

Inlet Depression: NONE

Table 28 - Downstream Channel Rating Curve (Crossing: STA 507+30)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
40.00	892.70	0.98
43.00	892.70	0.98
46.00	892.70	0.98
49.00	892.70	0.98
50.00	892.70	0.98
55.00	892.70	0.98
58.00	892.70	0.98
61.00	892.70	0.98
64.00	892.70	0.98
67.00	892.70	0.98
70.00	892.70	0.98

Tailwater Channel Data - STA 507+30

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 892.70 ft

Roadway Data for Crossing: STA 507+30

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 90.00 ft

Crest Elevation: 902.50 ft

Roadway Surface: Paved

Roadway Top Width: 4425.00 ft

Table 29 - Summary of Culvert Flows at Crossing: STA 624+49

Headwater Elevation (ft)	Total Discharge (cfs)	1-8X4 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
891.54	200.00	200.00	0.00	1
891.68	210.00	210.00	0.00	1
891.82	220.00	220.00	0.00	1
891.96	230.00	230.00	0.00	1
892.12	240.00	240.00	0.00	1
892.29	250.00	250.00	0.00	1
892.47	260.00	260.00	0.00	1
892.64	270.00	270.00	0.00	1
892.82	280.00	280.00	0.00	1
893.01	290.00	290.00	0.00	1
893.20	300.00	300.00	0.00	1
895.00	384.59	384.59	0.00	Overtopping

Site Data - 1-8X4

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 887.22 ft

Outlet Station: 78.00 ft

Outlet Elevation: 887.14 ft

Number of Barrels: 1

Culvert Data Summary - 1-8X4

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: 1:1 Bevel Headwall

Inlet Depression: NONE

Table 30 - Downstream Channel Rating Curve (Crossing: STA 624+49)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
200.00	889.50	2.87
210.00	889.50	2.87
220.00	889.50	2.87
230.00	889.50	2.87
240.00	889.50	2.87
250.00	889.50	2.87
260.00	889.50	2.87
270.00	889.50	2.87
280.00	889.50	2.87
290.00	889.50	2.87
300.00	889.50	2.87

Tailwater Channel Data - STA 624+49

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 889.50 ft

Roadway Data for Crossing: STA 624+49

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 895.00 ft

Roadway Surface: Paved

Roadway Top Width: 75.00 ft

Table 31 - Summary of Culvert Flows at Crossing: STA 634+76

Headwater Elevation (ft)	Total Discharge (cfs)	1-48" SD Discharge (cfs)	Roadway Discharge (cfs)	Iterations
902.47	90.00	90.00	0.00	1
902.94	92.00	92.00	0.00	1
903.43	94.00	94.00	0.00	1
903.92	96.00	96.00	0.00	1
904.42	98.00	98.00	0.00	1
904.94	100.00	100.00	0.00	1
905.03	102.00	100.37	1.48	15
905.06	104.00	100.46	3.38	6
905.07	106.00	100.53	5.30	5
905.09	108.00	100.60	7.28	5
905.11	110.00	100.66	9.16	4
905.00	100.25	100.25	0.00	Overtopping

Site Data - 1-48" SD

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 895.50 ft

Outlet Station: 2854.00 ft

Outlet Elevation: 888.17 ft

Number of Barrels: 1

Culvert Data Summary - 1-48" SD

Barrel Shape: Circular

Barrel Diameter: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Beveled Edge (1:1)

Inlet Depression: NONE

Table 32 - Downstream Channel Rating Curve (Crossing: STA 634+76)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
90.00	892.00	3.83
92.00	892.00	3.83
94.00	892.00	3.83
96.00	892.00	3.83
98.00	892.00	3.83
100.00	892.00	3.83
102.00	892.00	3.83
104.00	892.00	3.83
106.00	892.00	3.83
108.00	892.00	3.83
110.00	892.00	3.83

Tailwater Channel Data - STA 634+76

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 892.00 ft

Roadway Data for Crossing: STA 634+76

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 90.00 ft

Crest Elevation: 905.00 ft

Roadway Surface: Paved

Roadway Top Width: 2850.00 ft

Table 33 - Summary of Culvert Flows at Crossing: STA 666+35

Headwater Elevation (ft)	Total Discharge (cfs)	2-8X4 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
909.05	300.00	300.00	0.00	1
909.11	310.00	310.00	0.00	1
909.17	320.00	320.00	0.00	1
909.24	330.00	330.00	0.00	1
909.30	340.00	340.00	0.00	1
909.37	350.00	350.00	0.00	1
909.43	360.00	360.00	0.00	1
909.50	370.00	370.00	0.00	1
909.57	380.00	380.00	0.00	1
909.64	390.00	390.00	0.00	1
909.70	400.00	400.00	0.00	1
910.00	443.15	443.15	0.00	Overtopping

Site Data - 2-8X4

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 905.21 ft

Outlet Station: 331.00 ft

Outlet Elevation: 904.93 ft

Number of Barrels: 2

Culvert Data Summary - 2-8X4

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: 1:1 Bevel Headwall

Inlet Depression: NONE

Table 34 - Downstream Channel Rating Curve (Crossing: STA 666+35)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
300.00	908.00	3.07
310.00	908.00	3.07
320.00	908.00	3.07
330.00	908.00	3.07
340.00	908.00	3.07
350.00	908.00	3.07
360.00	908.00	3.07
370.00	908.00	3.07
380.00	908.00	3.07
390.00	908.00	3.07
400.00	908.00	3.07

Tailwater Channel Data - STA 666+35

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 908.00 ft

Roadway Data for Crossing: STA 666+35

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 910.00 ft

Roadway Surface: Paved

Roadway Top Width: 330.00 ft

Table 35 - Summary of Culvert Flows at Crossing: STA 686+28

Headwater Elevation (ft)	Total Discharge (cfs)	1-8X6 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
923.31	300.00	300.00	0.00	1
923.44	310.00	310.00	0.00	1
923.57	320.00	320.00	0.00	1
923.70	330.00	330.00	0.00	1
923.83	340.00	340.00	0.00	1
923.95	350.00	350.00	0.00	1
924.08	360.00	360.00	0.00	1
924.21	370.00	370.00	0.00	1
924.34	380.00	380.00	0.00	1
924.48	390.00	390.00	0.00	1
924.61	400.00	400.00	0.00	1
926.00	499.95	499.95	0.00	Overtopping

Site Data - 1-8X6

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 917.83 ft

Outlet Station: 196.00 ft

Outlet Elevation: 916.20 ft

Number of Barrels: 1

Culvert Data Summary - 1-8X6

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: 1:1 Bevel Headwall

Inlet Depression: NONE

Table 36 - Downstream Channel Rating Curve (Crossing: STA 686+28)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
300.00	920.00	3.80
310.00	920.00	3.80
320.00	920.00	3.80
330.00	920.00	3.80
340.00	920.00	3.80
350.00	920.00	3.80
360.00	920.00	3.80
370.00	920.00	3.80
380.00	920.00	3.80
390.00	920.00	3.80
400.00	920.00	3.80

Tailwater Channel Data - STA 686+28

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 920.00 ft

Roadway Data for Crossing: STA 686+28

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 926.00 ft

Roadway Surface: Paved

Roadway Top Width: 190.00 ft

Table 37 - Summary of Culvert Flows at Crossing: STA 695+63

Headwater Elevation (ft)	Total Discharge (cfs)	1-8X6 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
931.80	300.00	300.00	0.00	1
931.93	310.00	310.00	0.00	1
932.06	320.00	320.00	0.00	1
932.19	330.00	330.00	0.00	1
932.32	340.00	340.00	0.00	1
932.45	350.00	350.00	0.00	1
932.57	360.00	360.00	0.00	1
932.70	370.00	370.00	0.00	1
932.84	380.00	380.00	0.00	1
932.97	390.00	390.00	0.00	1
933.10	400.00	400.00	0.00	1
935.00	534.00	534.00	0.00	Overtopping

Site Data - 1-8X6

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 926.34 ft

Outlet Station: 274.00 ft

Outlet Elevation: 922.31 ft

Number of Barrels: 1

Culvert Data Summary - 1-8X6

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: 1:1 Bevel Headwall

Inlet Depression: NONE

Table 38 - Downstream Channel Rating Curve (Crossing: STA 695+63)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
300.00	925.00	2.69
310.00	925.00	2.69
320.00	925.00	2.69
330.00	925.00	2.69
340.00	925.00	2.69
350.00	925.00	2.69
360.00	925.00	2.69
370.00	925.00	2.69
380.00	925.00	2.69
390.00	925.00	2.69
400.00	925.00	2.69

Tailwater Channel Data - STA 695+63

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 925.00 ft

Roadway Data for Crossing: STA 695+63

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 935.00 ft

Roadway Surface: Paved

Roadway Top Width: 270.00 ft

Table 39 - Summary of Culvert Flows at Crossing: STA 710+32

Headwater Elevation (ft)	Total Discharge (cfs)	1-8X6 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
948.28	250.00	250.00	0.00	1
948.35	255.00	255.00	0.00	1
948.41	260.00	260.00	0.00	1
948.48	265.00	265.00	0.00	1
948.54	270.00	270.00	0.00	1
948.60	275.00	275.00	0.00	1
948.67	280.00	280.00	0.00	1
948.73	285.00	285.00	0.00	1
948.80	290.00	290.00	0.00	1
948.86	295.00	295.00	0.00	1
948.93	300.00	300.00	0.00	1
950.50	420.78	420.78	0.00	Overtopping

Site Data - 1-8X6

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 943.46 ft

Outlet Station: 522.00 ft

Outlet Elevation: 936.12 ft

Number of Barrels: 1

Culvert Data Summary - 1-8X6

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: 1:1 Bevel Headwall

Inlet Depression: NONE

Table 40 - Downstream Channel Rating Curve (Crossing: STA 710+32)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
250.00	939.00	2.88
255.00	939.00	2.88
260.00	939.00	2.88
265.00	939.00	2.88
270.00	939.00	2.88
275.00	939.00	2.88
280.00	939.00	2.88
285.00	939.00	2.88
290.00	939.00	2.88
295.00	939.00	2.88
300.00	939.00	2.88

Tailwater Channel Data - STA 710+32

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 939.00 ft

Roadway Data for Crossing: STA 710+32

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 950.50 ft

Roadway Surface: Paved

Roadway Top Width: 520.00 ft

Table 41 - Summary of Culvert Flows at Crossing: STA 740+65

Headwater Elevation (ft)	Total Discharge (cfs)	1-8X6 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
970.67	200.00	200.00	0.00	1
970.74	205.00	205.00	0.00	1
970.80	210.00	210.00	0.00	1
970.87	215.00	215.00	0.00	1
970.94	220.00	220.00	0.00	1
971.00	225.00	225.00	0.00	1
971.07	230.00	230.00	0.00	1
971.14	235.00	235.00	0.00	1
971.20	240.00	240.00	0.00	1
971.27	245.00	245.00	0.00	1
971.33	250.00	250.00	0.00	1
974.00	453.46	453.46	0.00	Overtopping

Site Data - 1-8X6

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 966.56 ft

Outlet Station: 141.00 ft

Outlet Elevation: 962.32 ft

Number of Barrels: 1

Culvert Data Summary - 1-8X6

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 6.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: 1:1 Bevel Headwall

Inlet Depression: NONE

Table 42 - Downstream Channel Rating Curve (Crossing: STA 740+65)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
200.00	965.00	2.68
205.00	965.00	2.68
210.00	965.00	2.68
215.00	965.00	2.68
220.00	965.00	2.68
225.00	965.00	2.68
230.00	965.00	2.68
235.00	965.00	2.68
240.00	965.00	2.68
245.00	965.00	2.68
250.00	965.00	2.68

Tailwater Channel Data - STA 740+65

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 965.00 ft

Roadway Data for Crossing: STA 740+65

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 974.00 ft

Roadway Surface: Paved

Roadway Top Width: 140.00 ft

Table 43 - Summary of Culvert Flows at Crossing: STA 755+75

Headwater Elevation (ft)	Total Discharge (cfs)	2-24" SD Discharge (cfs)	Roadway Discharge (cfs)	Iterations
994.77	40.00	40.00	0.00	1
994.92	42.00	42.00	0.00	1
995.07	44.00	44.00	0.00	1
995.23	46.00	46.00	0.00	1
995.40	48.00	48.00	0.00	1
995.69	50.00	50.00	0.00	1
996.03	52.00	50.71	1.17	30
996.05	54.00	50.76	3.06	5
996.07	56.00	50.80	5.10	5
996.09	58.00	50.84	7.03	4
996.11	60.00	50.87	9.03	4
996.00	50.65	50.65	0.00	Overtopping

Site Data - 2-24" SD

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 992.00 ft

Outlet Station: 1016.00 ft

Outlet Elevation: 981.81 ft

Number of Barrels: 2

Culvert Data Summary - 2-24" SD

Barrel Shape: Circular

Barrel Diameter: 2.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: Beveled Edge (1:1)

Inlet Depression: NONE

Table 44 - Downstream Channel Rating Curve (Crossing: STA 755+75)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
40.00	984.00	2.19
42.00	984.00	2.19
44.00	984.00	2.19
46.00	984.00	2.19
48.00	984.00	2.19
50.00	984.00	2.19
52.00	984.00	2.19
54.00	984.00	2.19
56.00	984.00	2.19
58.00	984.00	2.19
60.00	984.00	2.19

Tailwater Channel Data - STA 755+75

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 984.00 ft

Roadway Data for Crossing: STA 755+75

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 90.00 ft

Crest Elevation: 996.00 ft

Roadway Surface: Paved

Roadway Top Width: 1010.00 ft

Table 45 - Summary of Culvert Flows at Crossing: STA 812+79

Headwater Elevation (ft)	Total Discharge (cfs)	4-8X4 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
904.13	300.00	300.00	0.00	1
904.13	310.00	310.00	0.00	1
904.14	320.00	320.00	0.00	1
904.15	330.00	330.00	0.00	1
904.16	340.00	340.00	0.00	1
904.17	350.00	350.00	0.00	1
904.18	360.00	360.00	0.00	1
904.19	370.00	370.00	0.00	1
904.20	380.00	380.00	0.00	1
904.21	390.00	390.00	0.00	1
904.22	400.00	400.00	0.00	1
907.50	1586.31	1586.31	0.00	Overtopping

Site Data - 4-8X4

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 898.51 ft

Outlet Station: 94.00 ft

Outlet Elevation: 898.44 ft

Number of Barrels: 4

Culvert Data Summary - 4-8X4

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: 1:1 Bevel Headwall

Inlet Depression: NONE

Table 46 - Downstream Channel Rating Curve (Crossing: STA 812+79)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
300.00	904.00	5.56
310.00	904.00	5.56
320.00	904.00	5.56
330.00	904.00	5.56
340.00	904.00	5.56
350.00	904.00	5.56
360.00	904.00	5.56
370.00	904.00	5.56
380.00	904.00	5.56
390.00	904.00	5.56
400.00	904.00	5.56

Tailwater Channel Data - STA 812+79

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 904.00 ft

Roadway Data for Crossing: STA 812+79

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 907.50 ft

Roadway Surface: Paved

Roadway Top Width: 90.00 ft

Table 47 - Summary of Culvert Flows at Crossing: STA 851+11

Headwater Elevation (ft)	Total Discharge (cfs)	2-8X4 Discharge (cfs)	Roadway Discharge (cfs)	Iterations
906.11	300.00	300.00	0.00	1
906.17	310.00	310.00	0.00	1
906.23	320.00	320.00	0.00	1
906.30	330.00	330.00	0.00	1
906.36	340.00	340.00	0.00	1
906.42	350.00	350.00	0.00	1
906.49	360.00	360.00	0.00	1
906.50	370.00	370.00	0.00	1
906.62	380.00	380.00	0.00	1
906.69	390.00	390.00	0.00	1
906.75	400.00	400.00	0.00	1
909.00	553.44	553.44	0.00	Overtopping

Site Data - 2-8X4

Site Data Option: Culvert Invert Data

Inlet Station: 0.00 ft

Inlet Elevation: 902.07 ft

Outlet Station: 704.00 ft

Outlet Elevation: 901.50 ft

Number of Barrels: 2

Culvert Data Summary - 2-8X4

Barrel Shape: Concrete Box

Barrel Span: 8.00 ft

Barrel Rise: 4.00 ft

Barrel Material: Concrete

Embedment: 0.00 in

Barrel Manning's n: 0.0120

Inlet Type: Conventional

Inlet Edge Condition: 1:1 Bevel Headwall

Inlet Depression: NONE

Table 48 - Downstream Channel Rating Curve (Crossing: STA 851+11)

Flow (cfs)	Water Surface Elev (ft)	Depth (ft)
300.00	905.00	3.50
310.00	905.00	3.50
320.00	905.00	3.50
330.00	905.00	3.50
340.00	905.00	3.50
350.00	905.00	3.50
360.00	905.00	3.50
370.00	905.00	3.50
380.00	905.00	3.50
390.00	905.00	3.50
400.00	905.00	3.50

Tailwater Channel Data - STA 851+11

Tailwater Channel Option: Enter Constant Tailwater Elevation

Constant Tailwater Elevation: 905.00 ft

Roadway Data for Crossing: STA 851+11

Roadway Profile Shape: Constant Roadway Elevation

Crest Length: 50.00 ft

Crest Elevation: 909.00 ft

Roadway Surface: Paved

Roadway Top Width: 700.00 ft

Appendix F

Detention Basin Volume Report

DETENTION BASIN VOLUMES - CALCULATION SHEET
WATSON DRAINAGE SYSTEM PRE-DESIGN
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY - FCD NO. 2012-C003

	Railroad Basin	*Rainbow Basin*	*Dean Basin*	*Apache Basin*	*Maricopa Basin*		
A_1 =	258,737.68	301,027.60	174,054.95	80,501.81	164,857.55	(sf)	Bottom Contour Area
A_2 =	273,236.36	322,548.65	185,120.14	91,266.98	324,011.01	(sf)	Second Contour Area
A_3 =	287,361.11	343,421.83	195,855.31	103,281.46	367,745.88	(sf)	Third Contour Area
A_4 =	300,687.97	364,810.98	207,172.15	115,366.56	403,276.75	(sf)	Fourth Contour Area
A_5 =	314,093.24	684,278.65	218,756.29	127,758.41	440,981.06	(sf)	Fifth Contour Area
A_6 =	329,251.97	728,628.76	230,542.98	140,515.10	462,805.28	(sf)	Sixth Contour Area
A_7 =	344,381.57	743,072.57	242,536.02	153,619.78	481,623.22	(sf)	Top Contour Area
V =	1,469,373.51	2,229,888.29	1,009,202.86	548,181.87	1,849,846.12	(cf)	Design Basin Volume with 1' Freeboard
V =	33.73	51.19	23.17	12.58	42.47	(ac-ft)	Design Basin Volume with 1' Freeboard
V =	1,806,190.28	2,965,738.96	1,245,742.36	695,249.31	2,322,060.37	(cf)	Design Basin Volume with no Freeboard
V =	41.46	68.08	28.60	15.96	53.31	(ac-ft)	Design Basin Volume with no Freeboard
V_h =	33.58	47.68	23.06	12.61	33.52	(ac-ft)	Basin Volume from Hydrology Model

PROVIDED UNDER
SEPARATE COVER

Appendix G

Conceptual Design Plans

Appendix H

Conceptual Plan Cost Estimate

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Opinion of Probable Construction Cost - 15%

Contract FCD 2012C003
Watson Drainage System Pre-Design
3/25/2014

ITEM NO	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
	Construction Items				
201-1	CLEAR & GRUB	LS	1	1.42%	$541,782
215-1	CHANNEL EXCAVATION	CY	980,473	$6.00	$5,882,838
215-2	CHANNEL SUBGRADE PREPARATION	SY	177,679	$6.30	$1,119,378
350-2	SAWCUT, REMOVE & REPLACE PAVEMENT PER MAG STD DTL 200-B	SF	6,505	$9.40	$61,147
220-1	ROCK MULCH (3" MINUS, 5" THICK)	SY	74,511	$3.90	$290,593
350-3	REMOVE RIPRAP	CY	16,511	$20.00	$330,220
220-2	DUMPED RIPRAP (D50 = 12")	CY	7,847	$52.00	$408,044
220-3	DUMPED RIPRAP (D50 = 18")	CY	160	$46.00	$7,360
350-5	REMOVE CONCRETE DITCH	LF	1,868	$30.00	$56,040
220-4	GRADE CONTROL STRUCTURE PER DTL 9, DWG D1.02	CY	677	$62.40	$42,245
505-1	REINFORCED CONCRETE CHANNEL LINING PER STR SEC 3, DWG G1.04	SY	80,790	$74.25	$5,998,658
525-1	SHOTCRETE CHANNEL LINING PER STR SEC 4, DWG G1.04	SY	35,485	$44.00	$1,561,340
350-20	RELOCATE NATURAL GAS PIPE	LF	155	$26.00	$4,030
350-21	FIBER OPTIC LINE RELOCATION BY OTHERS	LS	4	$30,000.00	$120,000
505-3	48" STEEL CASING, JACK & BORE	LF	70	$750.00	$52,500
505-2	36" STEEL CASING, JACK & BORE	LF	70	$650.00	$45,500
505-27	VERTICAL DROP STRUCTURE PER DTL 11, DWG D1.03	LF	3,029	$300.00	$908,700
505-5	GILA RIVER OUTFALL CUTOFF WALL PER DTL 6, DWG D1.01	LF	204	$2,100.00	$428,400
350-22	WATER MAIN RELOCATION (12")	EA	4	$1,760.00	$7,040
350-6	WATER MAIN RELOCATION (16")	EA	3	$2,900.00	$8,700
505-4	GILA RIVER OUTFALL GRADE CONTROL STRUCTURE PER DTL 5, DWG D1.01	LF	253	$300.00	$75,900
321-1	AC MULTI-USE PATH STR SEC 1, DWG G1.04	SY	72,672	$15.80	$1,148,218
310-1	ABC MAINTENANCE ROAD PER STR SEC 2, DWG G1.04	SY	101,128	$5.00	$505,640
321-2	MAINTENANCE ROAD TURNAROUND PER DTL 4, DWG D1.01	EA	44	$790.00	$34,760
505-7	CONCRETE MAINTENANCE ROAD FORD PER MAG STD DTL 552	LF	204	$14.00	$2,856
350-8	SANITARY SEWER MANHOLE RELOCATION	EA	1	$7,100.00	$7,100
505-23	CONCRETE MAINTENANCE ROAD RAMP PER STR SEC3, DWG G1.04	SY	2,665	$33.00	$87,945
505-24	ABC MAINTENANCE ROAD RAMP PER STR SEC 2, DWG G1.04	SY	10,868	$5.00	$54,340
505-30	CHAIN LINK FENCE PER MAG STD DTL 160	LF	29,809	$15.90	$473,963
505-7	(2) 6'x4' CONCRETE BOX CULVERT	LF	138	$740.00	$102,120
350-10	REMOVE IRRIGATION PIPE	LF	1,505	$102.00	$153,510
505-8	(1) 6'x6' CONCRETE BOX CULVERT	LF	1,421	$430.00	$611,030
505-9	(2) 6'x6' CONCRETE BOX CULVERT	LF	231	$860.00	$198,660
505-10	(3) 6'x6' CONCRETE BOX CULVERT	LF	325	$1,290.00	$419,250
505-11	(1) 8'x4' CONCRETE BOX CULVERT	LF	360	$345.60	$124,416
505-12	(2) 8'x4' CONCRETE BOX CULVERT	LF	1,145	$691.20	$791,424
505-13	(3) 8'x4' CONCRETE BOX CULVERT	LF	212	$1,036.80	$219,802
505-31	(4) 8'x4' CONCRETE BOX CULVERT	LF	92	$1,382.40	$127,181
350-12	REMOVE CONCRETE-LINED IRRIGATION DITCH	LF	4,494	$59.00	$265,146
505-14	(1) 8'x6' CONCRETE BOX CULVERT	LF	1,153	$570.00	$657,210
350-13	REMOVE EARTH-LINED IRRIGATION DITCH	LF	5,048	$16.30	$82,282
505-23	(2) 8'x6' CONCRETE BOX CULVERT	LF	1,485	$1,026.00	$1,523,610
505-15	(4) 8'x5' CONCRETE BOX CULVERT	EA	140	$1,938.00	$271,320
350-15	REMOVE IRRIGATION TURNOUT STRUCTURE	EA	6	$17,500.00	$105,000
505-16	(2) 8'x7' & (2) 8'x5' CONCRETE BOX CULVERTS PER DTL 7, DWG D1.02	EA	300	$2,360.00	$708,000
505-17	CONCRETE BOX CULVERT WING WALLS PER ADOT STD DTL SD6.08	EA	10	$6,800.00	$68,000
505-18	CONCRETE BOX CULVERT WING WALLS PER ADOT STD DTL SD6.10, TYPE B	EA	28	$15,000.00	$420,000

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Opinion of Probable Construction Cost - 15%

Contract FCD 2012C003
Watson Drainage System Pre-Design
3/25/2014

ITEM NO	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
350-16	RELOCATE CHAIN LINK FENCE	LF	342	$26.00	$8,892
618-1	18" STORM DRAIN PIPE	LF	20	$92.00	$1,840
618-2	24" STORM DRAIN PIPE	LF	2,122	$104.00	$220,688
618-4	36" STORM DRAIN PIPE	LF	1,237	$106.00	$131,122
618-5	48" STORM DRAIN PIPE	LF	8,513	$168.00	$1,430,184
505-19	STORM DRAIN HEADWALL PER MAG STD DTL 501-1	EA	7	$3,100.00	$21,700
505-20	STORM DRAIN HEADWALL PER MAG STD DTL 501-3	EA	11	$8,200.00	$90,200
505-21	STORM DRAIN MANHOLE PER MAG STD DTL 522	EA	33	$3,600.00	$118,800
505-22	BOX CULVERT STORM DRAIN MANHOLE	EA	16	$2,800.00	$44,800
350-9	24" IRRIGATION PIPE	LF	865	$104.00	$89,960
350-10	30" IRRIGATION PIPE	LF	15,633	$122.00	$1,907,226
505-24	IRRIGATION MANHOLE PER MAG STD DTL 520	EA	45	$3,600.00	$162,000
505-25	IRRIGATION HEADWALL PER MAG STD DTL 501-1	EA	28	$4,000.00	$112,000
505-26	IRRIGATION TURNOUT STRUCTURE PER MAG STD DTL 504	EA	9	$4,500.00	$40,500
618-6	48" IRRIGATION PIPE	LF	144	$168.00	$24,192
618-7	24" IRRIGATION SIPHON DTL 8, DWG D1.02	EA	13	$49,200.00	$639,600
350-18	KINDER-MORGAN 20" PETROLEUM PIPELINE CROSSING	LS	1	$960,000.00	$960,000
430-1	HYDROSEED	SY	803,252	$0.80	$642,602
900-1	RID CANAL CROSSING	LS	2	$19,200.00	$38,400
430-3	TURF CHANNEL LINING	SY	116,916	$2.00	$233,832
900-2	BWCDD CANAL CROSSING	LS	1	$450,000.00	$450,000
430-4	TREES (24" BOX)	EA	4,156	$200.00	$831,200
430-5	TALL POT TREES	EA	1,996	$100.00	$199,600
900-4	RAILROAD CROSSING TEMPORARY REMOVAL & RELOCATION BY OTHERS	LS	1	$240,000.00	$240,000
430-6	SHRUBS	EA	23,890	$15.00	$358,350
350-20	FIBER OPTIC LINE RELOCATION	LS	4	$30,000.00	$120,000
440-1	DRIP IRRIGATION	AC	110	$15,000.00	$1,650,000
430-7	BOULDERS	EA	2,233	$130.00	$290,290
350-23	RELOCATE UPRR COMMUNICATION LINE BY OTHERS	EA	1	$30,000.00	$30,000
350-19	ANPP WATER LINE PROTECTION BY OTHERS	LS	1	$380,000.00	$380,000
618-8	30" IRRIGATION SIPHON DTL 8, DWG D1.02	EA	1	$61,500.00	$61,500
				Sub-Total	***$38,652,514***
	Right-of-Way Acquisition				
	LOW DENSITY RESIDENTIAL PROPERTY	SF	2,751,364	$1.40	$3,851,909
	MEDIUM DENSITY RESIDENTIAL PROPERTY	SF	7,422,753	$1.60	$11,876,405
	MIXED USE PROPERTY	SF	388,800	$2.00	$777,600
	COMMERICAL PROPERTY	SF	36,000	$3.00	$108,000
	INDUSTRIAL PROPERTY	SF	2,634,942	$2.50	$6,587,355
				Sub-Total	***$23,201,269***

Construction Sub-Total	***$38,652,514***
Right-of-Way Sub-Total	***$23,201,269***
Contingency (20%)	***$7,730,503***
PROJECT CONSTRUCTION TOTAL	***$69,584,285***

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Apache Reach

Opinion of Probable Construction Cost - 15%

Contract FCD 2012C003

Watson Drainage System Pre-Design

3/25/2014

ITEM NO	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
	Construction Items				
201-1	CLEAR & GRUB	LS	1	1.42%	$114,866
215-1	CHANNEL EXCAVATION	CY	152,770	$6.00	$916,620.00
215-2	CHANNEL SUBGRADE PREPARATION	SY	28,737	$6.30	$181,043
350-2	SAWCUT, REMOVE & REPLACE PAVEMENT PER MAG STD DTL 200-B	SF	1,415	$9.40	$13,301
220-2	DUMPED RIPRAP (D50 = 12")	CY	2,413	$52.00	$125,476
350-5	REMOVE CONCRETE DITCH	LF	981	$30.00	$29,430
525-1	SHOTCRETE CHANNEL LINING PER STR SEC 4, DWG G1.04	SY	31,826	$44.00	$1,400,344
505-2	36" STEEL CASING, JACK & BORE	LF	70	$650.00	$45,500
505-27	VERTICAL DROP STRUCTURE PER DTL 11, DWG D1.03	LF	1,731	$300.00	$519,300
350-22	WATER MAIN RELOCATION (12")	EA	3	$1,760.00	$5,280
321-1	AC MULTI-USE PATH STR SEC 1, DWG G1.04	SY	21,007	$15.80	$331,911
310-1	ABC MAINTENANCE ROAD PER STR SEC 2, DWG G1.04	SY	22,792	$5.00	$113,960
321-2	MAINTENANCE ROAD TURNAROUND PER DTL 4, DWG D1.01	EA	12	$790.00	$9,480
505-24	ABC MAINTENANCE ROAD RAMP PER STR SEC 2, DWG G1.04	SY	3,557	$5.00	$17,785
350-10	REMOVE IRRIGATION PIPE	LF	570	$102.00	$58,140
505-10	(3) 6'x6' CONCRETE BOX CULVERT	LF	325	$1,290.00	$419,250
505-12	(2) 8'x4' CONCRETE BOX CULVERT	LF	331	$691.20	$228,787
505-14	(1) 8'x6' CONCRETE BOX CULVERT	LF	1,153	$570.00	$657,210
505-17	CONCRETE BOX CULVERT WING WALLS PER ADOT STD DTL SD6.08	EA	1	$6,800.00	$6,800
505-18	CONCRETE BOX CULVERT WING WALLS PER ADOT STD DTL SD6.10, TYPE B	EA	11	$15,000.00	$165,000
350-16	RELOCATE CHAIN LINK FENCE	LF	42	$26.00	$1,092
618-2	24" STORM DRAIN PIPE	LF	2,057	$104.00	$213,928
618-5	48" STORM DRAIN PIPE	LF	576	$168.00	$96,768
505-19	STORM DRAIN HEADWALL PER MAG STD DTL 501-1	EA	1	$3,100.00	$3,100
505-20	STORM DRAIN HEADWALL PER MAG STD DTL 501-3	EA	2	$8,200.00	$16,400
505-21	STORM DRAIN MANHOLE PER MAG STD DTL 522	EA	12	$3,600.00	$43,200
350-9	24" IRRIGATION PIPE	LF	275	$104.00	$28,600
350-10	30" IRRIGATION PIPE	LF	10,037	$122.00	$1,224,514
505-24	IRRIGATION MANHOLE PER MAG STD DTL 520	EA	35	$3,600.00	$126,000
505-25	IRRIGATION HEADWALL PER MAG STD DTL 501-1	EA	6	$4,000.00	$24,000
505-26	IRRIGATION TURNOUT STRUCTURE PER MAG STD DTL 504	EA	6	$4,500.00	$27,000
618-7	24" IRRIGATION SIPHON DTL 8, DWG D1.02	EA	1	$49,200.00	$49,200
430-1	HYDROSEED	SY	125,480	$0.80	$100,384
900-1	RID CANAL CROSSING	LS	1	$19,200.00	$19,200
430-3	TURF CHANNEL LINING	SY	67,526	$2.00	$135,052
430-4	TREES (24" BOX)	EA	962	$200.00	$192,400
430-6	SHRUBS	EA	4,810	$15.00	$72,150
440-1	DRIP IRRIGATION	AC	22	$15,000.00	$330,000
430-7	BOULDERS	EA	769	$130.00	$99,970
				Sub-Total	***$8,181,888***
	Right-of-Way Acquisition				
	LOW DENSITY RESIDENTIAL PROPERTY	SF	0	$1.40	$0
	MEDIUM DENSITY RESIDENTIAL PROPERTY	SF	2,207,419	$1.60	$3,531,871
	MIXED USE PROPERTY	SF	0	$2.00	$0
	COMMERICAL PROPERTY	SF	0	$3.00	$0
	INDUSTRIAL PROPERTY	SF	270,240	$2.50	$675,600

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Apache Reach

Opinion of Probable Construction Cost - 15%

Contract FCD 2012C003

Watson Drainage System Pre-Design

3/25/2014

ITEM NO	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
				Sub-Total	*$4,207,471*

Construction Sub-Total	*$8,181,888*
Right-of-Way Sub-Total	*$4,207,471*
Contingency (20%)	*$1,636,377.69*
PROJECT CONSTRUCTION TOTAL	*$14,025,737*

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Maricopa Reach

Opinion of Probable Construction Cost - 15%

Contract FCD 2012C003

Watson Drainage System Pre-Design

3/25/2014

ITEM NO	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
	Construction Items				
201-1	CLEAR & GRUB	LS	1	1.42%	$59,650
215-1	CHANNEL EXCAVATION	CY	194,156	$6.00	$1,164,936.00
215-2	CHANNEL SUBGRADE PREPARATION	SY	70,126	$6.30	$441,794
220-1	ROCK MULCH (3" MINUS, 5" THICK)	SY	74,511	$3.90	$290,593
220-2	DUMPED RIPRAP (D50 = 12")	CY	120	$52.00	$6,240
505-1	REINFORCED CONCRETE CHANNEL LINING PER STR SEC 3, DWG G1.04	SY	863	$74.25	$64,078
350-20	RELOCATE NATURAL GAS PIPE	LF	75	$26.00	$1,950
321-1	AC MULTI-USE PATH STR SEC 1, DWG G1.04	SY	9,516	$15.80	$150,353
310-1	ABC MAINTENANCE ROAD PER STR SEC 2, DWG G1.04	SY	10,505	$5.00	$52,525
321-2	MAINTENANCE ROAD TURNAROUND PER DTL 4, DWG D1.01	EA	8	$790.00	$6,320
505-24	ABC MAINTENANCE ROAD RAMP PER STR SEC 2, DWG G1.04	SY	1,327	$5.00	$6,635
505-30	CHAIN LINK FENCE PER MAG STD DTL 160	LF	4,895	$15.90	$77,831
350-10	REMOVE IRRIGATION PIPE	LF	36	$102.00	$3,672
505-12	(2) 8'x4' CONCRETE BOX CULVERT	LF	704	$691.20	$486,605
505-31	(4) 8'x4' CONCRETE BOX CULVERT	LF	92	$1,382.40	$127,181
350-12	REMOVE CONCRETE-LINED IRRIGATION DITCH	LF	226	$59.00	$13,334
505-17	CONCRETE BOX CULVERT WING WALLS PER ADOT STD DTL SD6.08	EA	2	$6,800.00	$13,600
505-18	CONCRETE BOX CULVERT WING WALLS PER ADOT STD DTL SD6.10, TYPE B	EA	2	$15,000.00	$30,000
618-5	48" STORM DRAIN PIPE	LF	2,300	$168.00	$386,400
505-20	STORM DRAIN HEADWALL PER MAG STD DTL 501-3	EA	1	$8,200.00	$8,200
505-21	STORM DRAIN MANHOLE PER MAG STD DTL 522	EA	5	$3,600.00	$18,000
505-22	BOX CULVERT STORM DRAIN MANHOLE	EA	4	$2,800.00	$11,200
350-9	24" IRRIGATION PIPE	LF	21	$104.00	$2,184
350-10	30" IRRIGATION PIPE	LF	2,773	$122.00	$338,306
505-24	IRRIGATION MANHOLE PER MAG STD DTL 520	EA	4	$3,600.00	$14,400
505-25	IRRIGATION HEADWALL PER MAG STD DTL 501-1	EA	5	$4,000.00	$20,000
505-26	IRRIGATION TURNOUT STRUCTURE PER MAG STD DTL 504	EA	2	$4,500.00	$9,000
618-7	24" IRRIGATION SIPHON DTL 8, DWG D1.02	EA	1	$49,200.00	$49,200
430-1	HYDROSEED	SY	80,575	$0.80	$64,460
430-4	TREES (24" BOX)	EA	599	$200.00	$119,800
430-6	SHRUBS	EA	2,995	$15.00	$44,925
440-1	DRIP IRRIGATION	AC	5	$15,000.00	$75,000
430-7	BOULDERS	EA	479	$130.00	$62,270
				Sub-Total	***$4,248,840***
	Right-of-Way Acquisition				
	LOW DENSITY RESIDENTIAL PROPERTY	SF	0	$1.40	$0
	MEDIUM DENSITY RESIDENTIAL PROPERTY	SF	1,516,399	$1.60	$2,426,238
	MIXED USE PROPERTY	SF	0	$2.00	$0
	COMMERICAL PROPERTY	SF	0	$3.00	$0
	INDUSTRIAL PROPERTY	SF	319,200	$2.50	$798,000
				Sub-Total	***$3,224,238***

Construction Sub-Total	***$4,248,840***
Right-of-Way Sub-Total	***$3,224,238***
Contingency (20%)	***$849,768.02***
PROJECT CONSTRUCTION TOTAL	***$8,322,846***

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Watson Drain Reach

Opinion of Probable Construction Cost - 15%

Contract FCD 2012C003

Watson Drainage System Pre-Design

3/25/2014

ITEM NO	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
	Construction Items				
201-1	CLEAR & GRUB	LS	1	1.42%	$61,686
215-1	CHANNEL EXCAVATION	CY	176,860	$6.00	$1,061,160.00
215-2	CHANNEL SUBGRADE PREPARATION	SY	8,578	$6.30	$54,041
350-2	SAWCUT, REMOVE & REPLACE PAVEMENT PER MAG STD DTL 200-B	SF	2,718	$9.40	$25,549
350-3	REMOVE RIPRAP	CY	16,511	$20.00	$330,220
220-2	DUMPED RIPRAP (D50 = 12")	CY	2,483	$52.00	$129,116
220-3	DUMPED RIPRAP (D50 = 18")	CY	160	$46.00	$7,360
505-1	REINFORCED CONCRETE CHANNEL LINING PER STR SEC 3, DWG G1.04	SY	6,969	$74.25	$517,448
525-1	SHOTCRETE CHANNEL LINING PER STR SEC 4, DWG G1.04	SY	2,963	$44.00	$130,372
505-5	GILA RIVER OUTFALL CUTOFF WALL PER DTL 6, DWG D1.01	LF	204	$2,100.00	$428,400
350-22	WATER MAIN RELOCATION (12")	EA	1	$1,760.00	$1,760
505-4	GILA RIVER OUTFALL GRADE CONTROL STRUCTURE PER DTL 5, DWG D1.01	LF	217	$300.00	$65,100
321-1	AC MULTI-USE PATH STR SEC 1, DWG G1.04	SY	9,484	$15.80	$149,847
310-1	ABC MAINTENANCE ROAD PER STR SEC 2, DWG G1.04	SY	7,395	$5.00	$36,975
321-2	MAINTENANCE ROAD TURNAROUND PER DTL 4, DWG D1.01	EA	4	$790.00	$3,160
505-7	CONCRETE MAINTENANCE ROAD FORD PER MAG STD DTL 552	LF	204	$14.00	$2,856
505-23	CONCRETE MAINTENANCE ROAD RAMP PER STR SEC3, DWG G1.04	SY	190	$33.00	$6,270
505-24	ABC MAINTENANCE ROAD RAMP PER STR SEC 2, DWG G1.04	SY	2,850	$5.00	$14,250
350-10	REMOVE IRRIGATION PIPE	LF	170	$102.00	$17,340
505-15	(4) 8'x5' CONCRETE BOX CULVERT	EA	140	$1,938.00	$271,320
350-15	REMOVE IRRIGATION TURNOUT STRUCTURE	EA	4	$17,500.00	$70,000
505-16	(2) 8'x7' & (2) 8'x5' CONCRETE BOX CULVERTS PER DTL 7, DWG D1.02	EA	300	$2,360.00	$708,000
505-17	CONCRETE BOX CULVERT WING WALLS PER ADOT STD DTL SD6.08	EA	4	$6,800.00	$27,200
505-18	CONCRETE BOX CULVERT WING WALLS PER ADOT STD DTL SD6.10, TYPE B	EA	2	$15,000.00	$30,000
618-1	18" STORM DRAIN PIPE	LF	20	$92.00	$1,840
505-19	STORM DRAIN HEADWALL PER MAG STD DTL 501-1	EA	2	$3,100.00	$6,200
350-9	24" IRRIGATION PIPE	LF	283	$104.00	$29,432
505-25	IRRIGATION HEADWALL PER MAG STD DTL 501-1	EA	2	$4,000.00	$8,000
430-1	HYDROSEED	SY	92,505	$0.80	$74,004
430-4	TREES (24" BOX)	EA	38	$200.00	$7,600
430-5	TALL POT TREES	EA	655	$100.00	$65,500
430-6	SHRUBS	EA	190	$15.00	$2,850
430-7	BOULDERS	EA	31	$130.00	$4,030
				Sub-Total	***$4,393,887***
	Right-of-Way Acquisition				
	LOW DENSITY RESIDENTIAL PROPERTY	SF	839,694	$1.40	$1,175,572
	MEDIUM DENSITY RESIDENTIAL PROPERTY	SF	251,400	$1.60	$402,240
	MIXED USE PROPERTY	SF	0	$2.00	$0
	COMMERICAL PROPERTY	SF	0	$3.00	$0
	INDUSTRIAL PROPERTY	SF	0	$2.50	$0
				Sub-Total	***$1,577,812***

Construction Sub-Total	***$4,393,887***
Right-of-Way Sub-Total	***$1,577,812***
Contingency (20%)	***$878,777.42***
PROJECT CONSTRUCTION TOTAL	***$6,850,476***

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Industrial Reach

Opinion of Probable Construction Cost - 15%

Contract FCD 2012C003

Watson Drainage System Pre-Design

3/25/2014

ITEM NO	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
	Construction Items				
201-1	CLEAR & GRUB	LS	1	1.42%	$153,159
215-1	CHANNEL EXCAVATION	CY	200,801	$6.00	$1,204,806.00
215-2	CHANNEL SUBGRADE PREPARATION	SY	51,402	$6.30	$323,833
350-2	SAWCUT, REMOVE & REPLACE PAVEMENT PER MAG STD DTL 200-B	SF	1,108	$9.40	$10,415
220-2	DUMPED RIPRAP (D50 = 12")	CY	34	$52.00	$1,768
350-5	REMOVE CONCRETE DITCH	LF	233	$30.00	$6,990
505-1	REINFORCED CONCRETE CHANNEL LINING PER STR SEC 3, DWG G1.04	SY	57,583	$74.25	$4,275,538
350-21	FIBER OPTIC LINE RELOCATION BY OTHERS	LS	4	$30,000.00	$120,000
505-27	VERTICAL DROP STRUCTURE PER DTL 11, DWG D1.03	LF	96	$300.00	$28,800
350-6	WATER MAIN RELOCATION (16")	EA	2	$2,900.00	$5,800
505-4	GILA RIVER OUTFALL GRADE CONTROL STRUCTURE PER DTL 5, DWG D1.01	LF	36	$300.00	$10,800
310-1	ABC MAINTENANCE ROAD PER STR SEC 2, DWG G1.04	SY	29,179	$5.00	$145,895
321-2	MAINTENANCE ROAD TURNAROUND PER DTL 4, DWG D1.01	EA	8	$790.00	$6,320
350-8	SANITARY SEWER MANHOLE RELOCATION	EA	1	$7,100.00	$7,100
505-23	CONCRETE MAINTENANCE ROAD RAMP PER STR SEC3, DWG G1.04	SY	2,118	$33.00	$69,894
505-24	ABC MAINTENANCE ROAD RAMP PER STR SEC 2, DWG G1.04	SY	492	$5.00	$2,460
505-30	CHAIN LINK FENCE PER MAG STD DTL 160	LF	20,009	$15.90	$318,143
350-10	REMOVE IRRIGATION PIPE	LF	20	$102.00	$2,040
505-8	(1) 6'x6' CONCRETE BOX CULVERT	LF	285	$430.00	$122,550
505-11	(1) 8'x4' CONCRETE BOX CULVERT	LF	280	$345.60	$96,768
350-12	REMOVE CONCRETE-LINED IRRIGATION DITCH	LF	220	$59.00	$12,980
350-15	REMOVE IRRIGATION TURNOUT STRUCTURE	EA	1	$17,500.00	$17,500
505-17	CONCRETE BOX CULVERT WING WALLS PER ADOT STD DTL SD6.08	EA	2	$6,800.00	$13,600
505-18	CONCRETE BOX CULVERT WING WALLS PER ADOT STD DTL SD6.10, TYPE B	EA	1	$15,000.00	$15,000
618-2	24" STORM DRAIN PIPE	LF	65	$104.00	$6,760
618-5	48" STORM DRAIN PIPE	LF	5,238	$168.00	$879,984
505-19	STORM DRAIN HEADWALL PER MAG STD DTL 501-1	EA	3	$3,100.00	$9,300
505-20	STORM DRAIN HEADWALL PER MAG STD DTL 501-3	EA	4	$8,200.00	$32,800
505-21	STORM DRAIN MANHOLE PER MAG STD DTL 522	EA	12	$3,600.00	$43,200
505-22	BOX CULVERT STORM DRAIN MANHOLE	EA	1	$2,800.00	$2,800
350-9	24" IRRIGATION PIPE	LF	25	$104.00	$2,600
350-10	30" IRRIGATION PIPE	LF	112	$122.00	$13,664
505-25	IRRIGATION HEADWALL PER MAG STD DTL 501-1	EA	4	$4,000.00	$16,000
618-7	24" IRRIGATION SIPHON DTL 8, DWG D1.02	EA	6	$49,200.00	$295,200
350-18	KINDER-MORGAN 20" PETROLEUM PIPELINE CROSSING	LS	1	$960,000.00	$960,000
430-1	HYDROSEED	SY	124,018	$0.80	$99,214
900-2	BWCDD CANAL CROSSING	LS	1	$450,000.00	$450,000
430-4	TREES (24" BOX)	EA	522	$200.00	$104,400
900-4	RAILROAD CROSSING TEMPORARY REMOVAL & RELOCATION BY OTHERS	LS	1	$240,000.00	$240,000
430-6	SHRUBS	EA	5,220	$15.00	$78,300
350-20	FIBER OPTIC LINE RELOCATION	LS	4	$30,000.00	$120,000
440-1	DRIP IRRIGATION	AC	8	$15,000.00	$120,000
350-23	RELOCATE UPRR COMMUNICATION LINE BY OTHERS	EA	1	$30,000.00	$30,000
350-19	ANPP WATER LINE PROTECTION BY OTHERS	LS	1	$380,000.00	$380,000
				Sub-Total	***$10,909,522***
	Right-of-Way Acquisition				
	LOW DENSITY RESIDENTIAL PROPERTY	SF	0	$1.40	$0

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Industrial Reach

Opinion of Probable Construction Cost - 15%

Contract FCD 2012C003

Watson Drainage System Pre-Design

3/25/2014

ITEM NO	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
	MEDIUM DENSITY RESIDENTIAL PROPERTY	SF	821,615	$1.60	$1,314,583
	MIXED USE PROPERTY	SF	0	$2.00	$0
	COMMERICAL PROPERTY	SF	0	$3.00	$0
	INDUSTRIAL PROPERTY	SF	1,939,902	$2.50	$4,849,755
				Sub-Total	***$6,164,338***

Construction Sub-Total	***$10,909,522***
Right-of-Way Sub-Total	***$6,164,338***
Contingency (20%)	***$2,181,904.31***
PROJECT CONSTRUCTION TOTAL	***$19,255,764***

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

231st Reach

Opinion of Probable Construction Cost - 15%

Contract FCD 2012C003

Watson Drainage System Pre-Design

3/25/2014

ITEM NO	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
	Construction Items				
201-1	CLEAR & GRUB	LS	1	1.42%	$152,208
215-1	CHANNEL EXCAVATION	CY	255,886	$6.00	$1,535,316.00
215-2	CHANNEL SUBGRADE PREPARATION	SY	18,837	$6.30	$118,673
350-2	SAWCUT, REMOVE & REPLACE PAVEMENT PER MAG STD DTL 200-B	SF	1,264	$9.40	$11,882
220-2	DUMPED RIPRAP (D50 = 12")	CY	2,797	$52.00	$145,444
350-5	REMOVE CONCRETE DITCH	LF	654	$30.00	$19,620
220-4	GRADE CONTROL STRUCTURE PER DTL 9, DWG D1.02	CY	677	$62.40	$42,245
505-1	REINFORCED CONCRETE CHANNEL LINING PER STR SEC 3, DWG G1.04	SY	15,375	$74.25	$1,141,594
525-1	SHOTCRETE CHANNEL LINING PER STR SEC 4, DWG G1.04	SY	697	$44.00	$30,668
350-20	RELOCATE NATURAL GAS PIPE	LF	80	$26.00	$2,080
505-3	48" STEEL CASING, JACK & BORE	LF	70	$750.00	$52,500
505-27	VERTICAL DROP STRUCTURE PER DTL 11, DWG D1.03	LF	1,202	$300.00	$360,600
350-6	WATER MAIN RELOCATION (16")	EA	1	$2,900.00	$2,900
321-1	AC MULTI-USE PATH STR SEC 1, DWG G1.04	SY	32,665	$15.80	$516,107
310-1	ABC MAINTENANCE ROAD PER STR SEC 2, DWG G1.04	SY	31,257	$5.00	$156,285
321-2	MAINTENANCE ROAD TURNAROUND PER DTL 4, DWG D1.01	EA	12	$790.00	$9,480
505-23	CONCRETE MAINTENANCE ROAD RAMP PER STR SEC3, DWG G1.04	SY	357	$33.00	$11,781
505-24	ABC MAINTENANCE ROAD RAMP PER STR SEC 2, DWG G1.04	SY	2,642	$5.00	$13,210
505-30	CHAIN LINK FENCE PER MAG STD DTL 160	LF	4,380	$15.90	$69,642
505-7	(2) 6'x4' CONCRETE BOX CULVERT	LF	138	$740.00	$102,120
350-10	REMOVE IRRIGATION PIPE	LF	709	$102.00	$72,318
505-8	(1) 6'x6' CONCRETE BOX CULVERT	LF	1,136	$430.00	$488,480
505-9	(2) 6'x6' CONCRETE BOX CULVERT	LF	231	$860.00	$198,660
505-11	(1) 8'x4' CONCRETE BOX CULVERT	LF	80	$345.60	$27,648
505-12	(2) 8'x4' CONCRETE BOX CULVERT	LF	110	$691.20	$76,032
505-13	(3) 8'x4' CONCRETE BOX CULVERT	LF	212	$1,036.80	$219,802
350-12	REMOVE CONCRETE-LINED IRRIGATION DITCH	LF	4,048	$59.00	$238,832
350-13	REMOVE EARTH-LINED IRRIGATION DITCH	LF	5,048	$16.30	$82,282
505-23	(2) 8'x6' CONCRETE BOX CULVERT	LF	1,485	$1,026.00	$1,523,610
350-15	REMOVE IRRIGATION TURNOUT STRUCTURE	EA	1	$17,500.00	$17,500
505-17	CONCRETE BOX CULVERT WING WALLS PER ADOT STD DTL SD6.08	EA	1	$6,800.00	$6,800
505-18	CONCRETE BOX CULVERT WING WALLS PER ADOT STD DTL SD6.10, TYPE B	EA	12	$15,000.00	$180,000
350-16	RELOCATE CHAIN LINK FENCE	LF	300	$26.00	$7,800
618-4	36" STORM DRAIN PIPE	LF	1,237	$106.00	$131,122
618-5	48" STORM DRAIN PIPE	LF	399	$168.00	$67,032
505-19	STORM DRAIN HEADWALL PER MAG STD DTL 501-1	EA	1	$3,100.00	$3,100
505-20	STORM DRAIN HEADWALL PER MAG STD DTL 501-3	EA	4	$8,200.00	$32,800
505-21	STORM DRAIN MANHOLE PER MAG STD DTL 522	EA	4	$3,600.00	$14,400
505-22	BOX CULVERT STORM DRAIN MANHOLE	EA	11	$2,800.00	$30,800
350-9	24" IRRIGATION PIPE	LF	261	$104.00	$27,144
350-10	30" IRRIGATION PIPE	LF	2,711	$122.00	$330,742
505-24	IRRIGATION MANHOLE PER MAG STD DTL 520	EA	6	$3,600.00	$21,600
505-25	IRRIGATION HEADWALL PER MAG STD DTL 501-1	EA	11	$4,000.00	$44,000
505-26	IRRIGATION TURNOUT STRUCTURE PER MAG STD DTL 504	EA	1	$4,500.00	$4,500
618-6	48" IRRIGATION PIPE	LF	144	$168.00	$24,192
618-7	24" IRRIGATION SIPHON DTL 8, DWG D1.02	EA	5	$49,200.00	$246,000
430-1	HYDROSEED	SY	380,674	$0.80	$304,539

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

231st Reach

Opinion of Probable Construction Cost - 15%

Contract FCD 2012C003

Watson Drainage System Pre-Design

3/25/2014

ITEM NO	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
900-1	RID CANAL CROSSING	LS	1	$19,200.00	$19,200
430-3	TURF CHANNEL LINING	SY	49,391	$2.00	$98,782
430-4	TREES (24" BOX)	EA	2,035	$200.00	$407,000
430-6	SHRUBS	EA	10,675	$15.00	$160,125
440-1	DRIP IRRIGATION	AC	71	$15,000.00	$1,065,000
430-7	BOULDERS	EA	954	$130.00	$124,020
				Sub-Total	***$10,841,716***
	Right-of-Way Acquisition				
	LOW DENSITY RESIDENTIAL PROPERTY	SF	1,911,670	$1.40	$2,676,337
	MEDIUM DENSITY RESIDENTIAL PROPERTY	SF	2,625,920	$1.60	$4,201,472
	MIXED USE PROPERTY	SF	388,800	$2.00	$777,600
	COMMERICAL PROPERTY	SF	36,000	$3.00	$108,000
	INDUSTRIAL PROPERTY	SF	105,600	$2.50	$264,000
				Sub-Total	***$8,027,409***

Construction Sub-Total	***$10,841,716***
Right-of-Way Sub-Total	***$8,027,409***
Contingency (20%)	***$2,168,343.20***
PROJECT CONSTRUCTION TOTAL	***$21,037,469***