East Mesa
Area Drainage Master Plan Update
Recommended Alternative Report
For The Rittenhouse Zone
March 2014 - FCD 2011C017

EAST MESA AREA DRAINAGE
MASTER PLAN UPDATE

RECOMMENDED ALTERNATIVE REPORT FOR THE RITTENHOUSE ZONE

VOLUME RA

Contract FCD 2011C017

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EAST MESA AREA DRAINAGE MASTER PLAN UPDATE
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EAST MESA AREA DRAINAGE MASTER PLAN UPDATE

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RECOMMENDED ALTERNATIVE FOR THE RITTENHOUSE ZONE

VOLUME RA

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EAST MESA AREA DRAINAGE MASTER PLAN UPDATE
RECOMMENDED ALTERNATIVE REPORT
FOR THE RITTENHOUSE ZONE
VOLUME RA

SECTION RA-1: INTRODUCTION

The East Mesa Area Drainage Master Plan (ADMP) Update was initiated to develop and recommend context-sensitive and cost-effective strategies to reduce flood hazards and protect public safety in a 58-square-mile portion of southeastern Maricopa County. Entellus, Inc., was retained by the Flood Control District of Maricopa County (District) under Contract FCD 2011C017 to update the previous ADMP (*1998 ADMP*) prepared by others (**Reference 234**). This report presents the selected alternative and associated analyses for a portion of the original study area described below.

Physical changes have occurred in the watershed since completion of the *1998 ADMP*, including the first phase of the new SR-24 Gateway Freeway, currently under construction between SR-202 and Ellsworth Road. The new freeway will ultimately intercept a substantial amount of runoff and alter drainage patterns in the study area.

Another change in conditions is the publication of *NOAA Atlas 14 - Precipitation-Frequency Atlas of the United States, Volume 1 Version 4.0: Semiarid Southwest (Arizona, Southeast California, Nevada, New Mexico, Utah)*, which supersedes *NOAA Atlas II* used in the development of the original hydrology. The net effect of *NOAA Atlas 14* is a decrease in runoff volume estimated for the 100-year, 2-hour storm. Most local jurisdictions use this document as the basis for retention/detention requirements for new development; therefore, future conditions assumed for the *1998 ADMP* must be modified accordingly.

Finally, the *1998 ADMP* had included two regional detention basins to be located in Pinal County. Because the District prefers to locate infrastructure within Maricopa County where practicable, the location of these basins was revisited.

1.1 HYDROLOGY UPDATE

Since the *1998 ADMP*, the District generated an updated hydrologic model using the latest information available for the watershed, including planned future improvements. The hydrologic update also evaluated the effect of the new peak discharges on existing infrastructure for both existing and future conditions. The hydrologic analysis for the current update was based on this model, documented in the *2011 East Mesa Area Drainage Master Plan Hydrology Update* (*Hydrology Update*) (**Reference 99**). The District's hydrologic model was subsequently refined during the analysis of the recommended alternative (**Appendix A**).

1.2 PROJECT GOALS

The goals of this project are to update the *1998 ADMP* and develop recommendations that would provide an adequate regional drainage system that maximizes the use of existing infrastructure.

1.3 MODIFIED STUDY FOCUS

The watershed from the original East Mesa ADMP Update study area included the drainage area between the Powerline, Vineyard Road, and Rittenhouse Flood Retarding Structures (PVR Structures) on the east and the East Maricopa Floodway (EMF) on the west. It was divided into three somewhat hydrologically independent segments (**Figure RA 1.3**):

- **SR-24 Zone:** The portion of the watershed between the Powerline Floodway on the north and the future SR-24 alignment on the south.
- **Ellsworth Zone:** Extends from the future SR-24 alignment south to Germann Road within Maricopa County and to Queen Creek Road in Pinal County.
- **Rittenhouse Zone:** Extends from the Ellsworth Zone south to the study boundary at the Rittenhouse Channel and Ocotillo Road.

Entellus developed and evaluated drainage alternatives for all three zones, as documented previously in *Volume AD, Proposed Alternatives Development and Evaluation*. However, the two northern zones, SR24 and Ellsworth, were not carried further under this study effort. The recommended alternative for the Rittenhouse Zone is described herein.

1.4 RITTENHOUSE ZONE STUDY AREA

As shown in **Figure RA 1.4a**, the study area encompasses portions of Pinal County and Queen Creek and drains to the existing Rittenhouse Channel. The planning effort lies between the Maricopa/Pinal county boundary and the Rittenhouse Channel.

The Rittenhouse Zone includes a mix of residential, industrial, and agricultural development, except for a relatively small area of natural desert near the PVR Structures. Portions of the study area are experiencing rapid changes in growth, with agricultural and industrial uses being converted to residential and commercial developments.

1.4.1 Existing Drainage Facilities

Regional drainage infrastructure within the Rittenhouse Zone includes the Rittenhouse Channel and its extension along Queen Creek Road. In addition, individual developments have constructed channels and basins to handle local runoff. **Figure RA 1.4b** shows the location of the primary existing drainage facilities.

Another existing facility is a tail water ditch located in Pinal County along the Meridian Road alignment. This channel was not engineered, and its capacity and structural integrity is of concern. The channel embankment was overtopped and breached in the 1990s between Germann and Queen Creek roads.

1.4.2 **Drainage Issues**

There are capacity concerns with Rittenhouse Channel, and the area does not have coordinated regional drainage facilities. As development continues, a significant portion of agricultural storage will be lost; the amount of runoff will increase accordingly and concentrate along Germann and Queen Creek roads. As shown in **Table RA 1.4a**, this increase will have a negative effect on the Rittenhouse Channel, resulting in loss of freeboard and potentially overtopping in some reaches. **Figure RA 1.4c** shows the known drainage issues.

Table RA 1.4a – Comparison of Rittenhouse Channel Capacity with Existing and Future Discharges

Location	Channel Design Capacity (cfs)	Hydrologic Concentration Point	Existing Conditions 100-year Discharge (cfs)	Future Conditions 100-year Discharge (cfs)
East of Ellsworth Rd	520	CPR18	680	910
Ellsworth Rd to near Hawes Rd alignment	810	CPR22	690	890
Near Hawes Rd alignment to Germann Rd	1050	CPR21	870	1520
Germann Rd to south of Pecos Rd	1400	CPR25	910	1480
Power Rd and Pecos Rd to EMF	1500	CPR24	1050	1530

In addition to capacity concerns with Rittenhouse Channel, drainage issues have been reported along Germann and Queen Creek roads and are likely to worsen as farmlands are converted to urban developments in the future. Farmlands are flat and retain a considerable amount of runoff, typically much more than traditional residential and commercial developments. Additionally, the *NOAA Atlas 14* precipitation update essentially decreases the runoff volume required to be retained onsite by development. These circumstances have the effect of increasing runoff under future conditions. **Table RA 1.4b** shows flow increases that can be expected at specific locations within the study area.

Another location of concern is the combination channel/levee along Meridian Road, intended to intercept runoff from just south of Germann Road and convey it to Pecos Road. As previously noted, this channel is not engineered and its embankment on the west side has been breached in the past.

Table RA 1.4b - Increase of Flows Generated by Future Development

Location	Hydrologic Concentration Point	Existing Conditions 100-year Discharge (cfs)	Future Conditions 100-year Discharge (cfs)
Germann & Ellsworth	CPR16	749	1024
Ryan & Ellsworth	CPR17	166	729
Queen Creek & Ellsworth	CPR18	683	907
Germann & Signal Butte	CPR11	755	1147
Queen Creek & Signal Butte	CPR12	864	1165
Germann & Meridian	CPR8	460	721
Ryan & Meridian	CPR9	399	609
Queen Creek & Meridian	CPR10	1379	1384

1.5 PROJECT REPORTS

The East Mesa ADMP Update was conducted under several major tasks, and the work was documented accordingly:

- **Volume DC: Data Collection and Analysis**
  - Collection/review of available studies, documented problem drainage areas
  - Initial public and stakeholder input
  - Task included the SR24, Ellsworth, and Rittenhouse portions of the original study area
- **Volume AD: Proposed Alternatives Development and Evaluation**
  - Project brainstorming
  - Development and technical evaluation of alternatives
  - Preliminary cost estimates
  - Continued public and stakeholder input
  - Task included the SR24, Ellsworth, and Rittenhouse portions of the original study area
- **Volume RA: Recommended Alternative for the Rittenhouse Zone**
  - Presentation of Alternative – Rittenhouse Zone only
  - Technical evaluation of alternative
  - Estimated costs
  - Implementation considerations

- **Volume SP: Stakeholder Involvement Plan**
  - Identification of potential stakeholders
  - Proposed plan for effective interaction
  - Stakeholder involvement notebook

1.6 ACKNOWLEDGEMENTS

1.6.1 Flood Control District of Maricopa County

Jen Pokorski, AICP, CFM, Project Manager
Cathy Regester, PE, CFM, Senior Civil Engineer
Harry R. Cooper, RLA, Landscape Architect
Doug Williams, AICP, Planning Branch Manager

1.6.2 Project Partners

The following played active roles in shaping the alternatives, including:

Stephen Ganstrom, PE, City of Mesa Engineering
Lance Webb, PE, City of Mesa Engineering
Chris Dovel, Town Engineer, Town of Queen Creek
Chris Anaradian, Director of Development Services, Town of Queen Creek
Troy White, Public Works Division Manager, Town of Queen Creek

1.6.3 Consultant Team

Entellus was the prime consultant on the project. Hernan Aristizabal, PE, Project Manager, was supported by:

Mike Bonar, PE, Principal in Charge,
Ryan Sauer, PE, Project Engineer
Chris Christenson, GISP, GIS Specialist

Entellus was assisted by the following subconsultants:

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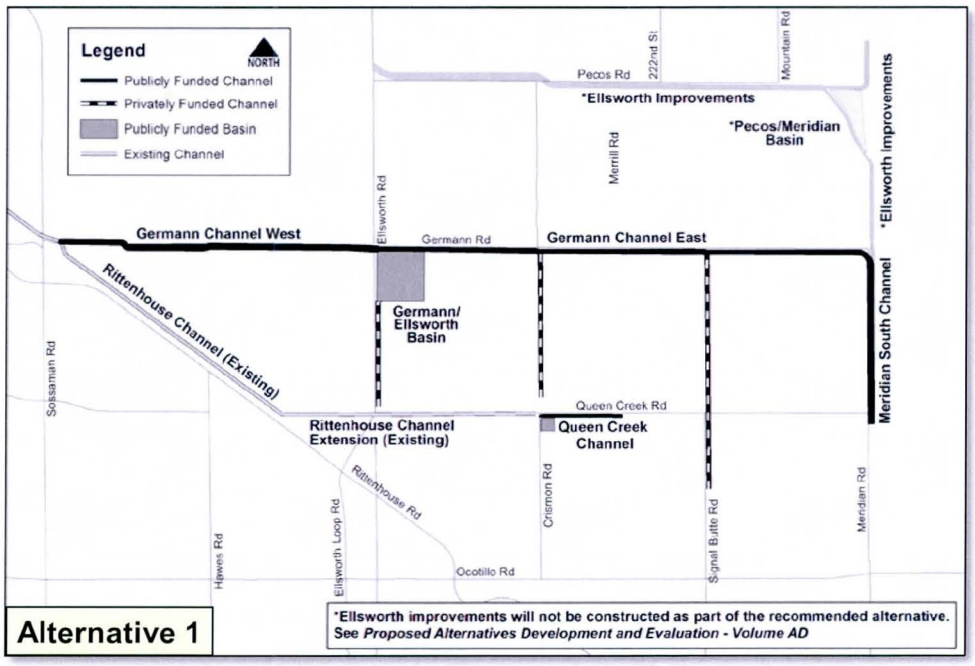
Landscape Architecture
Laurie Miller, PE, LTM Engineering, Inc.
Public/Stakeholder Involvement, Alternatives Development, Technical Review
Brian Fry, PE, JE Fuller Hydrology & Geomorphology
Alternatives Support and QA/QC
Heather A. Hespeler, PE, PG, CEG, Ninyo & Moore
Subsidence and Earth Fissuring

SECTION RA-2: SELECTION OF THE RECOMMENDED ALTERNATIVE

2.1 ALTERNATIVES CONSIDERED

As part of the East Mesa ADMP Update, the study team developed five alternatives for consideration to provide a regional drainage plan for the Rittenhouse Zone. Public and private sector stakeholders were invited to review the options and provide input.

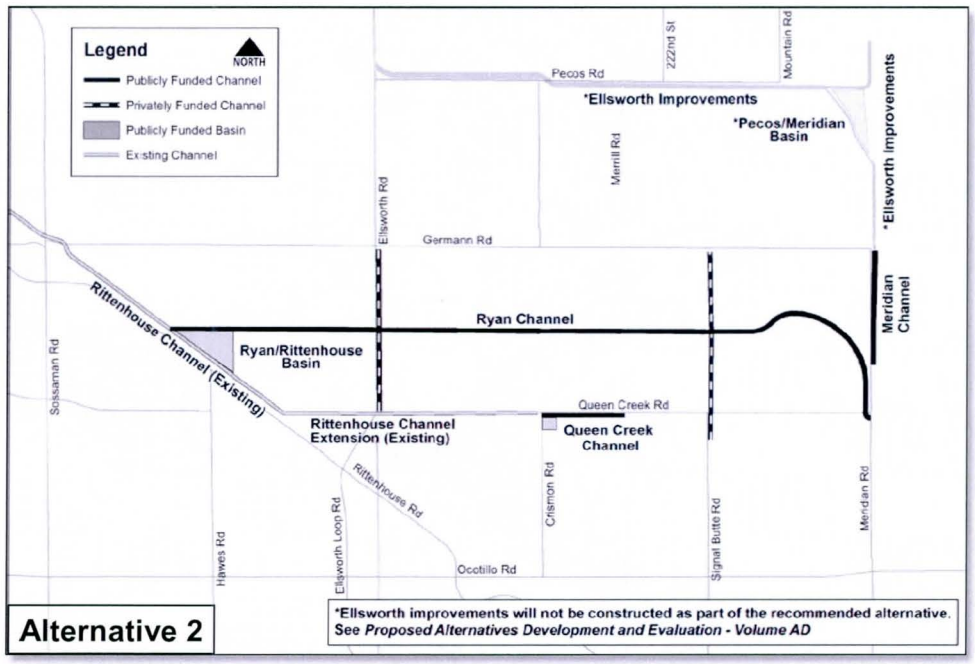
2.1.1 Alternative 1 – Germann Road Channel and Detention Basin



As shown in the diagram, components of Alternative 1 include:

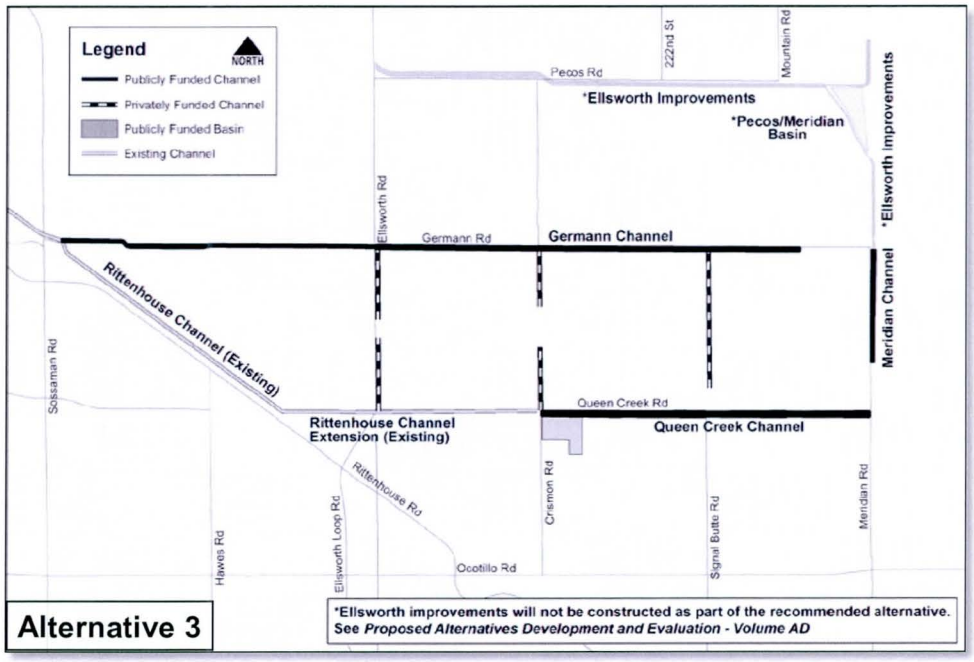
- A large channel along Germann Road to carry storm water from Pinal County to the Rittenhouse Channel
- North/south interceptor channels to collect local storm water, to be constructed by future developers as part of their onsite drainage conveyance system
- The planned channel extension along Queen Creek Road to collect local storm water
- A large detention basin near Germann and Ellsworth roads
- A small detention basin at Queen Creek and Crismon roads
- An interceptor channel along Meridian Road

2.1.2 **Alternative 2 – Ryan Road Channel**



This concept is similar to Alternative 1, except that the Germann Road channel would be moved south to follow the Ryan Road alignment along the Salt River Project (SRP) power line corridor. Between Meridian and Signal Butte roads, the channel would follow the future Signal Butte Road realignment. Also, the large detention basin near Germann and Ellsworth roads is eliminated and a smaller detention basin would be located at Hawes and Ryan roads.

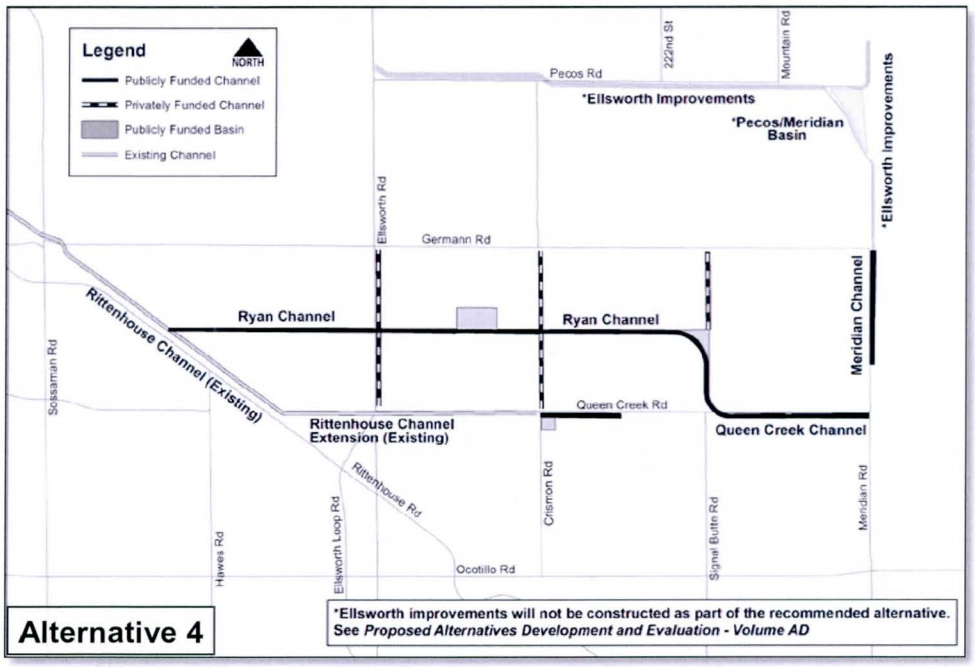
2.1.3 **Alternative 3 – Germann Road Channel & Queen Creek Road Channel/Detention Basin**



Alternative 3 is comprised of:

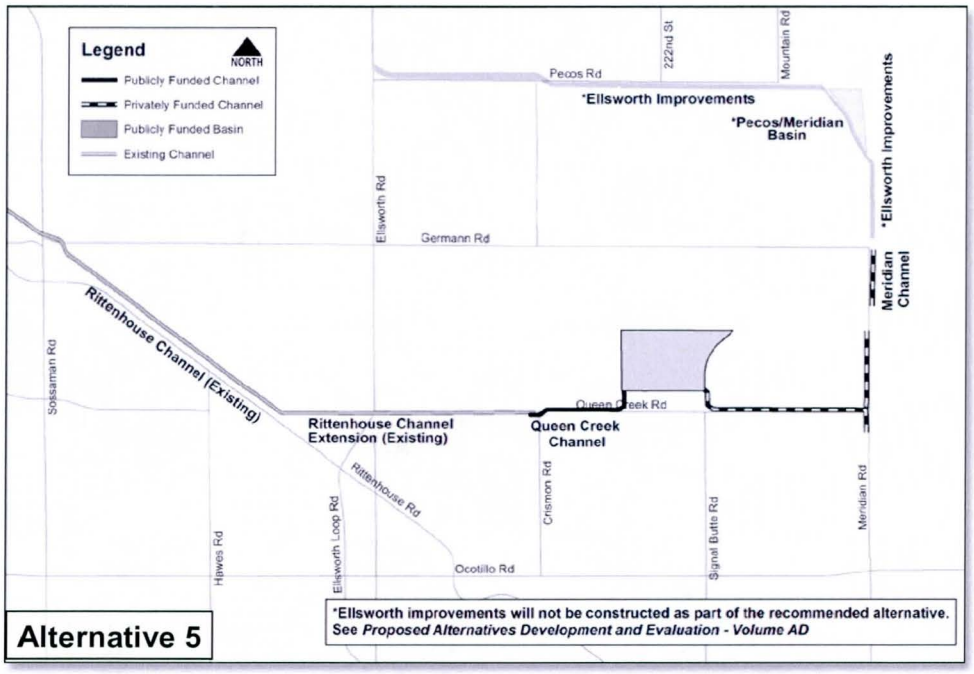
- A large channel along Germann Road to carry storm water from local sources to the Rittenhouse Channel
- The planned channel extension along Queen Creek Road to carry storm water from Pinal County and local sources to the Rittenhouse Channel Extension
- An interceptor channel along Meridian Road
- North/south interceptor channels to collect local storm water
- A detention basin near Queen Creek and Crismon roads

2.1.4 **Alternative 4 – Queen Creek/Ryan Road Channel and Detention Basins**



This concept is similar to Alternative 2, except that the channel would follow Queen Creek Road between Meridian and Signal Butte roads instead of along the future Signal Butte Road realignment. Also, the large detention basin at Germann and Ellsworth roads would be replaced by a basin near Crismon and Ryan road alignments and another small basin on Town-owned property at Signal Butte and Ryan road alignments. In addition, the portion of the Ryan Channel west of Ellsworth Road was modified to fit within the 100-foot SRP easement.

2.1.5 **Alternative 5 – Queen Creek Channel Extension and Detention Basins**



Alternative 5 is a significant departure from the others; in lieu of constructing a large, regional drainage infrastructure, the concept relies on participation from the Town of Queen Creek and developers to manage runoff. It includes the following elements:

- Increased onsite retention requirements for future development. Requires development to retain a 20% increase over the current retention requirement of 2.219 inches of rainfall. This would avoid overtaxing the Rittenhouse Channel.
- A north channel along Meridian Road to capture storm water from Pinal County and take it north to a future channel. Developers would be responsible for constructing the portion of the channel south of Germann Road as part of their offsite drainage conveyance system.
- A large detention basin within Queen Creek's future East Park Sports Complex to collect runoff from Pinal County and meter it out toward Queen Creek Road
- A south channel along Meridian Road and through the development to be constructed by development to pass offsite storm water from Pinal County and deliver it to the basin at the East Park Sports Complex.
- The planned channel extension along Queen Creek Road to collect drainage from the future East Park Sports Complex detention basin and ultimately take it to the Rittenhouse Channel.

Alternative 5 also assumes that SRP's future transmission corridor along the Ryan Road alignment will be preserved and used by adjacent property owners for open space and storm water retention.

2.2 STAKEHOLDER INPUT

A number of group and individual meetings were held with stakeholders to obtain their input on the alternatives. The stakeholders included SRP, Arizona Department of Transportation (ADOT), and landowners. The following feedback was obtained:

- SRP would be amenable to allowing detention and/or conveyance facilities within its power easement, subject to restrictions that would prevent interference with its power lines or maintenance work.
- ADOT is conducting a corridor study of Germann Road and voiced concern over very limited available right-of-way for a large channel.
- Area landowners were strongly opposed to a large channel along the Ryan Road alignment and noted reservations with locating regional detention basins on property slated for development.

Initial stakeholder feedback was documented in *Volume DC and Volume AD.* Additional stakeholder feedback is presented in **Section 2.3**, Selection Process.

2.3 SELECTION PROCESS

All five alternatives were previously considered based on the evaluation criteria documented in *Volume AD.* The criteria are summarized in **Table RA 2.3a**.

Table RA 2.3a - Evaluation Criteria

Performance Criteria	Definition	Range of Rating
Life-Cycle Cost	The cost to construct the facilities, as well as costs to maintain them throughout the useful life (assumed to be 50 years)	Low • Highest life-cycle cost High • Lowest life-cycle cost
Acceptability	Public, stakeholder, and agency support; compatibility with the surrounding environment; effect on biological resources; multi-use opportunities	High • Consensus of strong support by residents, stakeholders, and agencies • Is context-sensitive with surroundings • Enhances biological resources • Accommodates multi-use facilities Low • Strong opposition from residents, stakeholders, and agencies • Is not compatible with surroundings • Does not enhance biological resources • Does not support multi-use opportunities
Implementation	Ease of construction; ability to construct in phases; availability of funding partners; need for construction of interim facilities	High • Construction is straightforward • Construction of elements can be easily phased, and

Performance Criteria	Definition	Range of Rating
		segments are effective prior to completion of later phases • Has significant opportunities for funding partnerships • Does not require interim facilities Low • Construction is difficult and needs special equipment or materials • Phased construction does not offer flood protection until the entire facility is built • No significant opportunities for funding partnerships • Requires interim facilities to be constructed and later abandoned
Effectiveness	Level of flood protection; extent of watershed protected; use of existing drainage facilities	High • Provides 100-year flood protection typically offered by regional facilities • Protects a relatively large portion of the watershed • Fully uses the capacity of existing facilities Low • Provides reduced level of service as compared to 100-year flood protection • Protects a relatively small portion of the watershed • Does not maximize the capacity of existing facilities

The evaluation was conducted both with and without costs as a criterion. This allowed consideration of the benefits that could be realized, regardless of differences in cost, in order to fully appreciate comparative benefits. The results of the evaluation are reproduced in **Table RA 2.3b** and **Table RA 2.3c**.

Table RA 2.3b - Rittenhouse Zone - Evaluation Summary (Including Costs)

Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Life Cycle Costs	$39,947,000	$32,956,000	$34,183,000	$96,451,000	$9,679,000
Acceptability	Lowest	Low	Low	Moderate	Highest
Implementation	Moderate	Low	Moderate	Low	High
Effectiveness	High	High	High	Moderate	High
Ranking	🔴	🔴	🟡	🟡	🟢

Table RA 2.3c - Rittenhouse Zone - Evaluation Summary (Excluding Costs)

Criteria	Alternative 1	Alternative 2	Alternative 3	Alternative 4	Alternative 5
Acceptability	Lowest	Low	Low	Moderate	Highest
Implementation	Moderate	Low	Moderate	Low	High
Effectiveness	High	High	High	Moderate	High
Ranking					

2.3.1 Selection of Alternative 5

The benefits of Alternative 5 were found to be considerably greater than any of the other alternatives, and no fatal flaws were identified. Advantages include:

- *The existing drainage infrastructure is fully used.* Land already dedicated by property owners along Queen Creek Road will be used for the future channel. Also, the capacity of Rittenhouse Channel will be used fully without overtaxing it.
- *Does not require any new regional channels west of Crismon Road.* Disruption to parts of Queen Creek that have already been developed will be minimized
- *Minimizes expensive new infrastructure.* The detention basin and a small outlet channel will be located on property already owned by the Town (future East Park Sports Complex site). It is noted that the remaining privately-funded facilities would be needed regardless of the recommended alternative because new development is required to accept and convey offsite drainage that enters the property.
- *Does not require land purchases.* The future detention basin and outlet will be located on land that is owned by the Town for the future East Park Sports Complex. Land for the Queen Creek Channel Extension has already been dedicated by adjacent property owners.
- *Encourages open space in the design of future development.* The increase in retention requirements for future development fosters reduced densities and more open space.
- *Turns the single-purpose SRP utility corridor into an amenity.* Property owners adjacent to SRP's power transmission line can transform it into a multi-purpose amenity for the community and provide access to the future East Park Sports Complex.
- *Distributes contributions from future developers fairly.* Under the proposed alternative, retention requirements would be increased equally for future developments in order to avoid large, expensive channels. Otherwise, the greatest burden of future drainage facilities would be borne by the last properties to develop. This alternative avoids leaving the last developer "holding the bag."
- *Provides a road map for future development.* The proposed alternative will provide guidance for future development to construct a fully-functioning, coordinated drainage system.

Disadvantages of Alternative 5 were identified as follows:

- The alternative provides 100-year flood protection, except between Ellsworth and Hawes Road along Ryan Road. The system is "pinched" at Ellsworth Road by existing and near-future developments. Therefore, this portion of the system provides an estimated 75-year level of flood protection.
- The detention basin in the future East Park Sports Complex site will flood some of the sports fields during major storms. During this time, the fields will not be available for use. Additional field and equipment maintenance will also be needed after major storms.

2.3.2 **Summary of Rejected Alternatives**

During the evaluation, "fatal flaws" were identified with several of the alternatives. The following alternatives were no longer considered based on the disadvantages described below.

2.3.2.1 Alternative 1 Disadvantages

- The Germann Road Channel top width varies from 50 to 75 feet, and the required right-of-way is between 80 and 135 feet. The available right-of-way west of Ellsworth Road is very limited; channel construction could require purchase of existing homes.
- A channel along Germann Road would limit access to adjacent properties.
- Construction and maintenance costs would be high.
- The detention basin is located on prime real estate and would require a property owner to sell a considerable portion of land.
- No town parks are planned in the vicinity of the detention basin; therefore, its value as a multi-purpose facility is limited.
- Germann and Ellsworth roads are at a primary entrance to Queen Creek, and a single-purpose detention basin would present a visually poor image for the town.

2.3.2.2 Alternative 2 Disadvantages

- The Ryan Road Channel top width is 120 feet, and the required right-of-way is 180 feet, which is much wider than SRP's 100-foot easement.
- The available right-of-way west of Ellsworth Road is very limited.
- Construction and maintenance costs would be high.
- SRP has restrictions on building a channel within its power line corridor. This results in an even wider overall footprint.
- The detention basin at Hawes and Ryan Roads is located on land already slated for the Queen Creek Station development.

- Plans for Queen Creek Station don't allow for a large channel along the SRP power line corridor, and the existing Ellsworth Mini-Farms development prevents expansion to the north.
- Private-sector stakeholders have voiced strong opposition to this alternative.

2.3.2.3 Alternative 3 Disadvantages

- The channels along both Germann Road and Queen Creek Road would limit access to adjacent properties.
- Required right-of-way widths for the channels are high. The Queen Creek Road Channel right-of-way width is 135 feet. The Germann Road Channel right-of-way width east of Ellsworth Road is 135 feet; west of Ellsworth Road, the right-of-way width is 85 feet.
- The available right-of-way along Germann Road west of Ellsworth Road is very limited; channel construction could require purchase of existing homes.
- Construction and maintenance costs would be high.
- The proposed detention basin is located on prime real estate and would require the property owner(s) to sell nearly two entire parcels.
- No additional town parks are planned in the vicinity of the detention basin. Therefore, its value as a multi-purpose facility is limited.

2.3.2.4 Alternative 4 Disadvantages

- Depending on its location, the required channel right-of-way width for the Ryan Channel ranges from 135 to 265 feet.
- Available right-of-way along Ryan Road west of Ellsworth Road is very limited. The channel would also conflict with planned amenities within the Queen Creek Station development. Due to this ROW constriction, it does not appear that there is adequate ROW to safely convey the 100-year flood.
- Construction costs would be high, and maintenance costs would be very high.
- The detention basin west of the Crismon and Ryan road alignments is located on prime real estate and would require a property owner to sell a considerable portion of land.
- No additional town parks are planned in the vicinity of the proposed detention basin at Crismon and Ryan roads; therefore, its value as a multi-purpose facility is limited.
- Private sector stakeholders have voiced strong opposition to this alternative.

SECTION RA-3: REFINEMENT OF RECOMMENDED ALTERNATIVE

3.1 HYDROLOGIC REFINEMENT

The hydrologic analysis was based on a model developed for the *2011 East Mesa Area Drainage Master Plan Hydrology Update* (*Hydrology Update*) (**Reference 99**), which was prepared by the District. The hydrologic modeling for the Rittenhouse Zone was refined during the analysis of the recommended alternative (**Appendix A**).

3.1.1 **Drainage Characteristics**

The watershed contributing runoff to the Rittenhouse Zone covers approximately 13 square miles The Maricopa County portion is characterized by agricultural, industrial, and residential land uses with little undeveloped desert. The Pinal County portion of the watershed, which is outside the project planning area, has also experienced heavy agricultural and residential development.

3.1.2 **Methodology**

The U.S. Army Corps of Engineers HEC-1 Flood Hydrograph Package was used to estimate peak runoff. Use of the model was guided by the *Drainage Design Manual for Maricopa County, Arizona, Volume I, Hydrology (Hydrology Manual*).

3.2 DESIGN CRITERIA

Design criteria for proposed hydraulic structures were based on the District's June 2010 version of the *Drainage Design Manual for Maricopa County, Arizona, Volume II, Hydraulics (Hydraulics Manual).*

3.2.1 **Open Channels**

The proposed channels included riprap-lined and movable-bed types.

Channel Section. A range of channel bank side slopes and flow velocities were assumed as shown below:

Channel Type	Minimum Side Slope (h:v)	Maximum Side Slope (h:v)	Minimum Velocity (fps)	Maximum Velocity (fps)
Riprap	3:1	6:1	2.5	6.0
Movable Bed	6:1	12:1	2.5	4.0
Concrete	0:1	1:1	2.5	10.0

Flow depths were generally kept in the range of 3 to 5.5 feet. Bottom widths were estimated based on the assumed flow depth for the channel.

Per the *Hydraulics Manual*, freeboard was added at 25% of the flow depth plus the velocity head. A minimum freeboard of one foot was used for all channels regardless of

the required freeboard calculation. An exception to this criterion is a 2,000-foot section of channel within the East Park Sports Complex. For this segment, the east bank would spill into the park and flow into the basins with no freeboard provided. However, for the west bank the freeboard criterion was held, requiring a 2-foot high embankment. The conceptual design includes very conservative assumptions, and during the final design it is likely that the freeboard requirement may be met with little or no embankment (see **Appendix B-1** for potential refinement to be considered during final design).

Channel Roughness Coefficient. Manning's n was estimated for the banks and the channel bed separately, and a composite n value was used in hydraulic calculations. Factors considered were channel type, vegetation, the D_{50} size of the rocks found in nearby native soils, and recommended values for riprap. An n value of 0.015 was assumed for concrete and 0.04 was assumed for hydroseeded earthen channels.

Longitudinal Slope. The longitudinal slopes were set at the natural grade slope where possible and were set within the maximum Froude number and velocity range criteria.

Drop Structures and Channel Profile. All velocities were within the acceptable range; therefore no drop structures were required. Channel top-of-bank matches the adjacent natural ground elevation.

Side Drainage. Side drainage was incorporated in the channel configuration at specific locations with scuppers and riprap protection to prevent erosion of the channel side slopes. Along the Queen Creek Channel, side drainage will be intercepted by swales in the bank and conveyed to inlets. The inlets could be openings in the planned screen berm or pipe inlets with drains.

Maintenance Road. A 14-foot maintenance road/multi-use path is included adjacent to the Meridian Channel and is assumed to allow public access. The Queen Creek Channel extension and the East Park Sports Complex channels do not include a maintenance road since they can be accessed through public roads or park facilities. The road is assumed to have a 4-inch gravel surface.

Fencing. A guard rail is included for channels where the side slope along an adjacent street exceeds 3:1.

Concrete Lining. No concrete lining was specified for any of the recommended improvements.

3.2.1.1 Queen Creek Channel Landscaping

Design Concept. The Queen Creek Channel serves as the outfall for the East Park Sports Complex Basin, conveying storm water from the basin outfall at Merrill Road south to Queen Creek Road then west to the existing Rittenhouse Channel system. Visually, the Queen Creek Channel serves as a transitional element between two land uses with residential properties to the immediate south and industrial sites such as a large solar panel complex on the north. The Queen Creek Channel concept was developed in order to accomplish the following:

1. Accomplish the storm water mitigation requirements of the East Mesa Area Drainage Master Plan Update.
2. Provide screening of the hardened channel sections and serve as visual mitigation for suburban residents to the south looking over the channel north to the industrial sites.
3. Incorporate multi-purpose storm water management techniques such as street run-off harvesting into water harvesting micro-basins.

Landscape elements should be responsive to the requirements of the *Town of Queen Creek's Zoning Ordinance*, and integrate into any existing landscape areas.

Flood Protection Structural Method:	Enhanced Hard
Landscape Design Theme:	Enhanced Desert
Multi-use Function:	Incorporate the Town's 6-foot wide meandered sidewalk into the landscape buffer
Landscape Setbacks:	5 feet outside, 10 feet inside. Conceptual design included configuring the inside landscape setback adjacent to the roadway landscape setbacks for Queen Creek Road and Merrill Road
Side-slopes:	3:1 with 3" rock mulch (private side), vertical wall (street side). Include form liner and paint or stain for wall segments visible to the general public. This is believed to be limited to the reach along Merrill Road where the channel will be visible to both vehicle occupants on Merrill Road as well as visitors to the Barney Family Sports Complex.
Channel Bottom:	Earthen with hydroseed for erosion and dust control

Landscape Recommendations. Extending the wall height an additional two feet above the height needed for flood conveyance freeboard allows for additional berming which will be more effective in screening the channel. A view fence-type wall should also be incorporated into the design to provide security as well as added aesthetics in accordance with the *Town of Queen Creek's Zoning Ordinance Section 5.2 – Fencing*. Final design for the channel should incorporate recommendations from the Town's ordinance for the view fence and wall.

Landscape materials and densities should be in accordance with *Section 5.3 - Landscape*, and include an automatic irrigation system in accordance with zoning requirements. Street run-off water harvesting should augment irrigation system to provide natural irrigation to the vegetation in the right-of-way.

Moderate-sized trees limited to the road side of the channel were selected for this channel in order to reduce the potential "shading" of the solar complex while allowing for multi-story canopy vegetation in the channel frontage.

Shrub and accent species selected for the Queen Creek Channel as indicated in the channel plan legend are intended to provide multi-seasonal interest and effective year-round screening of the channel. A multi-story vegetative community including ground covers, moderate, and tall shrubs create greater visual interest and are more likely to accomplish the visual mitigation objectives for the structure.

3.2.1.2 Movable Bed Channel Landscaping

Design Concept. The reach of movable bed channel within the recommended alternative will be implemented by private entities, and subject to change based on the direction and goals of the private owners. The following design objectives and guidelines are included for continuity between the alternative development and the recommended plan, and to provide documentation for the design parameters developed for the channel. The conceptual moveable bed channel concept was developed in order to accomplish the following:

1. Accomplish the storm water mitigation requirements of the East Mesa Area Drainage Master Plan Update.
2. Replicate a natural wash with a dynamic low-flow component that may erode and deposit sediment within channel limits, but continues to protect adjacent properties through the use of barrier structures such as launchable riprap cut-off walls. Vegetation should be selected to best replicate that found in existing washes in the area.
3. Facilitate the use of the channel bottom as an equestrian trail and the use of the O&M road as a multi-use path.

Local flows should be captured in water-harvesting swales within the landscape setbacks to provide natural irrigation to the vegetation at the top of bank and reduce channel maintenance by controlling where offsite flows enter the channel system. Side-slope warping should be used to create a varied and meandered low-flow channel that serves a dual use as an equestrian path.

Flood Protection Structural Method: Semi-soft

Landscape Design Theme: Natural Riparian Sonoran Desert Wash

Multi-use Function: Equestrian trail (in low-flow), preserve passive open-space, and allow for dual-use of the O&M road as a multi-use path

Landscape Setbacks: 10 feet, both sides of channel

Side-slopes: 8:1 average, 6:1 to 12:1 allowed for side-slope warping.

Landscape Recommendations. Native riparian hydroseed would be applied to the landscape setback and side-slopes. No hydroseed is recommended in the low-flow component in order to minimize obstructions as an equestrian trail.

Trees should be native species planted as tall-pots to avoid the need for supplemental irrigation. Tree density should reflect that found adjacent to natural washes in the area. Based on a representative section of Siphon Draw Wash, one tree for every 20 feet of channel should be included in the design. Trees should be scattered into natural-appearing random groupings along the low-flow channel, with fewer trees placed along the top of bank.

3.2.2 Box Culverts

Height and Cover Requirements. The minimum height and cover for box culverts were assumed to be four feet and one foot, respectively.

Design Flow. The 100-year design flow used to size the channels was also used in sizing box culverts to mitigate backwater effects.

3.2.3 Queen Creek East Park Sports Complex Detention Basin

Formerly identified as East Park by the Town of Queen Creek, the East Park Sports Complex is intended to serve as a large, 90+ acre tournament-level ball field and soccer complex. Park programming includes:

- Eight ball fields – highest priority
- Five to nine soccer fields
- 25,000 sq. ft. recreation center that anchors an active core area to include basketball, tennis, and volleyball courts around a three-acre lake that also serves as a source for irrigation of the park turf
- Multiple playgrounds

A 23-acre public works yard and a 2.5-acre fire station also need to be accommodated on the Town-owned parcel. A minimum of 120 acre-feet of flood storage capacity has been integrated into the park concept as part of the regional flood mitigation plan.

A network of basins connected by a conveyance channel has been designed to the 15% level. The system accomplishes the flood mitigation needs of the project and accommodates the park program. This included a conveyance channel routed partially along the SRP easement on the north property line, then south along Merrill Road to the Queen Creek Channel, which connects to the existing Rittenhouse Channel Extension just west of Crismon Road. A deep sediment capture basin was designed at the intended inlet located near Signal Butte and Ryan roads, providing developers opportunity to connect to the basin system. Soccer fields and four ball fields were also located in basins connected to the channel. Detention basin design parameters are as follows:

Parameter	Minimum	Maximum
Side Slope	6:1	5:1
Longitudinal Slope	0.5% (turf or earthen) 0.2% (concrete)	1% 0.5%
Cross Slope	1%	n/a
Depth	2 ft	6 ft

Maintenance Access. No separate maintenance roads were assumed for the basin system since it will be located on Town property. The park facility design will need to accommodate access to the associated drainage channel.

Basin Outlet. The basin outlets are pipe culvert that conveys storm water from the individual basins back into the channel. The outlets range from 30" to 36" culverts.

Basin Overflows. For storms greater that the 100-year design, the basins will overflow into the channel or other non-critical areas such as parking lots or ball fields and eventually will re-enter the channel.

Basin Freeboard. The basin freeboard was set to one foot above the 100-year maximum water surface.

Basin Inlet Side Weirs. Side weirs are provided in the channel to divert flows to the basin. The side weirs work in conjunction with control structures in the channel, which restrict flow and force it across the side weirs into the basins.

Landscape Recommendations. Final landscape design for the park will be per the Town of Queen Creek and complement the park setting, with the following considerations:

- SRP has its own planting requirements; channel segments located within the SRP easement should be landscaped in accordance with the most current acceptable plant list and with SRP approval.
- Where possible, channel segments should be turf-lined to resist erosion and provide additional open-space value.
- Basin landscaping should be developed in accordance with the specific programming for those basins, including soccer fields, ball fields, and amphitheater use.

3.2.4 **Sediment Transport Estimates**

Scour depths and riprap sizes were generally estimated using the methodology described in the *Hydraulics Manual*. The specific equations and approach used for the analysis were referenced from the District's *River Mechanics Manual for DDMSW*. Sediment transport analysis was performed as part of the Proposed Alternatives Development and Evaluation and is documented in *Volume AD*. Scour estimates assumed the following:

- Factor of safety: 1.3
- Long-term scour: Level 1 - State Standard equation
- General scour: Lacey's equation
- Bend, local, and contraction scour is negligible
- Dune height of bed form scour: 0.225 x flow depth
- Low flow scour depth: 1 foot

Sediment yield for basins was estimated using DDMSW based on the methodology recommended in the *River Mechanics Manual for DDMSW*. Sediment yield calculations are included in **Appendix B2** - Sediment Yield Analysis.

3.2.5 **Life-cycle Cost Criteria**

Life-cycle cost includes initial construction costs, as well as continued operation and maintenance costs throughout its useful life. The following general assumptions were made when developing the life-cycle costs:

- The planning-level estimates of costs are for budgetary purposes only.
- The comparison cost estimates include design, major construction items, landscape aesthetics, right-of-way land acquisition, and major utility relocations. Landscape costs are within the ceiling limits specified in the District's Policy for Landscape and Aesthetics, assuming the future landscape character units of the LIA.
- Costs were estimated in 2012 dollars.
- A 20% contingency was added to the cost for each alternative.
- Unit costs for maintenance of retention basins and movable bed channels were developed using maintenance costs for the Rittenhouse FRS provided by the District. The East Park Sports Complex is an active recreational park that will require more maintenance than a regular detention basin. However, for the purposes of this analysis, it was assumed that additional maintenance will be a part of the regular park maintenance activities and was not included in the estimate.
- Unit costs for maintenance of riprap lined channels (hardened channels) were developed using maintenance costs for the East Maricopa Floodway provided by the District.
- Unit costs for land acquisition were based on land prices provided by the District. This estimate includes land acquisition cost for the Queen Creek Channel (including the reach along Merrill Road) and the East Park Sports Complex. The City already owns the Park site and has secured dedications from the developers for the Queen Creek Channel (including the Merrill Road Reach).

3.2.6 **Design Calculations**

Design calculations performed for this analysis included a HEC-RAS analysis for the Queen Creek, Meridian and East Park Sports Complex Basin system channels and a sediment yield analysis for the East Park Sports Complex detention basin. These analyses are included in **Appendix B1.**

Also, additional hydrologic analyses were performed to configure the multiple basins system within the East Park Sports Complex. This analysis was performed to ensure that a workable concept exists. However, during final design of the park and drainage facilities, the configuration could be modified based on final programming for the park as long it provides the storage required to mitigate capacity issues of downstream infrastructure. The hydrologic analysis is documented in **Appendix A**.

3.3 EXISTING UTILITIES AND DESIGN CONSTRAINTS

3.3.1 Existing Utilities

There are several utilities within the right-of-way of Queen Creek and Meridian roads. At this time, the exact location is not known, but it is likely that the proposed culvert under Queen Creek and Crismon roads will conflict with existing utilities. The following utilities would need to be relocated:

- 12-inch water line
- 8-inch water line
- Water line (size unknown)
- Gas line
- Fiber optic conduit

The culvert would also cross a sewer line; however, the sewer would most likely be too deep to be in conflict with the proposed culvert.

The Meridian Channel culvert under Germann Road, which would be constructed by private interests, may be in conflict with two existing gas lines that may need to be relocated. Additionally, at this location two high-voltage power poles are in close proximity to the proposed culvert and may require bracing during construction.

3.3.2 Future Utilities

SRP has been granted a Certificate of Environmental Compliance for its proposed Ball-Pfister 230 kV power transmission line. A 250-foot corridor has been approved along the Ryan Road alignment, and SRP is in the process of obtaining a 100-foot wide utility easement within the approved corridor. A segment of the future power line is along the Ryan Road alignment in Queen Creek, which runs along the north edge of the East Park Sports Complex, and could affect the location and configuration of the park channel. The timeframe for the line to be in service is between 2018 and 2022. Further discussion of the issues associated with co-locating drainage facilities with power transmission facilities within the SRP easement can be found in **Section 4.4**.

3.3.3 Planned Development

In the past year, there has been a marked increase in development interests in the Town of Queen Creek. At this writing, Queen Creek Station at Ellsworth and Ryan Roads and La Jara Farms at Rittenhouse and Ryan Roads are under construction. Additionally, owners of several large parcels within the Rittenhouse Zone are in various stages of planning.

3.3.4 Planned Public Drainage Improvements

The Town of Queen Creek has obtained a drainage easement along Queen Creek Road between Crismon and Merrill roads. The intent is to extend the Rittenhouse Channel

Extension, which is an element in the recommended alternative. The segment in the recommended alternative is referred to as the Queen Creek Channel.

3.3.5 **Transportation Studies**

The Arizona Department of Transportation (ADOT) performed a transportation study along Meridian Road between McDowell and Germann Roads. The corridor study was funded through ADOT's Planning Assistance for Rural Areas (PARA), with Pinal County and the City of Apache Junction as participating jurisdictions. The final report, *Meridian Road Corridor Study, Germann Road to McDowell Boulevard*, was completed in October 2013. Although the study reach is outside the Rittenhouse Zone, future drainage facilities would be required north of Germann Road to achieve full functionality of the recommended alternative for the East Mesa ADMP Update. The recommended alternative for Meridian Road consists of a total roadway right-of-way section of 130-150 feet and does not include or address regional drainage needs.

A similar study was completed in July 2013 for Germann Road between Ironwood and Power Roads. Regional drainage needs were considered in the study, but the Town of Queen Creek did not support a regional channel along Germann Road because of the limited available right-of-way and the need for drainage crossings of a channel. Therefore, the recommended alternative does not include a regional drainage solution within the roadway corridor.

3.3.6 **Drainage Infrastructure Constraints**

- ***Rittenhouse Channel Capacity.*** As previously noted, a primary drainage constraint of the Rittenhouse Zone is the capacity limitations of the Rittenhouse Channel. Because the Rittenhouse Channel is the downstream terminus, the design of any future facilities upstream must consider its capacity constraints.
- ***Rittenhouse Channel Extension Capacity.*** Another design constraint is the capacity of the Rittenhouse Channel Extension along Queen Creek Road to Crismon Road. The extension is an open channel except for a buried segment under Queen Creek High School. Discharge into the extension is limited to its capacity of 520 cfs.
- ***SRP Power Line Easement.*** A potential critical constraint or opportunity is the future power line easement along the north side of the East Park Sports Complex. The proposed channel to convey flow to and from the basins is adjacent to the easement. During design of the drainage facilities, co-locating the channel with the SRP power transmission facilities may be explored and likely would require adjustments to the channel configuration. The criteria to be considered while exploring the co-location of the channel and power transmission facilities is discussed in **Section 4.4**.
- ***Future Outfall.*** The outfall for the privately-built Meridian Channel is a future channel that may not be constructed for some time. If development occurs first, it would not have an adequate outfall. This would likely result in the flow backing up in the channel and spilling to the west in the vicinity of Germann

Road. Under current Town of Queen Creek regulations, the developer must convey offsite runoff through the development and discharge downstream in the same way as it discharges under predevelopment conditions. Until the outfall channel is constructed, the developer should provide for interim infrastructure to deliver these flows to their historical location. In order for the recommended alternative to function as intended, these flows need to be conveyed north along Meridian Road to Pecos Road. Until this happens, the area will have a lower level of protection than if the recommended alternative was fully implemented.

- ***Queen Creek Channel Right-of-Way.*** There is limited right-of-way along the Queen Creek Channel. Along the Barney Farms Family Sports Complex, the channel needs to fit within the existing 70-foot drainage easement along Merrill Road. Along Queen Creek Road, there is also a 70-foot drainage easement in front of the First Solar facility. In this area there is a 30-foot setback from the First Solar perimeter wall to the edge of the drainage easement. The setback is owned by First Solar. As part of our analysis, we assumed this land was not available for the channel. However, in the future we recommend exploring the possibility of trading the location of the drainage easement and the setback to be able to provide more screening of the channel and the First Solar perimeter wall.
- ***Sports Complex Programming.*** The East Park Sports Complex is programmed as a tournament baseball and soccer facility. Tournaments are usually scheduled months in advance and are very difficult to cancel or reschedule. This dictates the need to minimize disturbances that could affect play. The layout shown in the recommended alternative is only one of numerous layouts that could function as intended.
- ***Sports Complex Detention Design.*** The purpose of this facility is to reduce the 100-year downstream flows in the Queen Creek Channel to prevent runoff from exceeding the design capacity of the existing Rittenhouse Channel Extension and Rittenhouse Channel. In addition, the East Park Sports Complex basin reduces the impact to development of increased future flows. It is anticipated that during the programming of the park, significant variations will be explored by the Town, and as long as those variations provide the flow attenuation needed downstream, the intent of the recommended alternative is fulfilled.
- ***Sports Complex Design Inflow.*** Under the recommended plan, the park basin would only get runoff generated in Pinal County crossing into Maricopa County south of Ryan Road, and developers are required to convey these flows from the county boundary to Basin A on the east side of the park. The Town could choose to allow the development immediately to the east (upstream from the basin) to discharge excess on-site flow into the park basin. However, in that case the facilities within the park would need to be upgraded and additional storage within the park would be needed to compensate for the additional inflow.

SECTION RA-4: PRELIMINARY PLAN

The recommended alternative is presented in **Figure RA 4**. A conceptual design plan is presented in **Appendix C**. The recommended alternative effectively mitigates capacity issues in the Rittenhouse and Rittenhouse Extension channels. It also reduces and evenly distributes the impact of increased flows expected in the future under fully-developed conditions. The plan combines public and privately-funded facilities to create a coordinated regional drainage system. It provides 100-year protection, except for a segment of reduced protection along Ryan Road from Merrill Road to the Rittenhouse Channel. Table RA-4.1 shows the reduction in peak flow provided by the recommended alternative throughout the Rittenhouse Zone.

Table RA-4.1 - Future Flows with and without Recommended Improvements

Location	Channel Design Capacity (cfs)	Concentration Point	Future Conditions 100-year Discharge (cfs)	Future Conditions with Recommended Improvements 100-year Discharge (cfs)	Flow Reduction by Recommended Improvements (cfs)
Queen Creek Rd and Meridian Rd *	N/A	CPR10	1380	1380	0
Queen Creek Rd and Signal Butte Rd	N/A	CPR12	1170	340	830
Queen Creek Rd and Crismon Rd	520	CPR15	950	520	430
Rittenhouse Extension East of Ellsworth Rd	520	CPR18	910	470	440
Rittenhouse Channel, Ellsworth Rd to near Hawes Rd alignment	810	CPR22	890	450	440
Rittenhouse Channel near Hawes Rd alignment to Germann Rd	1050	CPR21	1520	600	920
Rittenhouse Channel Germann Rd to south of Pecos Rd	1400	CPR25	1480	640	840
Rittenhouse Channel Power Rd and Pecos Rd to EMF	1500	CPR24	1530	700	830
Ryan Rd and Meridian *	N/A	CPR9	610	610	0
Ryan Rd and Crismon Rd	N/A	DIVR14/DIV14A	750	510	240
Ryan Rd and Ellsworth	N/A	CPR17	730	250	480
Germann Rd and Meridian Rd *	N/A	CPR8	720	720	0
Germann Rd and Signal Butte Rd	N/A	CPR11/DIVR11	1150	440	710
Germann Rd and Crismon Rd	N/A	CPR13	1070	340	730
Germann Rd and Ellsworth	N/A	CPR16	1020	320	700

* Flows from Pinal County

As described herein, the recommended alternative is composed of both publicly-funded and privately-funded elements.

4.1 PUBLICLY-FUNDED PLAN ELEMENTS

4.1.1 East Park Sports Complex Detention Basin System

Location. Within the Town's future East Park Sports Complex north of Queen Creek Road, between Merrill Road and the Signal Butte Road alignment. The basin system is located next to and south of SRP's future transmission corridor.

Purpose. Accept offsite drainage generated in Pinal County. The basin will attenuate flow and reduce peak discharges to the downstream Queen Creek Channel described later in this section and mitigate capacity issues in the existing Rittenhouse and Rittenhouse Extension channels and reduces the impact to development of increased future flows generated in Pinal County.

Project Elements. The system includes four separate basins interconnected with a channel that conveys storm water to the basins and provides an outlet from the basins. Basin A is an online basin and basins B, C, and D are offline. The following are the design characteristics of the four basins:

Basin ID	Area (acres)	Volume (ac-ft)	Depth	Inlet	Outlet
Basin A	4.5	19.1	5' +1' fb	Private Channels	Control structure on basin channel
Basin B	10.3	47.7	5' + 1' fb	125 side weir	30"pipe
Basin C	0.7	1	3' + 1' fb	20 ft side weir	18" pipe
Basin D	20.6	70.8	1'-5' + 1' fb	330 ft side weir	36" pipe

Basin A includes a sediment trap to minimize deposition elsewhere in the park facilities.

The interconnecting channel starts at Basin A on the northeast corner of the park and conveys storm water through the park, delivering flows to the basins via side weirs. The channel has online control structures that, in conjunction with the side weirs, control the flows entering the offline basins. The following are the characteristics of the basin channel:

Reach	Top Width (ft)	Bottom Width (ft)	Side Slope	Channel Depth (ft)	Flow (cfs)	Velocity (fps)
Basin A to Basin B	310	varies	6:1	6 to 7	1350	1.5 to 3.4
Basin B to Basin C	310	varies	6:1	6 to 7	500	1.5 to 3.4
Basin C to Queen Creek Channel	310	varies	6:1	6 to 7	320	1.5 to 3.4

The channel contains two culverts: one for the main park access road (5-10' x 5' CBC) just east of Basin B and the other at the southwest corner of the park (4-10' x 4' CBC). Additionally, there are three online control structures that restrict flow in the channel and allow it to pass over the side weirs into the basins.

Special Considerations. The detention basin is co-located with park facilities and was configured according to programming needs provided by the Town. The conceptual layout will need to be adjusted according to the park's final design and Town-specified requirements for all-weather usage of tournament play areas. A portion of the connecting channel could be within the future SRP power easement but would need to consider SRP requirements. The drainage area contributing to this basin system does not include the area east of the East Park Sports Complex. As shown in **Figure RA 4**, these flows should be routed north towards Germann Road. If the Town chooses to allow developers to direct local flows into the basin system, then they will need to adjust the basin configuration to accommodate the additional flow.

Right-of-Way Requirements. The basin site is located on property owned by the Town.

4.1.2 Queen Creek Channel

Location. Along the east side of Merrill Road from the south boundary of the East Park Sports Complex to Queen Creek Road, and then on the north side of Queen Creek Road from Crismon to Merrill roads.

Purpose. The channel is the outfall for the East Park Sports Complex Basin system and also accepts local flows generated in the vicinity of the channel. The channel conveys local and basin flows to the Rittenhouse Channel Extension.

Project Elements. The channel is lined with riprap and includes a vertical retaining

wall on one side of the channel, which allows for landscape screening from the road. It includes several culvert crossings along its alignment, including the crossing of Merrill Road, Queen Creek/Crismon roads, and the driveway for the Barney Family Sports Complex. All three culverts are 4-barrel 10' x 4' concrete box culverts.

Reach	Top Width (ft)	Bottom Width (ft)	Side Slope	Channel Depth (ft)	Flow (cfs)	Velocity (fps)
Along Merrill Road	55+15 buffer	40'	3:1 0:1	5 to 6	330	2.4 to 2.5
Along Queen Creek Road	55+15 buffer	40'	3:1 0:1	5 to 6	520	3.8 to 4.1

Special Considerations. The limiting factor in the configuration of the channel was the available right-of-way. The drainage easement was adequate for a 100-year trapezoidal riprap channel. However, the channel section would take the entire easement and landscape/aesthetic treatments would be very limited. To improve the aesthetic treatment, the channel was modified to include a vertical wall on one side. This configuration accommodates a 15-foot landscape buffer to screen the channel from view from the street. The configuration did not significantly increase costs since the cost of the wall was partially offset by a significant reduction in riprap required. Additionally, the required excavation volume was reduced.

Right-of-Way Requirements. There is an existing 70-foot easement along the entire length of the channel. Along the Queen Creek Solar property, there is an additional 30-foot setback between the drainage easement and its perimeter wall. It may be possible to form an agreement to use the setback and provide better landscape screening of the channel and solar farm perimeter wall.

4.2 PRIVATELY-CONSTRUCTED PLAN ELEMENTS

4.2.1 Basin Inlet Channel(s)

Location. Between the Maricopa/Pinal county boundary and the sediment basin within the East Park Sports Complex basin system (northeast corner of the park). The exact locations of the channel(s) are not critical, as long as the system intercepts the flow from Pinal County south of the Ryan Road alignment and conveys it to the park basin at its designated inlet.

Purpose. Intercept runoff generated in Pinal County south of the Ryan Road alignment and convey it to the park basin.

Project Elements. Channel system with sufficient capacity to convey flows from Pinal County to the Park basin. The system can be configured to best suit the needs and character of future development in the area. The channel(s) need to convey the flows

from future condition hydrologic model concentration points CPR9 and CPR10 (See **Appendix A** and the *Hydrology Update*).

Special Considerations. The exact locations of flows from Pinal County crossing the county boundary are not known at this time. There is some question of potential diversions that may or may not occur in Pinal County that would affect the point of entry into Maricopa County. The developer is responsible for identifying the locations and magnitude of these flows and constructing infrastructure to convey the runoff to the park basin. The East Park Sports Complex basin was designed to accept 1,380 cfs and a volume of approximately 140 acre-feet. This includes the volume that would be generated within the park itself.

Right-of-Way Requirements. The developers are to provide the required drainage easements needed in accordance with Town of Queen Creek regulations.

4.2.2 **Meridian Road Channel**

Location. Along the west side of Meridian Road starting north of the Ryan Road alignment and extending north to Germann Road. It would outfall into a future channel that would continue north to Pecos Road.

Purpose. Intercept offsite runoff from Pinal County crossing the county boundary north of the Ryan Road alignment and convey it north and out of the Rittenhouse Zone.

Project Elements. This channel was configured as a movable bed channel with mild side slopes and low velocities to mimic a natural wash. The developer may choose to construct a different type of channel, as long as it can convey 720 cfs (see Appendix A). The channel includes a 5-barrel 10' X 5' concrete box culvert at the downstream end to cross both the future Meridian Road and future improvements to Germann Road. The proposed publicly-funded Meridian Channel (Germann Road to Pecos Road) will tie in at the downstream end of the culvert. The plan assumes that the developer will construct the culvert and plug the downstream side. However, the right-of-way for Meridian Road on the east side (Pinal County) has not been dedicated at this time and is still private property. Pending dedication, the developer may only be able to construct the culvert to the county boundary.

Special Considerations. The intended outfall for this channel is a future channel along Meridian Road continuing north to Pecos Road. It is unknown when or if the publicly-funded outlet channel segment will be constructed, and it is likely that the developer's segment will be constructed first. The developer will be required to construct interim facilities to meet Town of Queen Creek regulations. It is also the responsibility of the developer to construct permanent and interim facilities that will facilitate future connection to the north segment.

It should be noted that the recommended plan directs this flow away from the Rittenhouse Zone. If the publicly-funded segment is not constructed and flows are allowed to continue west instead, the level of protection provided west of this location will be lower than intended and flooding potential in portions of the Rittenhouse Zone may increase.

Right-of-Way Requirements. The developer is responsible for the required drainage easements to construct the channel. The developer must also provide drainage easements for any interim facilities that may be required to meet Town of Queen Creek regulations until the outfall channel is constructed.

4.2.3 **Increased Retention Requirement**

Location. All undeveloped areas within the Rittenhouse Zone. See **Figure RA 4** for areas covered by the increased retention requirement.

Purpose. Mitigate increased flows resulting from land use changes from agricultural to urban development and recent changes to precipitation data (NOAA 14). Unmitigated flow increases under future conditions would exceed the design capacity of the Rittenhouse Channel.

Project Elements. The Town of Queen Creek refers to the county regulations for its retention requirement. The County requires developers to retain the volume of runoff from a 100-year, 2-hour storm base on *NOAA Atlas 14* precipitation depths (2.26 inches). This increased retention element requires developers to retain at least runoff from a 2-hour storm with a precipitation depth of 2.6 inches, or a more stringent requirement if one is adopted in the future, whichever is greater. Compared to current regulations, the 2.6-inch retention requirement represents a 20% increase.

Special Considerations. The Town will need to enforce this requirement as part of its plan review process (see **Section RA-5: Implementation Plan** for more details).

Right-of-Way Requirements. The developer is responsible for providing additional drainage easements to accommodate the additional retention facilities.

4.3 LANDSCAPE DESIGN PLANS

The drainage elements of the recommended plan were configured based on input from the Town of Queen Creek and from existing legal and physical constraints such as the existing dedicated drainage easement width. They were refined to create opportunity for incorporating minimal landscape buffers for screening hardened facilities and adjacent industrial facilities. Structure types, structural methods, and landscape design themes identified in the Landscape Inventory Analysis (LIA) were used to identify context-sensitive treatments for the proposed facilities to the extent possible. Visual mitigation was proposed in the form of landscape buffers with screening landscape materials, berms, and water-harvesting micro-basins where limited rights-of-way or existing drainage easements required the use of a channel lining or flood protection method that was not compatible with the future setting. Although not included in the design or cost estimates, the basin site was developed and evaluated to accommodate multi-use facilities in the future. Such additions would be implemented if funding is secured independent of the flood protection project. The Queen Creek Channel landscape concept integrates a channel landscape buffer with the landscape setback associated with Queen Creek Road, creating a more effective buffer condition that allows for screening berms and plant materials.

Landscape aesthetics and multi-use opportunities were developed in tandem with the engineering design of the recommended facilities. Close collaboration between the

disciplines ensured that the multi-use benefits complement the flood mitigation functions and achieved multiple project objectives. Design guidelines, facility configuration requirements, and landscape design themes for the Queen Creek Channel and retention basin system are described below. Conceptual landscape plans and sections that illustrate the design elements described are included in **Appendix C**.

Future Design Refinement and Considerations. Comments from the Town of Queen Creek related to the basin and park concept plan include the following, to be considered and refined during subsequent design phases:

- Consider ways to reduce the channel width, such as using concrete rather than turf.
- Consider options for accommodating additional soccer fields above the five currently shown. Previous master plans for the park had up to nine fields.
- Consider deepening the first "triangle basin" at Signal Butte, as well as the soccer field basin, to reduce the retention requirement elsewhere on the site.
- The Town is open to locating the lake in the deeper "triangle basin" area, potentially incorporating an amphitheater into its final design.
- Move the Parks maintenance equipment yard into the public works yard as the Parks maintenance crews can be housed within and access the park directly from the centrally located yard depicted in the proposed concept plan.
- Provide eight full-sized ball fields, eliminating the dedicated little league field.

4.4 FINAL DESIGN CONSIDERATIONS

The purpose of the East Park Sports Complex basin is to control flows in order to mitigate future conditions' capacity issues in the downstream drainage system (Queen Creek Channel, Rittenhouse Extension Channel, and Rittenhouse Channel). To accomplish this, a conceptual design was developed that utilizes a combination of channels, basins, and control structures within the park site. This concept provides 140 acre-feet of storage to limit the outflow from the basin to no more than 320 cfs. Also, the basin system needs to be configured to sufficiently delay flow releases in order to allow for local peaks to dissipate prior to the occurrence of any significant discharge from the park basin. These are the minimum requirements for storage and peak outflow: however, park programming and channel and basin configuration can change as long as the flood control functions are met.

The following is a discussion of potential issues identified in this concept and how they may be resolved.

Freeboard along the Park channel: The conceptual design indicates that portions of the channel are above ground level (see **Conceptual Plans Sheet 3 of 6**). Mostly, this is only the freeboard portion of the channel; however, there is a small reach where the water surface is above existing ground (approximately from Sta 48+00 to Sta 56+00). The concept has several conservative assumptions and the final design may eliminate this issue. These refinements may include one or several of the following:

- Provide an embankment or concrete floodwall to contain the flows and provide adequate freeboard.
- Lower the basin inlet weirs (side weirs) to lower the water surface elevation.
- Provide more storage in the upstream basins to reduce the flow that needs to be conveyed in the channel. For example, if the entire storage volume is provided in the upstream end of the park, the channel would only need to convey 320 cfs through the park while the current configuration carries approximately 1,300 cfs upstream of Basin B and approximately 900 cfs upstream from Basin D.
- Explore the advantages and disadvantages of on-line versus off-line basins.
- Consider other channel configurations including steeper side slopes, different bottom width, low flow channels, and others. Also, consider alternate lining materials such as concrete, riprap, turf, etc.
- Consider placing shallower basins near the outlet channel and compensate by increasing storage on the upper portion of the park.
- Coordinate with the Parks Department to develop a design that balances the requirements of the sports and drainage facilities with some of the potential modifications to the park programming that were identified in **Section 4.3**.

Joint Use of SRP Easement: The concept implies that the future SRP easement along the north side of the park may not be used. However, the study team has met with SRP and presented several different options for shared corridors and discussed potential criteria for joint use. (See *Stakeholders Involvement Plan - Volume SP*)

Design of the future channel may consider co-locating the channel with the SRP easement along the north side of the East Park Sports Complex. This will require close coordination with SRP. As shown on the conceptual plan, the entire 100-foot transmission line easement is shown outside of the channel. However, as part of the stakeholder coordination process, a concept for co-located drainage and power facilities was developed (see **Figure RA 4.4**) and reviewed by SRP. Following are some of the considerations that would need to be addressed during the design phase of the project if the drainage facilities are to be co-located in a portion of the SRP Easement:

- The SRP poles must be located in the center of its easement in order to accommodate access for equipment needed to service the type of pole.
- Access must be maintained to the power lines on both sides of the power poles.
- SRP requires 35' W by 60' L flat (max 20H:1V slope) wire setup areas every 100 feet between poles.
- Pole set up areas must be a 100' by 100' pad centered on each pole.
- Access ramps must be provided to the poles and to the lines between the poles at no steeper than a driving slope of 10H:1V.

- The maximum cross slope must not be more than 10H:1V on driving areas but at the poles and at the wire set up areas a must not be greater than 20H:1V. The Center 20 feet of the easement could have a slope steeper than 10H:1V as long as ramps are provided to cross from one side of the easement to the other.
- The bases of the power poles must be above the frequent water surface elevation in the channel. The standard "reveal height" (height above ground) is 2-3 feet. The reveal height may need to be increased by elevating the concrete supports under the poles and or providing a low flow channel to keep low flows away from the poles.
- A low flow channel must be constructed; it should be located outside of the SRP easement and contain the 10-year flow.
- The vertical distance between ground surface and 69 kV power lines cannot exceed 85 feet.
- Vegetation on the channel side slopes within the 100-foot easement must conform to SRP specifications, i.e., material must be crushable. Requirements are more stringent within a 50-foot distance before and after each pole location for the width of the easement. For example, turf cannot be spray-irrigated.
- Irrigation equipment and components are not allowed where SRP needs vehicular access.
- Trees would not be allowed within the SRP easement.

Other Final Design Considerations: The drainage solution presented in this report is conceptual only and further refinement needs to be performed during the final design. Individual considerations for each the plan features are documented in **Section 4.1 and 4.2**. The following are some additional issues that would need further evaluation:

- The main entrance to the East Park Sports Complex is shown in the Conceptual Plans as being along the north boundary of the Park (Ryan Road). However, since the Town of Queen Creek is not planning to extend Ryan Road east of Ellsworth Road, the main entrance culvert could be removed or moved somewhere else.
- The programming for the facilities within the East Park Sports complex is in its infancy and may change substantially as the planning for this facility progresses. The final drainage facilities design needs to be analyzed in conjunction with the final programming for the park to insure a good balance between the needs of the drainage system and the needs of the park.

SECTION RA-5: IMPLEMENTATION PLAN

The Town is interested in implementing an overlay of increased retention to avoid greater flows resulting from future development and recent changes to precipitation data (NOAA 14). Unmitigated flow increases under future conditions would exceed the design capacity of the Rittenhouse Channel and result in a reduced level of regional flood protection.

The overlay is an equitable solution that shares the burden of a regional drainage infrastructure evenly over future developments. Additionally, the Town would share the burden by incorporating a large regional detention basin within its future East Park Sports Complex.

Timing of the implementation of individual plan elements is critical, and the ideal sequence is as follows:

1. Adopt a policy requiring additional retention for undeveloped areas within the Rittenhouse Zone. Impacted properties are shown on **Figure RA 4**
2. Design and construct the Queen Creek Channel
3. Design and construct the East Park Sports Complex Basin System
4. Design and construct the basin inlet channel(s) - (by developers)
5. Design and construct the Meridian Channel north of Germann Road (This is not a part of this plan but it is the outfall to the developer-constructed Meridian Channel)
6. Design and construct the Meridian Channel to Germann (by developers)

It is very unlikely that the plan would be implemented in this ideal sequence. Based on funding and priorities among the different implementation partners, it is unlikely that the park basin system or the outfall channel would be constructed prior to land development in this area.

Considering the very real possibility that the privately-funded facilities would be constructed before the outfalls are in place, there is a need to anticipate interim solutions to mitigate the lack of outfall. Discussion of these constraints is included later in this section.

5.1 REGULATORY ELEMENTS

As a backdrop to implementing the recommended alternative, it is important to consider the existing regulatory elements that the Town has adopted and in what general ways they will be modified. The Town's drainage regulations are based on the following guidance documents, which are promulgated by Maricopa County:

- *Floodplain Regulations for Maricopa County*
- *Drainage Policies and Standards for Maricopa County*
- *Drainage Design Manual for Maricopa County, Volumes 1, 2, & 3*

The *Maricopa County Drainage Policies and Standards* and the *Maricopa County Drainage Regulations* require developers to intercept offsite flow and direct it to onsite conveyance facilities. The policies, standards and regulations further require that offsite flow be discharged at the downstream drainage network such that the discharge returns to its historic flow path and pre-development flow characteristics.

There are two main regulatory elements that will be modified as part of this plan. The first is the modification to the retention requirement for all undeveloped area within the Rittenhouse Zone. The second is a requirement for developers to deliver specific offsite flows to specific locations (East Park Sports Complex Basin system and Meridian outfall channel).

5.2 PROCEDURAL IMPLEMENTATION OF THE ADMP UPDATE

The first step in implementing the recommended alternative is for the Town to adopt the East Mesa ADMP Update. Second, the Town will need to make changes in its development requirements to allow staff to regulate and enforce the increased retention policy.

The specifics of modifying the Town's Engineering requirements will likely involve an update to the Town's existing drainage and improvement requirements to reflect and reference the additional requirements of the ADMP Update. The Town will ultimately need to verify which of its own engineering requirements should be changed for the most effective implementation.

5.3 OPTIMAL PHASING AND INTERIM STRUCTURES

The recommended alternative is a very effective and creative integrated solution, incorporating both increased retention by future developments and regional drainage system improvements. It relies on both publicly- and privately-funded regional drainage facilities for it to function as intended.

If the ideal sequence of implementation described above is not possible, the plan has flexibility to accommodate a variety of options. Construction of the regional detention basin is a priority because it will act as the outfall for offsite runoff generated in Pinal County. However, since future development is likely to occur prior to the construction of the basin, some interim facilities may be required to protect existing infrastructure downstream. If development occurs east of the future East Park Sports Complex before the detention basin system can be constructed, an interim solution may be required. Similarly, if this development occurs prior to the construction of the future Meridian outfall channel (not a part of this plan), interim facilities may be required. The following sections expand on these issues.

5.3.1 Implementation of Basin Inlet Channel(s)

This plan requires the developer to provide channel(s) to intersect and convey the offsite flows crossing the Maricopa/Pinal county boundary south of the Ryan Road alignment to the site of Basin A in the East Park Sports Complex. If the channel(s) are constructed prior to the basin, the Town and developer(s) need to agree on interim infrastructure that may be required. One possibility is for the developer to do some of the grading within the basin park to return the flow to historical conditions. Another would be for developers to provide interim spreader basins onsite to return flow to historical conditions. The critical element is that the channel(s) could ultimately tie into the basin system once it is constructed.

5.3.2 Implementation of the Developer-Constructed Meridian Channel Component

Ultimately, the Meridian Channel should outfall to the proposed drainage system for the Ellsworth Zone. The Meridian Channel is likely to be constructed by developers before the outfall system can be constructed. There is an existing channel along Meridian Road between Germann and Pecos roads, but it is a small agricultural tail water ditch with limited capacity. Also, just north of Germann Road a driveway was constructed that blocks the channel and prevents flows from continuing north in the channel.

Unless and until the outfall is constructed, flow will back up in the new channel and overtop the banks. The overflow will continue west along Germann Road and adjacent properties. This may create an adverse condition along Germann Road, and the developer would be responsible for implementing interim solutions to mitigate the impacts.

It should be noted that the level of protection provided by this alternative assumes that the runoff from Pinal County currently entering the Meridian Channel will not contribute runoff to the Rittenhouse Zone. If discharge is allowed to flow west into the Rittenhouse Zone, the downstream level of protection will be reduced. Subsequently, the potential for flooding downstream will increase compared with the full implementation of the recommended alternative.

The required infrastructure to convey offsite flows typically consists of an onsite channel that discharges to a spreader basin at the downstream end. These interim facilities could be abandoned eventually and the flows redirected along the Meridian Road alignment to the future Pecos Road drainage system.

5.4 COST ESTIMATE

Estimated costs for the recommended alternative are presented in **Table RA 5.4** at the end of this report.

The cost estimates for the facilities in the recommended alternative were refined from the estimates presented in *Volume AD - Proposed Alternatives Development and Evaluation*. Subsequently, a more detailed analysis was performed for the recommended alternative, and a better understanding of the needs and constraints was developed. This resulted in some differences in required improvements. During the final design, the culvert sizing, upstream channel freeboard, and final layout should be further optimized in light of more detailed information, which could result in additional cost adjustments. Detailed cost data are included as **Appendix D**.

5.5 PROJECT FUNDING

Upon adoption by the Town Council, the District and Town staff will develop a Capital Improvements Project proposal. The District would then evaluate the Town's proposal for potential cost sharing.

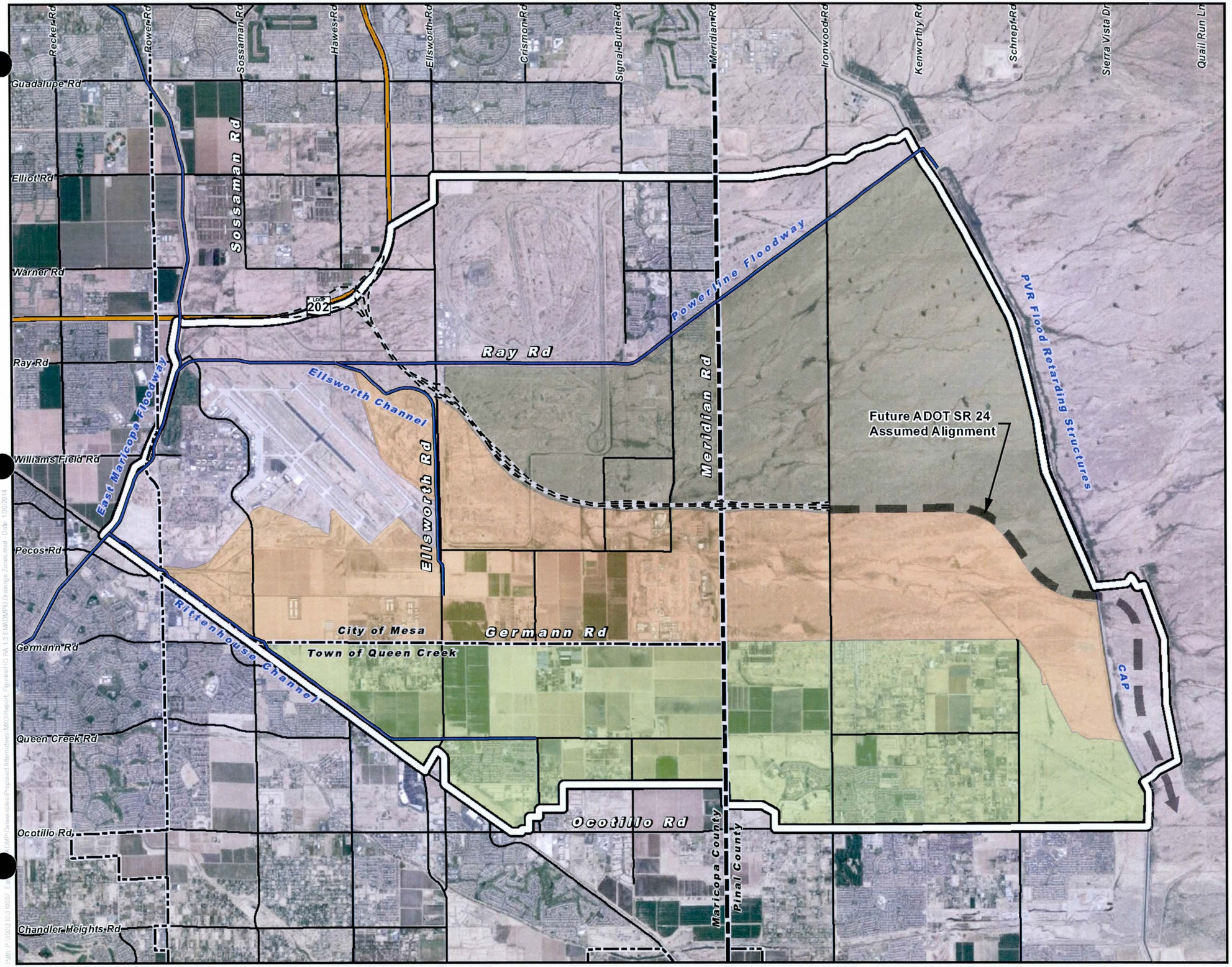
The District is a potential funding partner for the drainage portion of future improvements. Drainage improvements would include the regional detention basin and inlet/outlet works, a

portion of the detention basin landscaping, and the extension of the existing Queen Creek Channel. However, the cost for park amenities would be borne entirely by the Town.

It is noted that the future Meridian Channel Outfall north of Germann Road and detention basin at Pecos and Meridian roads is likely to be publicly funded. Although these elements are not a part of the recommended alternative for the Rittenhouse Zone, they would need to be constructed in order to achieve full functionality by intercepting offsite runoff in the northeastern area of the zone. Therefore, the District and City of Mesa could partner in the publically-funded portion of the Meridian Channel and detention basin near Pecos Road. Depending on timing of future development, Pinal County could also be a funding partner for the Meridian Channel Outfall segment. If Meridian Road is improved in the future, ADOT may consider participating as well.

Table RA 5.4 Estimated Costs for the Recommended Alternative

Channels	Construction	Landscaping	Utility Relocation	Land Acquisition	Maintenance	Contingency	Total
Merrill Channel	$ 538,000	$ 75,000	$ 14,000	$ 149,000	$ 36,000	$ 162,000	$ 974,000
Queen Creek Channel	$2,129,000	$ 147,000	$ 397,000	$ 199,000	$ 207,000	$ 616,000	$ 3,695,000
Subtotal	$ 2,667,000	$ 222,000	$ 411,000	$ 348,000	$ 243,000	$ 778,000	**$ 4,669,000**
Basins	**Construction**	**Landscaping**	**Utility Relocation**	**Land Acquisition**	**Maintenance**	**Contingency**	**Total**
East Park Sports Complex Retention Basin	$ 3,378,000	$ 481,000	-	$ 1,485,000	$ 492,000	$ 1,167,000	$ 7,003,000
Grand Total							**$ 11,672,000**



EAST MESA
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FCD 2011C017

LEGEND

- Project Boundary
- Corporate Boundary
- County Boundary
- FCDMC Regional Channel
- Future SR 24

Drainage Zones

- SR 24 System
- Ellsworth System
- Rittenhouse System

LOCATION MAP

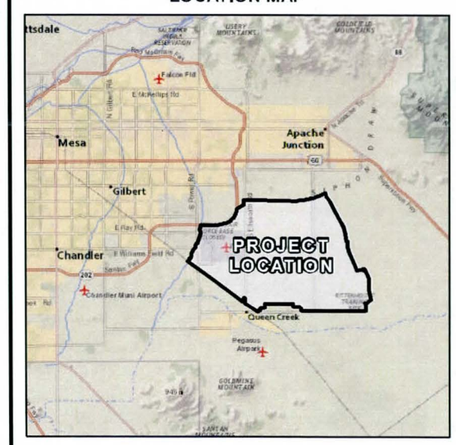

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FIGURE RA 1.3
EAST MESA ADMPU
DRAINAGE ZONES

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AREA DRAINAGE
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Flood Control District of Maricopa County

LEGEND

- Rittenhouse Zone Boundary
- Project Boundary
- Corporate Boundary
- County Boundary
- FCDMC Regional Channel
- Future SR 24

LOCATION MAP

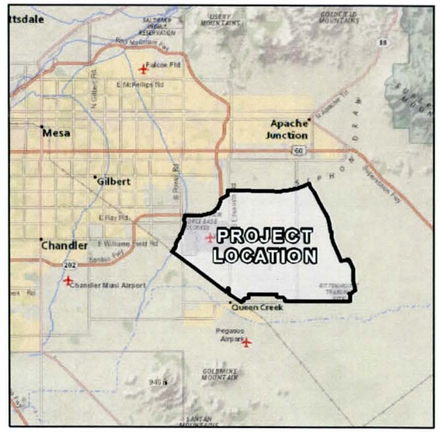

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FIGURE RA 1.4a
RITTENHOUSE ZONE STUDY AREA

Recker Rd
Power Rd
Sossaman Rd
Hawes Rd
Ellsworth Rd
Crismon Rd
Signal Butte Rd
Meridian Rd
Ironwood Rd
Kenworthy Rd
Schnepf Rd
Sierra Vista Dr
Quail Run Ln
Guadalupe Rd
Elliot Rd
Warner Rd
Ray Rd
Williams Field Rd
Pecos Rd
Germann Rd
Queen Creek Rd
Ocotillo Rd
Chandler Heights Rd
Loop 202
Sossaman Rd
Ray Rd
Powerline Floodway
PVR Flood Retarding Structures
East Maricopa Floodway
Ellsworth Channel
Ellsworth Rd
Meridian Rd
Future ADOT SR 24
Assumed Alignment
Rittenhouse Channel
City of Mesa
Town of Queen Creek
Germann Rd
CAP
Ocotillo Rd
Maricopa County
Pinal County

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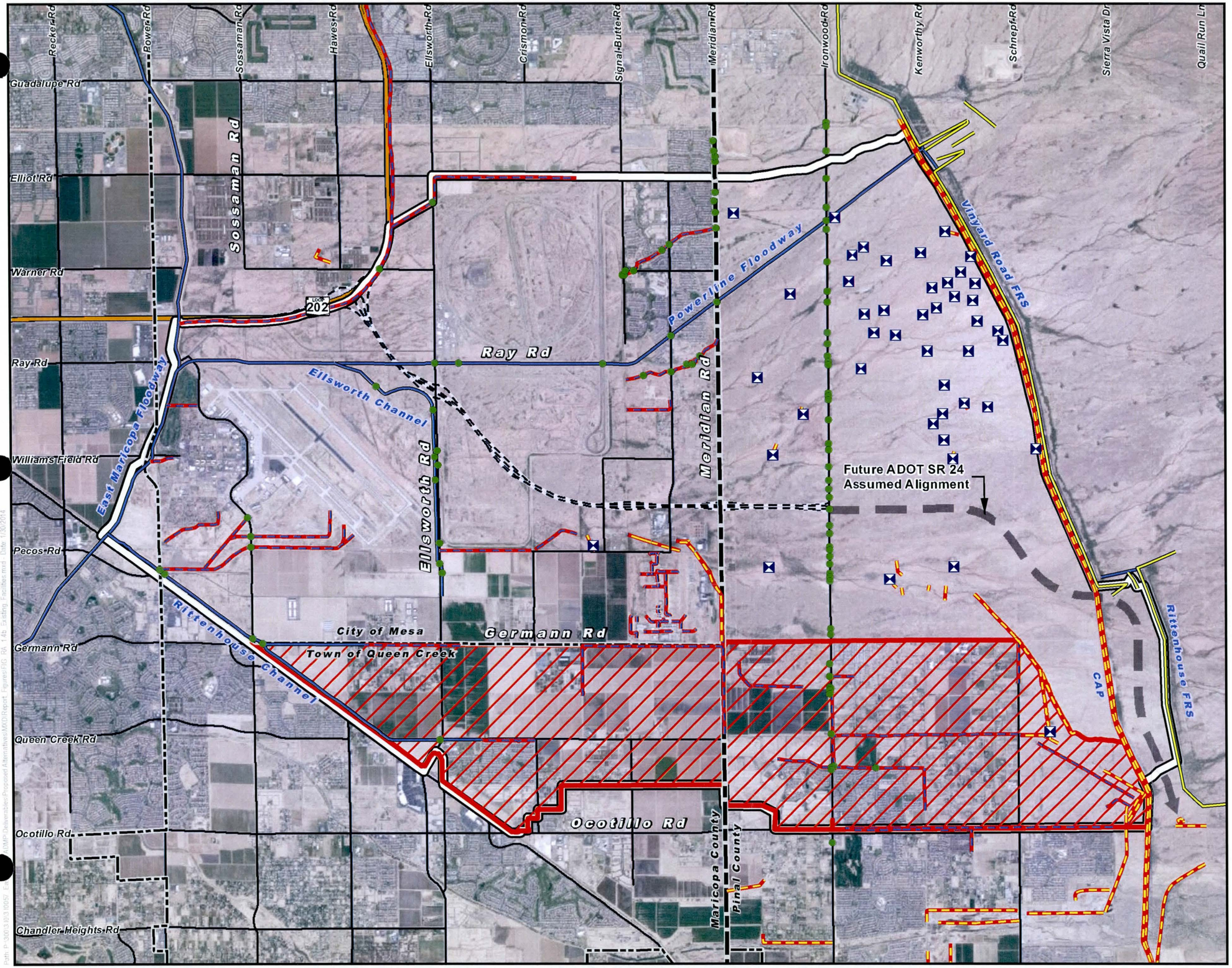
Flood Control District of Maricopa County



LEGEND

- Stock Pond
- Culvert
- Channel - FCDMC
- Channel - Unknown Condition
- Embankment - FCDMC
- Embankment - Unknown Condition
- Future SR 24
- Project Boundary
- Corporate Boundary
- County Boundary
- Rittenhouse Zone Boundary

LOCATION MAP

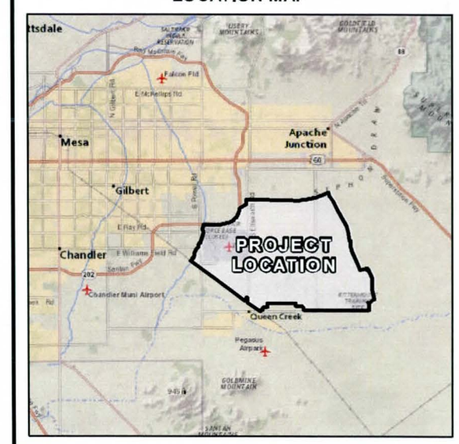


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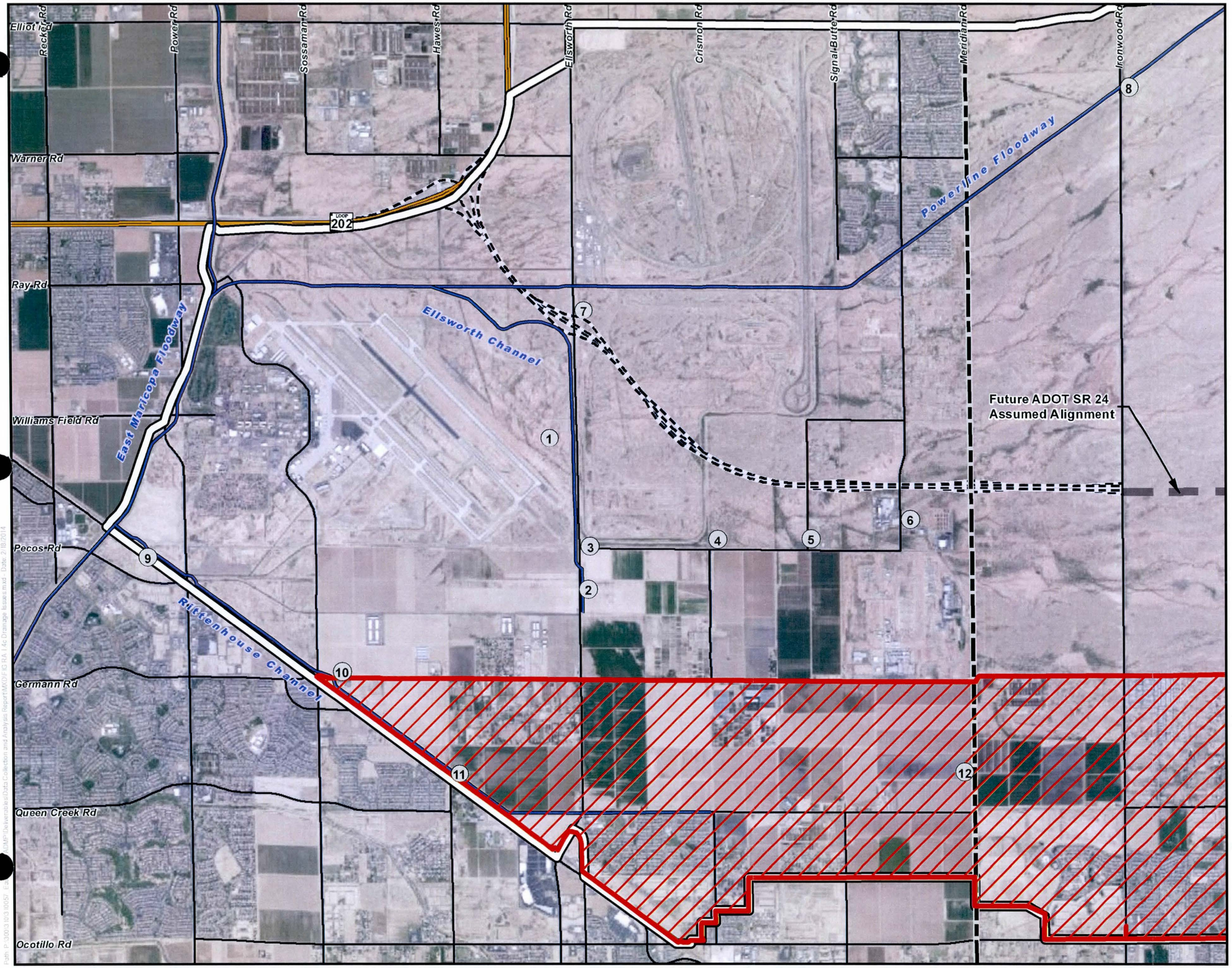
FIGURE RA 1.4b
EXISTING DRAINAGE FACILITIES



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LEGEND

- Project Boundary
- County Boundary
- Rittenhouse Zone Boundary
- FCDMC Regional Channel
- Future SR 24

Rittenhouse Zone Drainage Issues

9 Rittenhouse Channel freeboard deficiencies (future conditions)

10 Rittenhouse Channel overtopping (future conditions)

11 Rittenhouse Channel freeboard deficiencies (future conditions)

12 Breach of non-engineered berm

NOTE: See table AD 2.2 in the *Alternative Development Report - Volume AD* for drainage issues outside the Rittenhouse Zone

LOCATION MAP

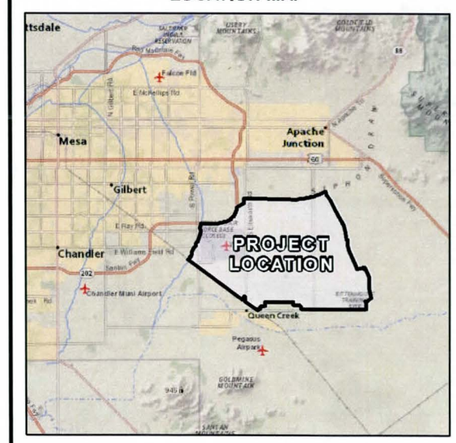

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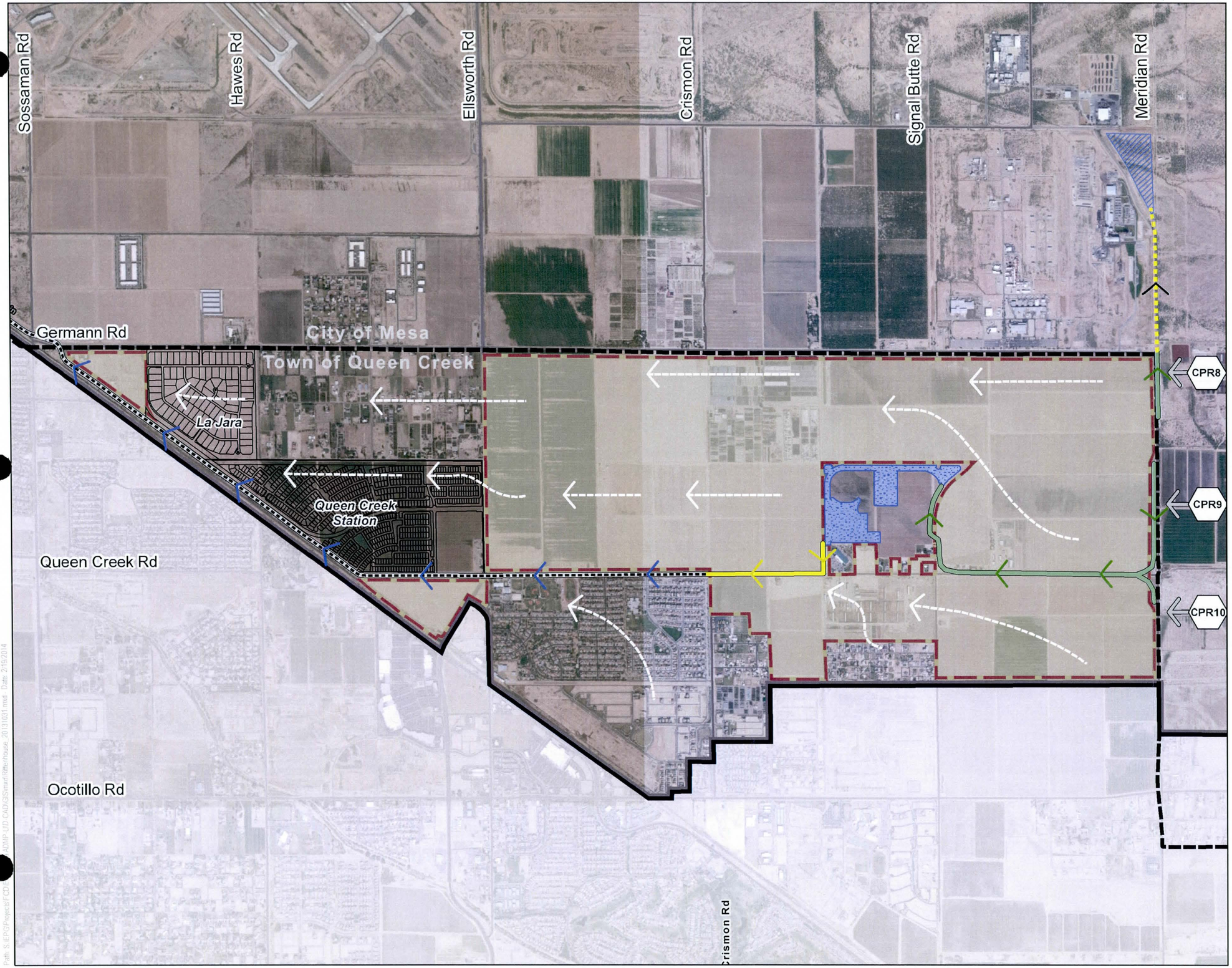
FIGURE RA 1.4c
DRAINAGE ISSUES



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LEGEND

Proposed Publicly-Funded Facilities
- Channel with Flow Direction
- Detention Basin

Proposed Privately-Funded Facilities
- Channel with Flow Direction
- Increased Onsite Retention Requirement Areas

Existing Facilities
- Channel or Pipe with Flow Direction

Reference Features
- Project Boundary
- Queen Creek Boundary
- General Direction of Flow in Excess of Increased Retention Requirement
- CPR10 Concentration Point from Offsite Pinal County Flows (See Appendix A)

Proposed Ellsworth Zone System
(not a part of the recommended alternative)
- Channel with Flow Direction
- Detention Basin

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Miles

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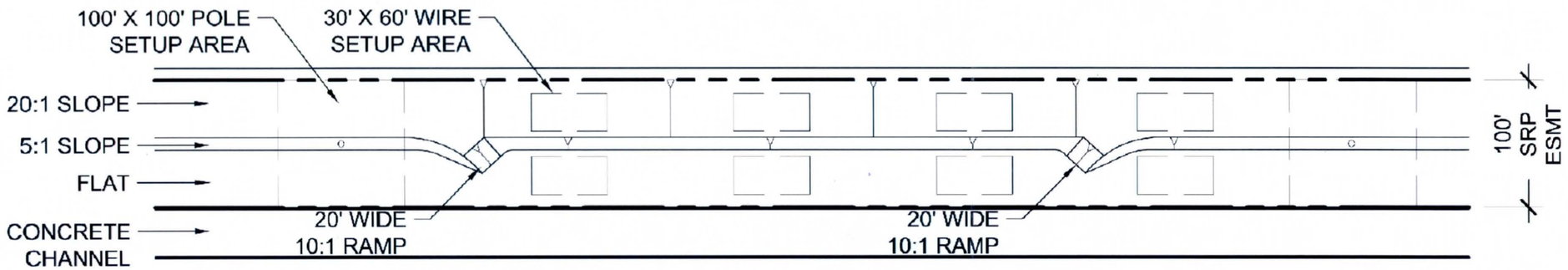
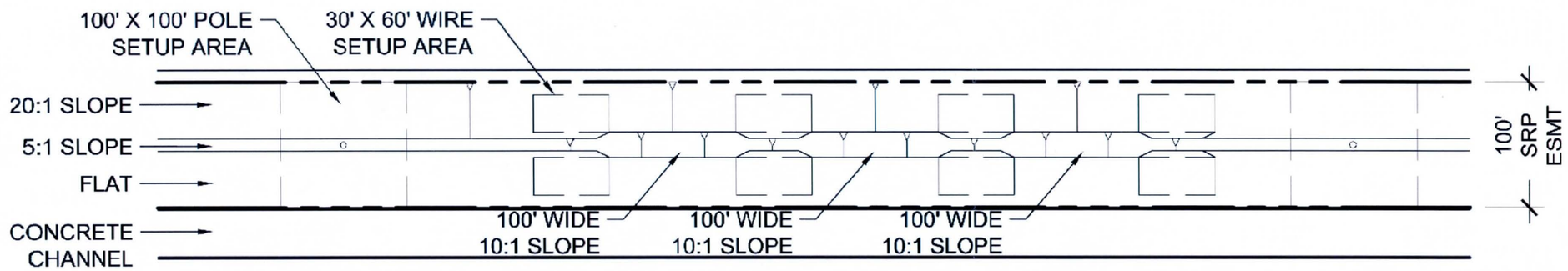
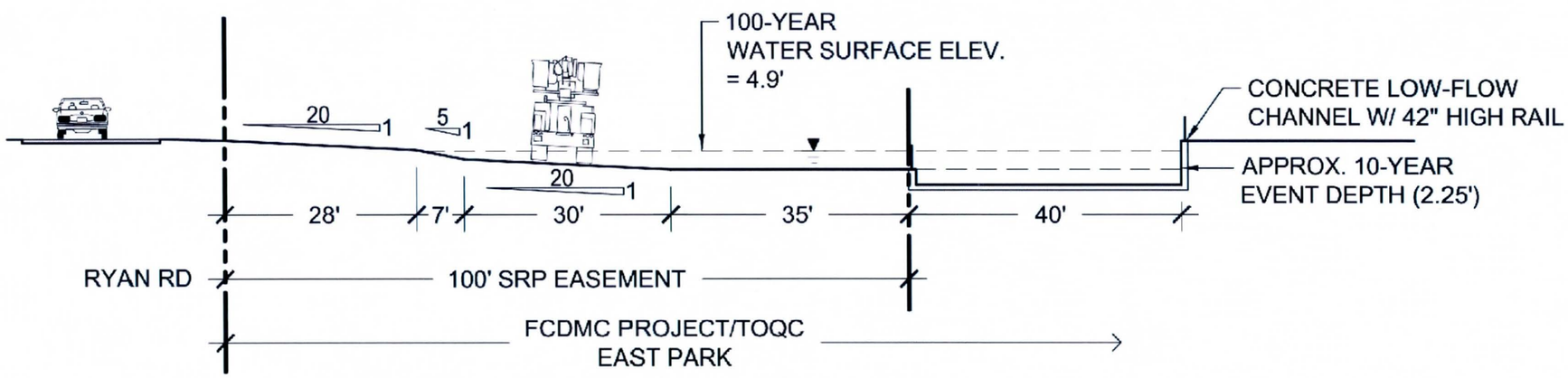
FIGURE RA 4
RECOMMENDED ALTERNATIVE



SRP EASEMENT CONCEPT PLAN VIEW ALT. A - RAMPS BETWEEN POLES



SRP EASEMENT CONCEPT PLAN VIEW ALT. B - 10:1 SLOPES BETWEEN WIRE SETUP AREAS



RYAN ROAD CHANNEL - SRP CORRIDOR W/ RYAN RD.

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LEGEND

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FIGURE RA 4.4
SRP / CHANNEL
CO-LOCATION CONCEPT

APPENDIX A. HYDROLOGIC ANALYSIS OF RECOMMENDED ALTERNATIVE

HEC-1 models and supporting calculations and parameters

Recommended Alternative for Rittenhouse:

Hydrologic modifications:

A modification was made to the stage-storage-discharge relationship of the Sports Complex detention for the preferred Rittenhouse alternative. The previous hydrologic model assumed a simple single stage-storage-discharge element to model flow through the site. As described below, the revised model reflects a refined site layout of separate retention areas connected by a large channel.

SSPRT1 – Retention Area #1 (Basin A):

The retention area farthest upstream was modeled as an online basin with a maximum storage volume of approximately 19 acre-ft. A channel structure consisting of varied-depth weirs was included to create storage and allow for flow to continue to the next retention area.

SSPRT2 – Retention Area #2 (Basin B):

The second retention area was modeled as an offline basin. This is a much larger basin with a maximum volume of about 47 acre-ft. A weir on the channel structure regulates flow between the channel and the retention basin.

Small Retention Not Modeled (Basin C):

A small retention basin of approximately one acre-foot exists along the channel. Due to its small size, the basin was not modeled.

SSPRT3 – Retention Area #3 (Basin D):

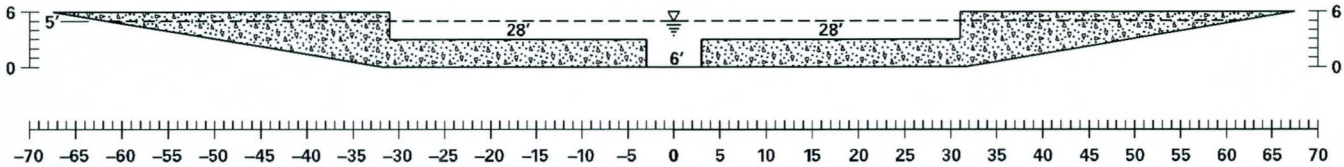
The final retention basin is the largest of the four and is intended as the least frequent to be inundated. During lesser flows, storm water would bypass the basin and enter the Sports Complex outfall channel via box culverts. From there, flow would continue directly to the Queen Creek Channel. Retention Area #3 would accept storm water only when the capacity of the outfall channel is exceeded. The total retention volume is approximately 70 acre-feet.

It is noted that the final design of the Sports Complex retention and conveyance system will require more detailed analysis to determine the exact location, sizing, and function of all structures.

Preliminary calculations for the control structures diverting flow into the basins were originally performed manually and these preliminary calculations are documented below. The performance of the hydraulic structures was also verified using a steady state HEC-RAS model of the East Park Sports Complex Channel with the control structures included in the hydrology model. Minor modifications to the control structures (not reflected in this analysis) were made based on the HEC-RAS results. The HEC-RAS model is documented in **Appendix B1 HEC-RAS**

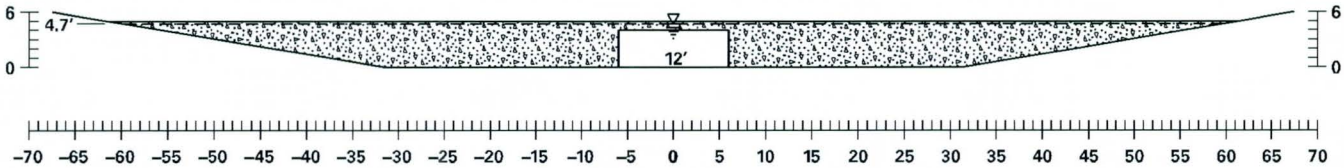
SSPRT1
Channel Structure

SSPRT2
Channel Structure



NOTE: Retention Basin Weir Dimension (Not Shown)
Weir Length > 130 Ft.
Weir Invert = 3 Ft.

SSPRT3
Channel Structure



NOTE: Retention Basin Weir Dimension (Not Shown)
Weir Length > 375 Ft.
Weir Invert = 4 Ft.

Entellus

Volume Estimation
Using the Conic Method

CLIENT: FCDMC
JOB: East Mesa ADMP
JOB NO. 310.057

SSPRT1

	Elevation 1 [ft]	Elevation 2 [ft]	Area 1 [ft]	Area 2 [ft]	Height [ft]	Volume [ft^3]	Volume [ac-ft]
	1424	1425	147000	154800	1	150883	3.5
	1424	1426	147000	162600	2	309469	7.1
	1424	1427	147000	170400	3	475668	10.9
	1424	1428	147000	178200	4	649400	14.9
	1424	1429	147000	186000	5	830590	19.1
FREEBOARD	1424	1430	147000	214000	6	1076728	24.7

Maximum Discharge [cfs]	1364
Maximum Stage [ft]	4.95
Maximum Volume [ac-ft]	18.8

SSPRT2

	Elevation 1 [ft]	Elevation 2 [ft]	Area 1 [ft]	Area 2 [ft]	Height [ft]	Volume [ft^3]	Volume [ac-ft]
	1422	1423	382000	393000	1	387487	8.9
	1422	1424	382000	403500	2	785402	18.0
	1422	1425	382000	414000	3	1193678	27.4
	1422	1425.1	382000	415000	3.1	1234997	28.4
	1422	1425.2	382000	416000	3.2	1276414	29.3
	1422	1426	382000	424700	4	1612646	37.0
	1422	1426.2	382000	426800	4.2	1697611	39.0
	1422	1427	382000	435500	5	2042290	46.9
FREEBOARD	1422	1428	382000	446000	6	2481523	57.0

Maximum Discharge [cfs]	957
Maximum Stage [ft]	4.95
Maximum Volume [ac-ft]	46.5

SSPRT3

	Elevation 1 [ft]	Elevation 2 [ft]	Area 1 [ft]	Area 2 [ft]	Height [ft]	Volume [ft^3]	Volume [ac-ft]	Cumulative Volume [ac-ft]
	1418	1419	149400	156870	1	153120	3.5	3.5
	1419	1422	651800	684390	3	2004086	46	49.5
	1422	1423	790000	877000	1	833121	19	68.6
FREEBOARD	1422	1424	790000	895400	2	1684300	39	88.2

NOTE: The **S**SPRT3 retention basin has multiple levels.
70 acre-ft was utilized in the model, as this was the value estimated by EPG.

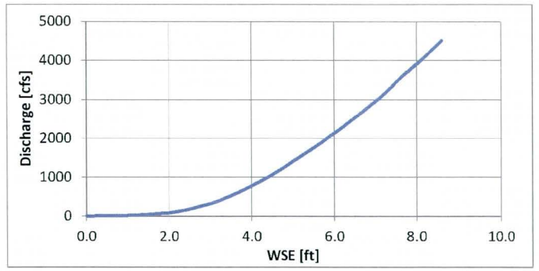
Maximum Discharge [cfs]	328
Maximum Stage [ft]	4.7
Maximum Volume [ac-ft]	64.2

Entellus

CLIENT: FCDMC
JOB: East Mesa ADMP
JOB NO. 310.057

SSPRT1

Analysis Type: Not Equal Invert
Rating Curve Interval: 0.2 [ft]



Type WEIR

Bottom Length [ft]	4
Weir Coefficient	2.9
Invert Elevation [ft]	0.00
Top Elevation [ft]	5.00

HW [ft]	W.S. Elevation [ft]	Discharge [cfs]
0.00	0.0	0
0.20	0.2	1
0.40	0.4	3
0.60	0.6	5
0.80	0.8	8
1.00	1.0	12
1.20	1.2	15
1.40	1.4	19
1.60	1.6	23
1.80	1.8	28
2.00	2.0	33
2.20	2.2	38
2.40	2.4	43
2.60	2.6	49
2.80	2.8	54
3.00	3.0	60
3.20	3.2	66
3.40	3.4	73
3.60	3.6	79
3.80	3.8	86
4.00	4.0	93
4.20	4.2	100
4.40	4.4	107
4.60	4.6	114
4.80	4.8	122
5.00	5.0	130
5.20	5.2	138
5.40	5.4	146
5.60	5.6	154
5.80	5.8	162
6.00	6.0	170
6.20	6.2	179
6.40	6.4	188
6.60	6.6	197
6.80	6.8	206
7.00	7.0	215
7.20	7.2	224
7.40	7.4	234
7.60	7.6	243
7.80	7.8	253
8.00	8.0	262
8.20	8.2	272
8.40	8.4	282
8.60	8.6	293

Type WEIR

Bottom Length [ft]	16
Weir Coefficient	2.9
Invert Elevation [ft]	1.00
Top Elevation [ft]	5.00

HW [ft]	W.S. Elevation [ft]	Discharge [cfs]
0.00	0.0	0
0.00	0.2	0
0.00	0.4	0
0.00	0.6	0
0.00	0.8	0
0.00	1.0	0
0.20	1.2	4
0.40	1.4	12
0.60	1.6	22
0.80	1.8	33
1.00	2.0	46
1.20	2.2	61
1.40	2.4	77
1.60	2.6	94
1.80	2.8	112
2.00	3.0	131
2.20	3.2	151
2.40	3.4	173
2.60	3.6	195
2.80	3.8	217
3.00	4.0	241
3.20	4.2	266
3.40	4.4	291
3.60	4.6	317
3.80	4.8	344
4.00	5.0	371
4.20	5.2	399
4.40	5.4	428
4.60	5.6	458
4.80	5.8	488
5.00	6.0	519
5.20	6.2	550
5.40	6.4	582
5.60	6.6	615
5.80	6.8	648
6.00	7.0	682
6.20	7.2	716
6.40	7.4	751
6.60	7.6	787
6.80	7.8	823
7.00	8.0	859
7.20	8.2	896
7.40	8.4	934
7.60	8.6	972

Type WEIR

Bottom Length [ft]	44
Weir Coefficient	2.9
Invert Elevation [ft]	2.00
Top Elevation [ft]	5.00

HW [ft]	W.S. Elevation [ft]	Discharge [cfs]
0.00	0.0	0
0.00	0.2	0
0.00	0.4	0
0.00	0.6	0
0.00	0.8	0
0.00	1.0	0
0.00	1.2	0
0.00	1.4	0
0.00	1.6	0
0.00	1.8	0
0.00	2.0	0
0.20	2.2	11
0.40	2.4	32
0.60	2.6	59
0.80	2.8	91
1.00	3.0	128
1.20	3.2	168
1.40	3.4	211
1.60	3.6	258
1.80	3.8	308
2.00	4.0	361
2.20	4.2	416
2.40	4.4	474
2.60	4.6	535
2.80	4.8	598
3.00	5.0	663
3.20	5.2	730
3.40	5.4	800
3.60	5.6	872
3.80	5.8	945
4.00	6.0	1021
4.20	6.2	1098
4.40	6.4	1178
4.60	6.6	1259
4.80	6.8	1342
5.00	7.0	1427
5.20	7.2	1513
5.40	7.4	1601
5.60	7.6	1691
5.80	7.8	1782
6.00	8.0	1875
6.20	8.2	1970
6.40	8.4	2066
6.60	8.6	2164

Type WEIR

Bottom Length [ft]	28
Weir Coefficient	2.9
Invert Elevation [ft]	3.00
Top Elevation [ft]	5.00

HW [ft]	W.S. Elevation [ft]	Discharge [cfs]
0.00	0.0	0
0.00	0.2	0
0.00	0.4	0
0.00	0.6	0
0.00	0.8	0
0.00	1.0	0
0.00	1.2	0
0.00	1.4	0
0.00	1.6	0
0.00	1.8	0
0.00	2.0	0
0.00	2.2	0
0.00	2.4	0
0.00	2.6	0
0.00	2.8	0
0.00	3.0	0
0.20	3.2	7
0.40	3.4	21
0.60	3.6	38
0.80	3.8	58
1.00	4.0	81
1.20	4.2	107
1.40	4.4	135
1.60	4.6	164
1.80	4.8	196
2.00	5.0	230
2.20	5.2	265
2.40	5.4	302
2.60	5.6	340
2.80	5.8	380
3.00	6.0	422
3.20	6.2	465
3.40	6.4	509
3.60	6.6	555
3.80	6.8	601
4.00	7.0	650
4.20	7.2	699
4.40	7.4	749
4.60	7.6	801
4.80	7.8	854
5.00	8.0	908
5.20	8.2	963
5.40	8.4	1019
5.60	8.6	1076

SUMMARY

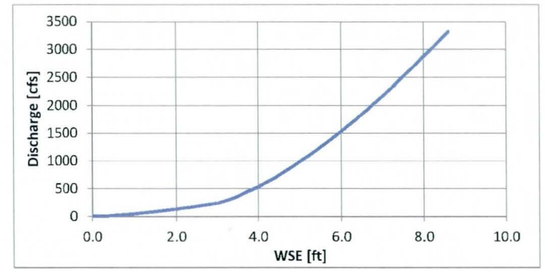
W.S. Elevation [ft]	Discharge [cfs]
0.0	0
0.2	1
0.4	3
0.6	5
0.8	8
1.0	12
1.2	19
1.4	31
1.6	45
1.8	61
2.0	79
2.2	110
2.4	152
2.6	202
2.8	258
3.0	319
3.2	393
3.4	477
3.6	570
3.8	670
4.0	776
4.2	889
4.4	1007
4.6	1131
4.8	1260
5.0	1394
5.2	1532
5.4	1676
5.6	1823
5.8	1976
6.0	2132
6.2	2292
6.4	2457
6.6	2625
6.8	2797
7.0	2973
7.2	3152
7.4	3335
7.6	3522
7.8	3712
8.0	3905
8.2	4102
8.4	4301
8.6	4504

Entellus

CLIENT: FCDMC
JOB: East Mesa ADMP
JOB NO. 310.057

SSPRT2

Analysis Type: Not Equal Invert
Rating Curve Interval: 0.2 [ft]



NOTE: The maximum difference between the incoming and outgoing hydrograph was utilized to size the weir to the retention basin. The weir should be larger than this value to allow for adequate flow to enter the retention basin from the channel and to account for other factors not accounted for in this analysis. The maximum stage was estimated as being 4.95 ft. This is approximately 2.0 ft above the invert of the weir.

Type WEIR

Bottom Length [ft]	16
Weir Coefficient	2.9
Invert Elevation [ft]	0.00
Top Elevation [ft]	5.00

HW [ft]	W.S. Elevation [ft]	Discharge [cfs]
0.00	0.0	0
0.20	0.2	4
0.40	0.4	12
0.60	0.6	22
0.80	0.8	33
1.00	1.0	46
1.20	1.2	61
1.40	1.4	77
1.60	1.6	94
1.80	1.8	112
2.00	2.0	131
2.20	2.2	151
2.40	2.4	173
2.60	2.6	195
2.80	2.8	217
3.00	3.0	241
3.20	3.2	266
3.40	3.4	291
3.60	3.6	317
3.80	3.8	344
4.00	4.0	371
4.20	4.2	399
4.40	4.4	428
4.60	4.6	458
4.80	4.8	488
5.00	5.0	519
5.20	5.2	550
5.40	5.4	582
5.60	5.6	615
5.80	5.8	648
6.00	6.0	682
6.20	6.2	716
6.40	6.4	751
6.60	6.6	787
6.80	6.8	823
7.00	7.0	859
7.20	7.2	896
7.40	7.4	934
7.60	7.6	972
7.80	7.8	1011
8.00	8.0	1050
8.20	8.2	1090
8.40	8.4	1130
8.60	8.6	1170

Type WEIR

Bottom Length [ft]	0
Weir Coefficient	2.9
Invert Elevation [ft]	1.00
Top Elevation [ft]	5.00

HW [ft]	W.S. Elevation [ft]	Discharge [cfs]
0.00	0.0	0
0.00	0.2	0
0.00	0.4	0
0.00	0.6	0
0.00	0.8	0
0.00	1.0	0
0.20	1.2	0
0.40	1.4	0
0.60	1.6	0
0.80	1.8	0
1.00	2.0	0
1.20	2.2	0
1.40	2.4	0
1.60	2.6	0
1.80	2.8	0
2.00	3.0	0
2.20	3.2	0
2.40	3.4	0
2.60	3.6	0
2.80	3.8	0
3.00	4.0	0
3.20	4.2	0
3.40	4.4	0
3.60	4.6	0
3.80	4.8	0
4.00	5.0	0
4.20	5.2	0
4.40	5.4	0
4.60	5.6	0
4.80	5.8	0
5.00	6.0	0
5.20	6.2	0
5.40	6.4	0
5.60	6.6	0
5.80	6.8	0
6.00	7.0	0
6.20	7.2	0
6.40	7.4	0
6.60	7.6	0
6.80	7.8	0
7.00	8.0	0
7.20	8.2	0
7.40	8.4	0
7.60	8.6	0

Type WEIR

Bottom Length [ft]	0
Weir Coefficient	2.9
Invert Elevation [ft]	2.00
Top Elevation [ft]	5.00

HW [ft]	W.S. Elevation [ft]	Discharge [cfs]
0.00	0.0	0
0.00	0.2	0
0.00	0.4	0
0.00	0.6	0
0.00	0.8	0
0.00	1.0	0
0.00	1.2	0
0.00	1.4	0
0.00	1.6	0
0.00	1.8	0
0.00	2.0	0
0.20	2.2	0
0.40	2.4	0
0.60	2.6	0
0.80	2.8	0
1.00	3.0	0
1.20	3.2	0
1.40	3.4	0
1.60	3.6	0
1.80	3.8	0
2.00	4.0	0
2.20	4.2	0
2.40	4.4	0
2.60	4.6	0
2.80	4.8	0
3.00	5.0	0
3.20	5.2	0
3.40	5.4	0
3.60	5.6	0
3.80	5.8	0
4.00	6.0	0
4.20	6.2	0
4.40	6.4	0
4.60	6.6	0
4.80	6.8	0
5.00	7.0	0
5.20	7.2	0
5.40	7.4	0
5.60	7.6	0
5.80	7.8	0
6.00	8.0	0
6.20	8.2	0
6.40	8.4	0
6.60	8.6	0

Type WEIR

Bottom Length [ft]	56
Weir Coefficient	2.9
Invert Elevation [ft]	3.00
Top Elevation [ft]	5.00

HW [ft]	W.S. Elevation [ft]	Discharge [cfs]
0.00	0.0	0
0.00	0.2	0
0.00	0.4	0
0.00	0.6	0
0.00	0.8	0
0.00	1.0	0
0.00	1.2	0
0.00	1.4	0
0.00	1.6	0
0.00	1.8	0
0.00	2.0	0
0.00	2.2	0
0.00	2.4	0
0.00	2.6	0
0.00	2.8	0
0.00	3.0	0
0.20	3.2	15
0.40	3.4	41
0.60	3.6	75
0.80	3.8	116
1.00	4.0	162
1.20	4.2	213
1.40	4.4	269
1.60	4.6	329
1.80	4.8	392
2.00	5.0	459
2.20	5.2	530
2.40	5.4	604
2.60	5.6	681
2.80	5.8	761
3.00	6.0	844
3.20	6.2	930
3.40	6.4	1018
3.60	6.6	1109
3.80	6.8	1203
4.00	7.0	1299
4.20	7.2	1398
4.40	7.4	1499
4.60	7.6	1602
4.80	7.8	1708
5.00	8.0	1816
5.20	8.2	1926
5.40	8.4	2038
5.60	8.6	2152

SUMMARY

W.S. Elevation [ft]	Discharge [cfs]
0.0	0
0.2	4
0.4	12
0.6	22
0.8	33
1.0	46
1.2	61
1.4	77
1.6	94
1.8	112
2.0	131
2.2	151
2.4	173
2.6	195
2.8	217
3.0	241
3.2	280
3.4	332
3.6	392
3.8	460
4.0	534
4.2	613
4.4	697
4.6	786
4.8	880
5.0	978
5.2	1080
5.4	1186
5.6	1296
5.8	1409
6.0	1526
6.2	1646
6.4	1769
6.6	1896
6.8	2026
7.0	2159
7.2	2294
7.4	2433
7.6	2574
7.8	2719
8.0	2866
8.2	3015
8.4	3168
8.6	3322

WEIR To Retention

Maximum Q [cfs]	1050
Bottom Length [ft]	130
Weir Coefficient	2.9
Invert Elevation [ft]	3.00
Top Elevation [ft]	5.00

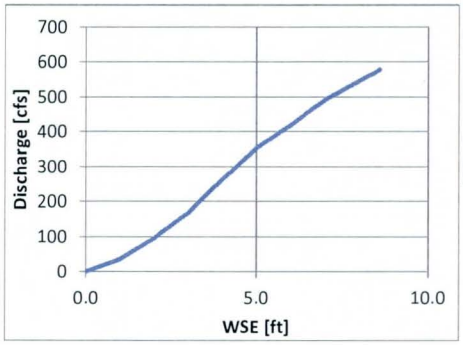
HW [ft]	W.S. Elevation [ft]	Discharge [cfs]
0.00	0.0	0
0.00	0.2	0
0.00	0.4	0
0.00	0.6	0
0.00	0.8	0
0.00	1.0	0
0.00	1.2	0
0.00	1.4	0
0.00	1.6	0
0.00	1.8	0
0.00	2.0	0
0.00	2.2	0
0.00	2.4	0
0.00	2.6	0
0.00	2.8	0
0.00	3.0	0
0.20	3.2	34
0.40	3.4	95
0.60	3.6	175
0.80	3.8	270
1.00	4.0	377
1.20	4.2	496
1.40	4.4	625
1.60	4.6	763
1.80	4.8	910
2.00	5.0	1066
2.20	5.2	1230
2.40	5.4	1402
2.60	5.6	1581
2.80	5.8	1766
3.00	6.0	1959
3.20	6.2	2158
3.40	6.4	2364
3.60	6.6	2575
3.80	6.8	2793
4.00	7.0	3016
4.20	7.2	3245
4.40	7.4	3480
4.60	7.6	3719
4.80	7.8	3965
5.00	8.0	4215
5.20	8.2	4470
5.40	8.4	4731
5.60	8.6	4996

Entellus

CLIENT: FCDMC
JOB: East Mesa ADMP
JOB NO. 310.057

Analysis Type: Not Equal Invert
Rating Curve Interval: 0.2 [ft]

SSPRT3



NOTE: The maximum difference between the incoming and outgoing hydrograph was utilized to size the weir to the retention basin. The weir should be larger than this value to allow for adequate flow to enter the retention basin from the channel and to account for other factors not accounted for in this analysis. The maximum stage was estimated as being4.7 ft, This is approximately 0.7 ft above the invert of the weir.

Type	RBC
Height [ft]	4
Width [ft]	12.00
No. of Barrels	1.00
Invert Elevation [ft]	0
Top Elevation [ft]	5

WEIR To Retention

Incoming Q [cfs]	630
Bottom Length [ft]	375.00
Weir Coefficient	2.90
Invert Elevation [ft]	4
Top Elevation [ft]	5

HW [ft]	HW/D	W.S. Elevation [ft]	Discharge [cfs]
0.00	0.00	0.0	0
0.20	0.05	0.2	7
0.40	0.10	0.4	14
0.60	0.15	0.6	22
0.80	0.20	0.8	29
1.00	0.25	1.0	36
1.20	0.30	1.2	48
1.40	0.35	1.4	60
1.60	0.40	1.6	72
1.80	0.45	1.8	84
2.00	0.50	2.0	96
2.20	0.55	2.2	110
2.40	0.60	2.4	125
2.60	0.65	2.6	139
2.80	0.70	2.8	154
3.00	0.75	3.0	168
3.20	0.80	3.2	187
3.40	0.85	3.4	206
3.60	0.90	3.6	226
3.80	0.95	3.8	245
4.00	1.00	4.0	264
4.20	1.05	4.2	282
4.40	1.10	4.4	300
4.60	1.15	4.6	318
4.80	1.20	4.8	336
5.00	1.25	5.0	354
5.20	1.30	5.2	367
5.40	1.35	5.4	380
5.60	1.40	5.6	394
5.80	1.45	5.8	407
6.00	1.50	6.0	420
6.20	1.55	6.2	434
6.40	1.60	6.4	449
6.60	1.65	6.6	463
6.80	1.70	6.8	478
7.00	1.75	7.0	492
7.20	1.80	7.2	503
7.40	1.85	7.4	514
7.60	1.90	7.6	524
7.80	1.95	7.8	535
8.00	2.00	8.0	546
8.20	2.05	8.2	557
8.40	2.10	8.4	568
8.60	2.15	8.6	578

SUMMARY

W.S. Elevation [ft]	Discharge [cfs]
0.0	0
0.2	7
0.4	14
0.6	22
0.8	29
1.0	36
1.2	48
1.4	60
1.6	72
1.8	84
2.0	96
2.2	110
2.4	125
2.6	139
2.8	154
3.0	168
3.2	187
3.4	206
3.6	226
3.8	245
4.0	264
4.2	282
4.4	300
4.6	318
4.8	336
5.0	354
5.2	367
5.4	380
5.6	394
5.8	407
6.0	420
6.2	434
6.4	449
6.6	463
6.8	478
7.0	492
7.2	503
7.4	514
7.6	524
7.8	535
8.0	546
8.2	557
8.4	568
8.6	578

HW [ft]	W.S. Elevation [ft]	Discharge [cfs]
0.00	0.0	0
0.00	0.2	0
0.00	0.4	0
0.00	0.6	0
0.00	0.8	0
0.00	1.0	0
0.00	1.2	0
0.00	1.4	0
0.00	1.6	0
0.00	1.8	0
0.00	2.0	0
0.00	2.2	0
0.00	2.4	0
0.00	2.6	0
0.00	2.8	0
0.00	3.0	0
0.00	3.2	0
0.00	3.4	0
0.00	3.6	0
0.00	3.8	0
0.00	4.0	0
0.20	4.2	97
0.40	4.4	275
0.60	4.6	505
0.80	4.8	778
1.00	5.0	1088
1.20	5.2	1430
1.40	5.4	1801
1.60	5.6	2201
1.80	5.8	2626
2.00	6.0	3076
2.20	6.2	3549
2.40	6.4	4043
2.60	6.6	4559
2.80	6.8	5095
3.00	7.0	5651
3.20	7.2	6225
3.40	7.4	6818
3.60	7.6	7428
3.80	7.8	8056
4.00	8.0	8700
4.20	8.2	9361
4.40	8.4	10037
4.60	8.6	10729

```
1****************************************
 *                                      *
 *   FLOOD HYDROGRAPH PACKAGE  (HEC-1)  *
 *             JUN   1998               *
 *           VERSION 4.1                *
 *                                      *
 *  RUN DATE   12DEC13  TIME  13:54:43  *
 *                                      *
****************************************
```

```
*************************************
*                                   *
*   U.S. ARMY CORPS OF ENGINEERS    *
*   HYDROLOGIC ENGINEERING CENTER   *
*         609 SECOND STREET         *
*      DAVIS, CALIFORNIA 95616      *
*          (916) 756-1104           *
*                                   *
*************************************
```

```
X     X  XXXXXXX   XXXXX          X
X     X  X       X     X        XX
X     X  X       X               X
XXXXXXX  XXXX    X        XXXXX  X
X     X  X       X               X
X     X  X       X     X         X
X     X  XXXXXXX   XXXXX        XXX
```

THIS PROGRAM REPLACES ALL PREVIOUS VERSIONS OF HEC-1 KNOWN AS HEC1 (JAN 73), HEC1GS, HEC1DB, AND HEC1KW.

THE DEFINITIONS OF VARIABLES -RTIMP- AND -RTIOR- HAVE CHANGED FROM THOSE USED WITH THE 1973-STYLE INPUT STRUCTURE.
THE DEFINITION OF -AMSKK- ON RM-CARD WAS CHANGED WITH REVISIONS DATED 28 SEP 81. THIS IS THE FORTRAN77 VERSION
NEW OPTIONS: DAMBREAK OUTFLOW SUBMERGENCE , SINGLE EVENT DAMAGE CALCULATION, DSS:WRITE STAGE FREQUENCY,
DSS:READ TIME SERIES AT DESIRED CALCULATION INTERVAL LOSS RATE:GREEN AND AMPT INFILTRATION
KINEMATIC WAVE: NEW FINITE DIFFERENCE ALGORITHM


```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

   1          ID   2013.12.12
   2          ID   Modified to refine the configuration of the retention on the Sports Complex
   3          ID   site. Multiple Stage Storage Discharge records were added to model the flow
   4          ID   through the various retention basins within the site. The order of cards
   5          ID   for the stage - storage through the Sports Complex site is as follows:
   6          ID
   7          ID          INFLOW          = PINAL
   8          ID          STORAGE ROUTE   = SSPRT1
   9          ID          CHANNEL ROUTE   = RSPRT1
  10          ID          STORAGE ROUTE   = SSPRT2
  11          ID          CHANNEL ROUTE   = RSPRT2
  12          ID          STORAGE ROUTE   = SSPRT3
  13          ID          CHANNEL ROUTE   = RSPRT3
  14          ID          OUTFLOW         = RPINAL (MERRILL / QUEEN CREEK CHANNEL)
  15          ID
  16          ID   -*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-*-
2296          KK   PINAL
2297          KO       3
2298          KM
2299          KM   Added this combine to represent the flow entering from Pinal County and
2300          KM   the Barney / City Park Detention Basin sub-area
              * HC     4
2301          HC       3
2302          ZW   A=PINAL C=FLOW F=100YEAR
              *
              * KKSBPINL
              * KO     3
              * KM This represents the proposed Sports Complex Retention basin
              * RS     1    STOR
              * SV     0       4       6       8      10      12      14      18     120      1
              * SQ     0      10      35      95     150     215     250     275     330      3
              * SE     0       4       6       8      10      12      14      18     120      1
              *
              *
```

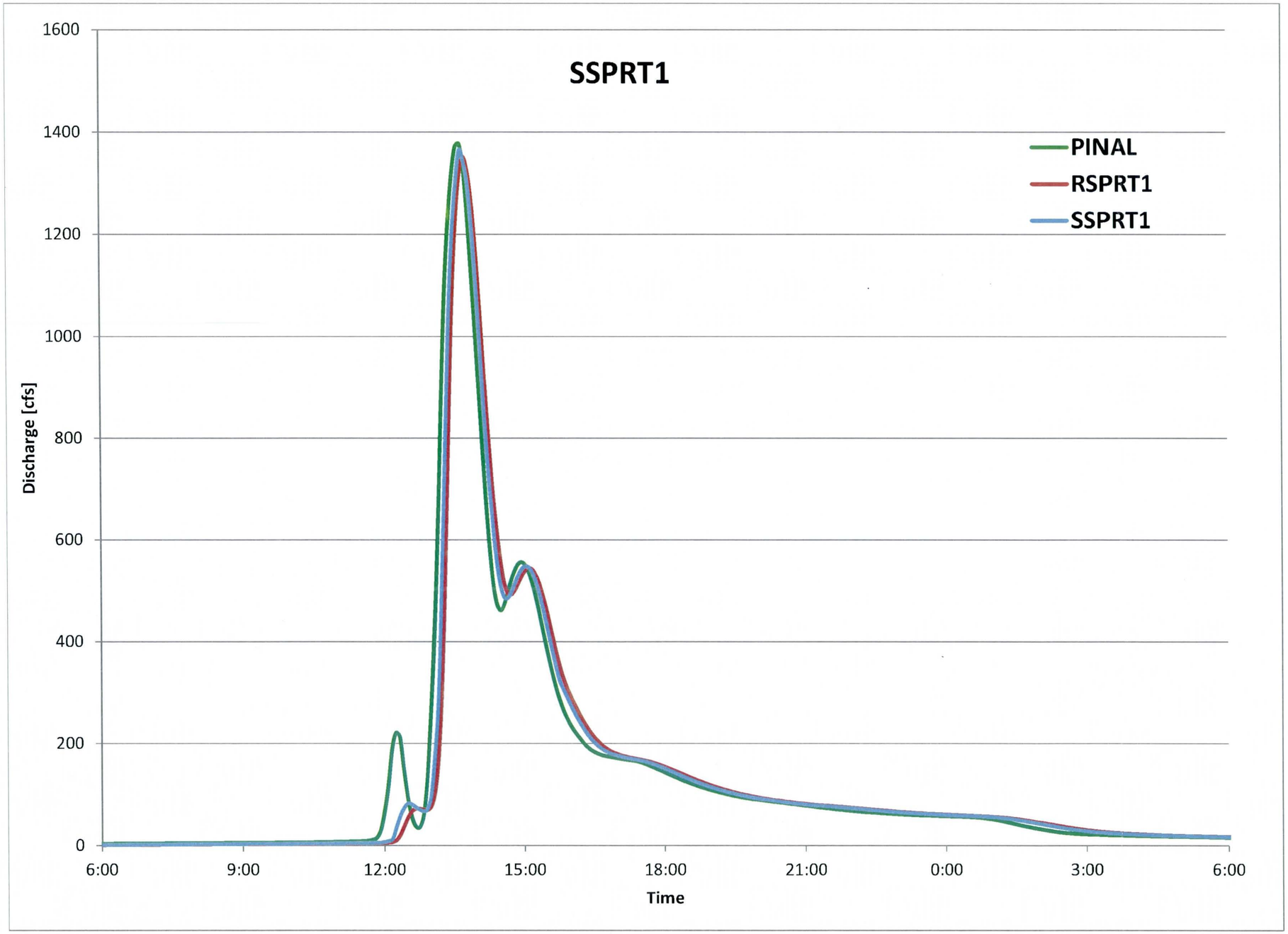


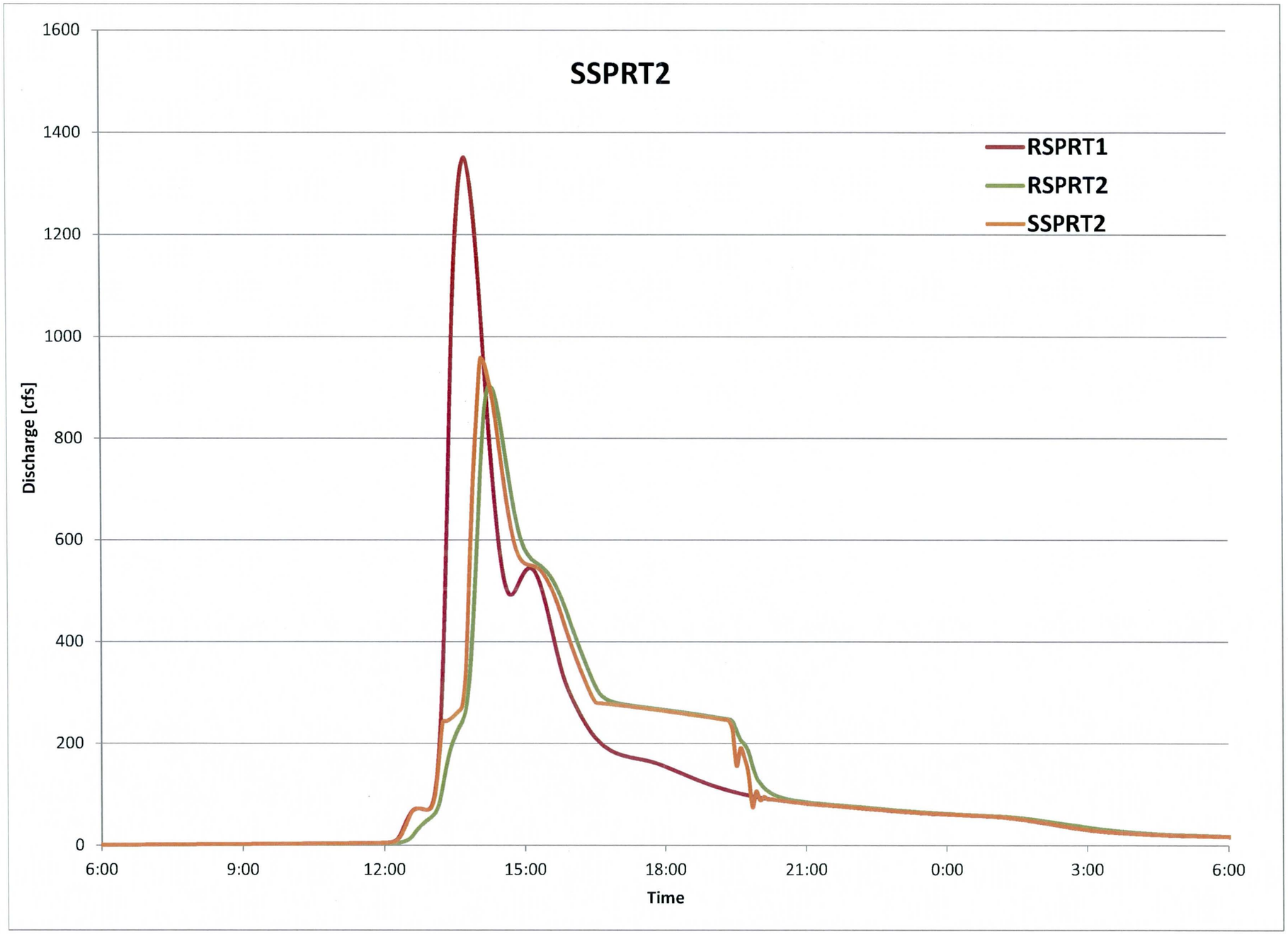
```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

2303          KK  SSPRT1
2304          KO       3
2305          KM   Estimated the storage volume for depths below 5' through
2306          KM   interpolation and the conic method.
2307          KM
2308          KM
2309          RS       1    STOR
2310          SV       0     3.5     7.0    11.0    15.0    19.0    19.1
2311          SQ       0      12      79     319     776    1394    2132
2312          SE       0       1       2       3       4       5     6.0
2313          ZW   A=SSPRT1 C=FLOW F=100YEAR
              *
              *
```

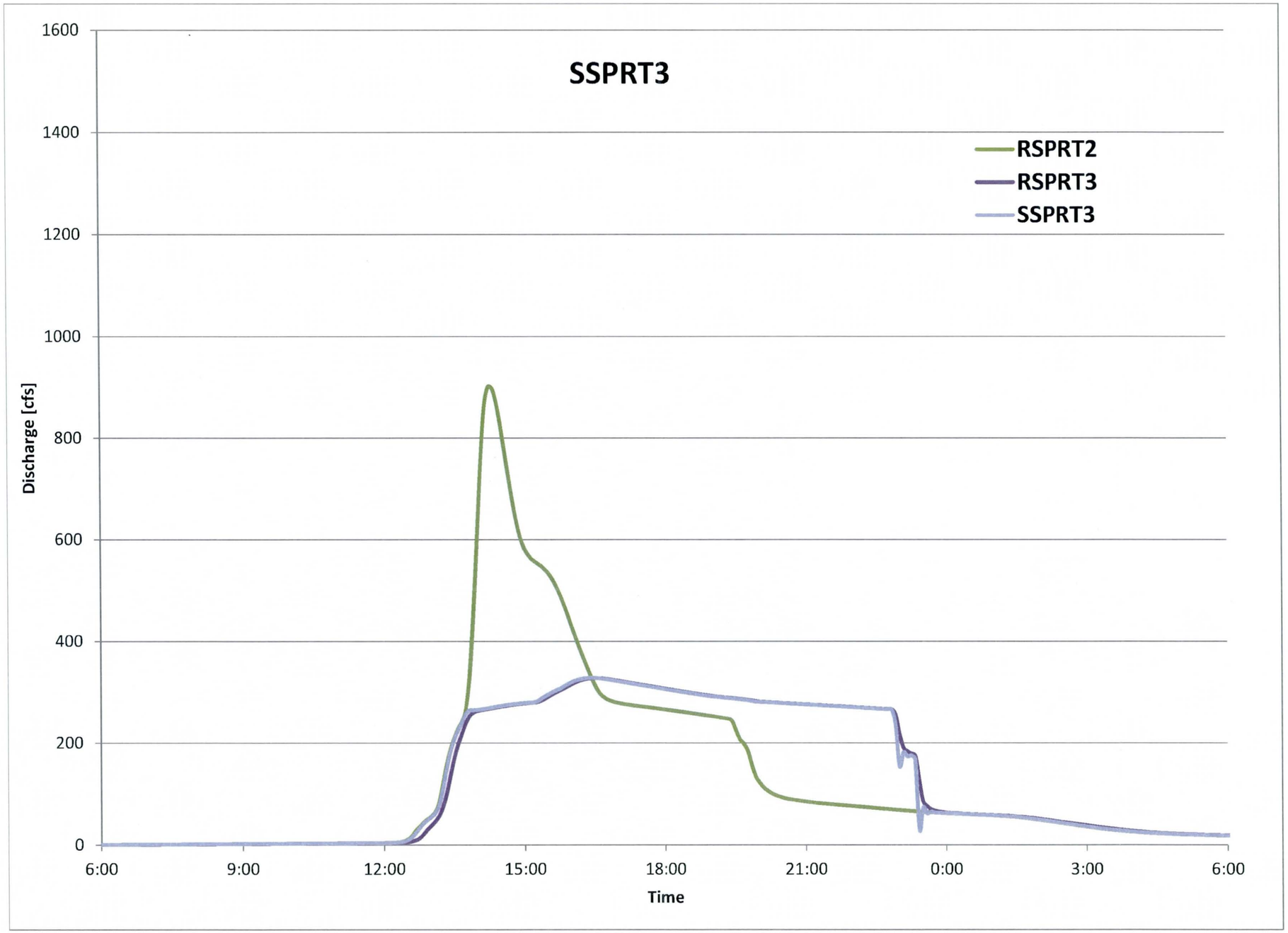
```
2314          KK  RSPRT1
2315          KO       3
2316          RS       1    FLOW
              * *****Channel Assumptions***** *
              * Right Side Slope = 6:1
              * Left Side Slope = 6:1
              * Bottom Width = 60'
              * Channel Depth = 6'
2317          RC   0.040   0.040   0.040    1000  0.0018
2318          RX       0       9      18      36      96     114     123     132
2319          RY       6     4.5       3       0       0       3     4.5       6
2320          ZW   A=RSPRT1 C=FLOW F=100YEAR
              *
              *

2321          KK  SSPRT2
2322          KO       3
2323          KM   The assumption was that 3 feet of the channel depth passes through unimpeded
2324          KM   and then spills into the retention area.
2325          KM
2326          RS       1    STOR
2327          SV       0     0.1    0.14     0.2    0.24     0.3    29.0    37.0    47.0    47.1
2328          SQ       0      46      77     131     173     241     280     534     978    1526
2329          SE       0       1     1.4       2     2.4       3     3.2       4       5       6
2330          ZW   A=SSPRT2 C=FLOW F=100YEAR
              *
              *

2331          KK  RSPRT2
2332          KO       3
2333          RS       1    FLOW
              * *****Channel Assumptions***** *
              * Right Side Slope = 6:1
              * Left Side Slope = 6:1
              * Bottom Width = 60'
              * Channel Depth = 6'
2334          RC   0.040   0.040   0.040    2000  0.0018
2335          RX       0       9      18      36      96     114     123     132
2336          RY       6     4.5       3       0       0       3     4.5       6
2337          ZW   A=RSPRT2 C=FLOW F=100YEAR
              *
              *
```



```
LINE          ID.......1.......2.......3.......4.......5.......6.......7.......8.......9......10

2338          KK  SSPRT3
2339          KO       3
2340          RS       1    STOR
2341          KM   The assumption was that 4 feet of the channel depth passes through unimpeded
2342          KM   and then spills into the retention area.
2343          KM
2344          RS       1    STOR
2345          SV       0     0.1     0.2     0.3     0.4    54.0    70.0    70.1    70.2
2346          SQ       0      36      96     168     264     282     354     420    1000
2347          SE       0       1       2       3       4     4.2       5       6       7
2348          ZW   A=SSPRT3 C=FLOW F=100YEAR
              *
              *

2349          KK  RSPRT3
2350          RS       1    FLOW
              * *****Channel Assumptions***** *
              * Right Side Slope = 6:1
              * Left Side Slope = 6:1
              * Bottom Width = 60'
              * Channel Depth = 6'
2351          RC   0.040   0.040   0.040    1000  0.0018
2352          RX       0       9      18      36      96     114     123     132
2353          RY       6     4.5       3       0       0       3     4.5       6
2354          ZW   A=RSPRT3 C=FLOW F=100YEAR
              *
              *

2355          KK  RPINAL   ROUTE
2356          KM   This route represents flow leaving the City Park Retention Basin
2357          KM   flowing to Queen Creek Road Channel:
2358          KM   Geometry assumptions:  S=0.0004, BW=40', H:Z=3:1, n=0.04
2359          RS       1    FLOW
2360          RC   0.040   0.040   0.040     800  0.0004
2361          RX       0      12      18      24      64      70      76      88
2362          RY       8       4       2       0       0       2       4       8
```


SSPRT1
PINAL
RSPRT1
SSPRT1
Discharge [cfs]
1600
1400
1200
1000
800
600
400
200
0
6:00
9:00
12:00
15:00
18:00
21:00
0:00
3:00
6:00
Time


SSPRT2
RSPRT1
RSPRT2
SSPRT2
Discharge [cfs]
1600
1400
1200
1000
800
600
400
200
0
6:00
9:00
12:00
15:00
18:00
21:00
0:00
3:00
6:00
Time


SSPRT3
RSPRT2
RSPRT3
SSPRT3
Discharge [cfs]
1600
1400
1200
1000
800
600
400
200
0
6:00
9:00
12:00
15:00
18:00
21:00
0:00
3:00
6:00
Time

Entellus

BY DATE

CLIENT CHECK DATE

JOB JOB No.

Line #	Culvert ID	Effective Height (ft) D	Effective Width (ft) B	Invert Elevation (ft) Ei	Stage Elevation (ft) Es	Headwater Depth (ft) HW=Es-Ei	HW / D	Q / B	Q (cfs) Q=B*(Q/B)
1									
2									
3									
4									
5									
6									

Drainage Design Manual for Maricopa County, Volume II, Hydraulics

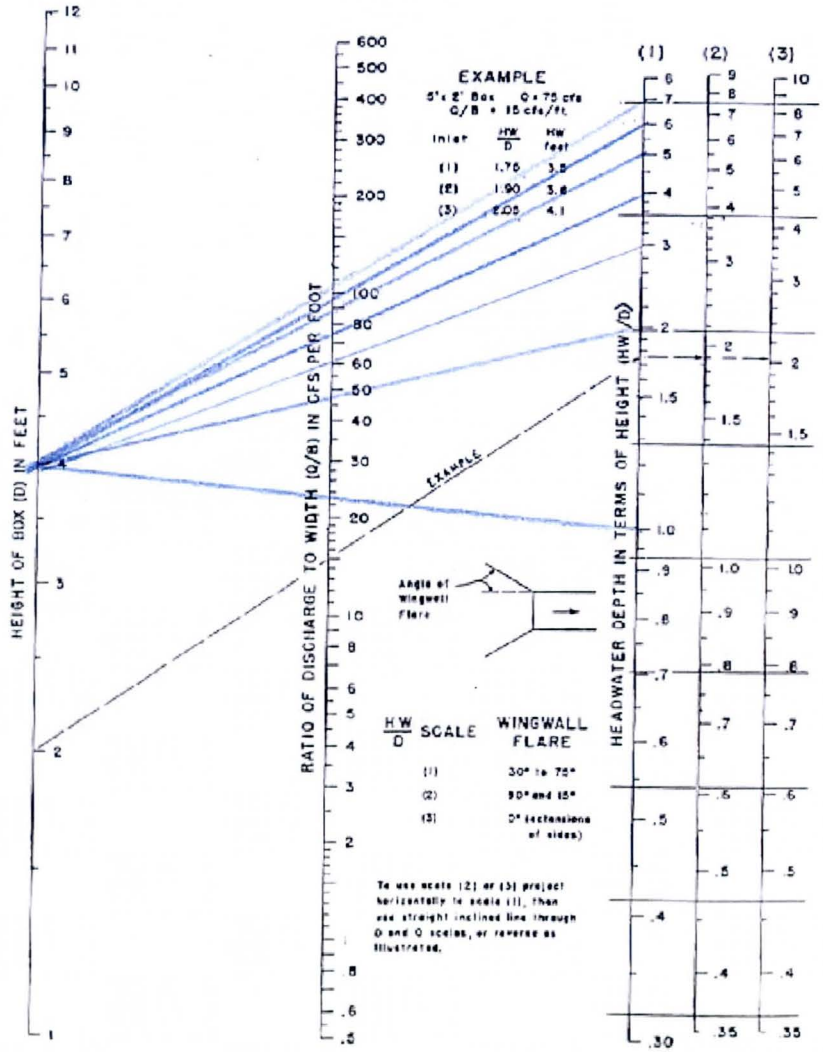


Figure 5.26
Headwater Depth for Box Culverts with Inlet Control
(USDOT FHWA, HDS-5, 1985)

APPENDIX B. HYDRAULIC AND SEDIMENT YIELD ANALYSIS OF RECOMMENDED ALTERNATIVE

HEC-RAS models and supporting documentation

EAST MESA AREA DRAINAGE MASTER PLAN UPDATE

QUEEN CREEK AND MERIDIAN CHANNEL HYDRAULIC ANALYSIS TECHNICAL MEMORANDUM

Contract FCD 2011C017

January 2014
Rev February 2014

Prepared by:

Intelligent Engineering

Innovative *Solutions*

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EAST MESA AREA DRAINAGE MASTER PLAN UPDATE
FCD 2011C017
QUEEN CREEK AND MERIDIAN CHANNEL HYDRAULIC ANALYSIS
TECHNICAL MEMORANDUM

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EAST MESA AREA DRAINAGE MASTER PLAN UPDATE
QUEEN CREEK AND MERIDIAN CHANNELS HYDRAULIC ANALYSIS
TECHNICAL MEMORANDUM

SECTION 1: INTRODUCTION

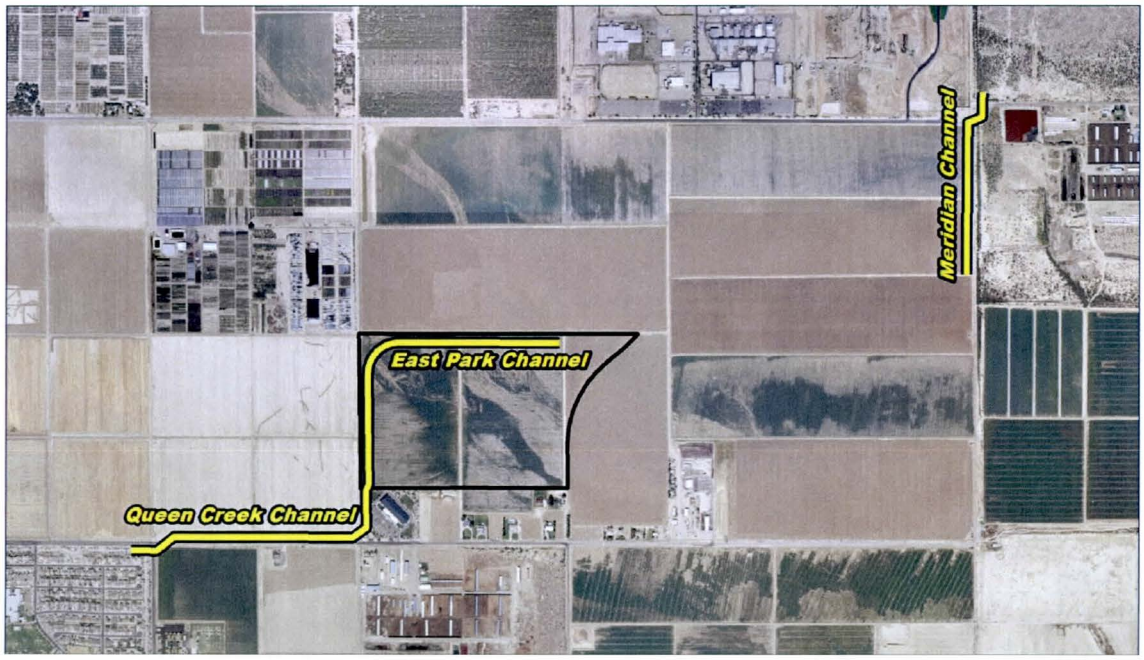
The East Mesa Area Drainage Master Plan (ADMP) Update was initiated to develop and recommend context-sensitive and cost-effective strategies to reduce flood hazards and protect public safety in a 58-square-mile portion of southeastern Maricopa County. The study area includes portions of Mesa, Queen Creek, Gilbert, and unincorporated Maricopa and Pinal counties. The Flood Control District of Maricopa County (District) retained Entellus, Inc., under Contract FCD 2011C017 to prepare an update to the previous ADMP prepared by others in 1998 (*1998 ADMP*) (Reference 234).

As part of the recommended alternative for the Rittenhouse Zone, Entellus prepared a HEC-RAS model of the two main channels for this alternative. The first channel modeled is the Queen Creek Channel and the second is the Meridian Channel.

1.1 Project Location

Both channels are located in southeast Maricopa County within the Rittenhouse Zone of the East Mesa ADMP Update study area (**Figure 1.1**). The Queen Creek Channel is the outfall for the East Park Sports Complex Basin and outfalls into the existing Rittenhouse Channel Extension.

Figure 1.1 Location Map



SECTION 2: MAPPING AND SURVEY INFORMATION

Mapping was provided by the District and consisted of 2-foot contour interval mapping. The details regarding mapping used are as follows:

Project ID:	1286
Contract Number:	FCD 07-39
Project Name:	Mesa Mapping
Topo ID:	600
Flight date:	03/10/2008
Contour Interval:	2 ft
DTM Data:	Yes
Vertical Datum:	NAVD88
Horizontal Datum:	NAD 1983 HARN, State Plane Arizona Central FIPS 0202, International Feet

SECTION 3: HYDROLOGY

Peak discharges for the channels were obtained from the refined Rittenhouse Zone HEC-1 hydrologic model for the preferred alternative (100-year, 24-hour future condition model with increased future retention).

Table 3 - Design Flows

Channel	Location	Concentration Point	Flow (cfs)
Park Channel	From Basin A to Basin B	PINAL	1380
Park Channel	From Basin B to Basin D	N/A	980
Park Channel	From Basin D to edge of park	N/A	330
Queen Creek	Sports Complex Basin to Queen Creek Road along east side of Merrill Road	RSPRT3	330
Queen Creek	Along north side of Queen Creek Road from Merrill Road to Crismon Road	CPR15	520
Meridian	Along the west side of Meridian Road	CPR8	720

SECTION 4: HYDRAULICS

4.1 Method Description

Hydraulic analysis of the Powerline Floodway was performed using the U.S. Army Corps of Engineers HEC-RAS 4.1.0 program. Modeling parameters were estimated per the guidelines of the *Drainage Design Manual for Maricopa County - Hydraulics.*

4.2 Work Study Maps

Work maps were not developed since floodplain delineation is not a part of this study.

4.3 Parameter Estimation

4.3.1 Roughness Coefficient

The roughness coefficients used were the same as those documented in the previous *Proposed Alternatives Development and Evaluation Report*. For the Queen Creek Channel, a value of 0.04 was used. This is a conservative value based on the configuration and materials and may allow for some additional landscape within the flow portion of the channel.

The n-value for the improved Meridian Channel was set to 0.036 based on equations described in the District's Hydraulics Manual. The overbanks' roughness coefficient was set to 0.05; however, the assumed value does not impact the results since the flow stays within the channel for all proposed improvements. For the n-value for the portion of Meridian Channel downstream from Germann Road (existing channel), average values of 0.04 for the channel and 0.05 for the overbanks were used. These values represent average conditions since there are areas of high vegetation density but also areas of bare ground with little obstruction.

The n-value for the East Park Sports Complex Channel was set to 0.04 to be consistent with the downstream channel.

4.3.2 Contraction and Expansion Coefficients

The contraction and expansion coefficients were set to 0.1 and 0.3 for all reaches except in the vicinity of culverts. Near the culverts, coefficients were increased to 0.3 and 0.5.

4.4 Cross-Section Description

Cross-sections were cut from left to right looking downstream. The cross-section identifier for the Queen Creek Channel reflects the distance from the confluence Rittenhouse Extension Channel and, for the Meridian Channel, the alignment of the Meridian Channel at Pecos Road. The cross-sections were cut from a Triangulated Irregular Network (TIN) provided by the District.

Bank stations were located at the edge of the channel, which allows the use of the average n-value for the channel and a different n-value for the overbanks.

Queen Creek Channel

Cross-sections were modified using the channel modification routine within HEC-RAS to reflect the proposed final channel configuration. For the Queen Creek Channel, two different templates were used, one for the upstream portion (East Park Sports Complex Basin to Queen Creek Road) and a second for the rest of the channel. Both of these templates were essentially identical, but slopes and flows used with each were different. The cross-section utilizes a vertical concrete wall on the road side, a 40 foot bottom and 3:1 embankment opposite the road.

Meridian Channel South of Germann Road

For the Meridian Channel, channel modifications were only made for the portion south (upstream) of Germann Road. Two templates with slide geometric differences were utilized to reflect slope differences between the upstream portion of the improvement and the downstream portion.

Meridian Channel North of Germann Road

The Meridian Channel model was extended north to Pecos Road. Between Germann and Pecos roads, the cross sections for existing ground were used and include an existing small channel and berm that run along the east side of the Commercial Metals Company (CMC) property. The CMC property is located on the west side of the Meridian road alignment between Germann and Pecos roads.

A separate model was also generated to include future improvements to this reach of the channel. The channel modification option of HEC-RAS was utilized to generate the new section based on channel configuration similar to the one used in the upstream reach.

East Park Sports Complex Channel

For the East Park Sports Complex Channel the Queen Creek Channel HEC-RAS model was extended to reflect the future alignment of the channel through the Park. Cross-sections were generated using the channel modification option within HEC-RAS and varies from 50 to 60-foot bottom widths and 6:1 side slopes for this analysis. For the area near the northwest corner of the Park, one foot of fill was assumed before carving the proposed channel. This is needed due to a local low area in the vicinity.

4.5 Modeling Considerations

4.5.1 Hydraulic Jumps and Drop Analysis

There are no hydraulic jumps or drop structures within these two channels.

4.5.2 Bridges and Culverts

Culverts were modeled using the culvert routine within HEC-RAS and were sized to minimize backwater effects on upstream channel.

The Queen Creek Channel includes three culverts. The first one replaces the existing culvert at the driveway to the Barney Family Sports Complex and the other two are proposed to cross Merrill Road just north of the Queen Creek intersection and across Queen Creek Road and Crismon Road. The downstream headwall for this culvert was built by the developer and the model ties in at this location.

The Meridian Channel includes one proposed culvert at the downstream end of the improvements (Germann Road).

The East Park Sports Complex Basin system includes two proposed culverts, one at the entry driveway from Ryan Road and the other near the Barney Family Sports Complex Property. The size of these culverts was verified using HEC-RAS.

4.5.3 Berms and Dikes

No berms or dikes were modeled within the proposed improvement areas. However, the existing berm along the east CMC property boundary was modeled.

4.5.4 Other On-Line Structures

The on-line weir option of HEC-RAS was utilized to model the control weirs across the East Park Sports Complex Channel. Three on-line weirs were modeled. The upstream-most on-line weir restricts flow from leaving Basin A, an on-line retention basin. The second on-line weir controls flow into Basin B and the downstream-most on-line weir controls flow entering basin D. The configuration of this last structure is a 11.3'x4'rectangular opening at the bottom of the channel. The other two are contracted weirs.

4.5.5 Lateral Flow

The lateral flow option of HEC-RAS was utilized to size the side weirs diverting flow into the two main off-line detention basins in the East Park Sports Complex. The weir coefficient for these side weirs was set to 2.0 and the weir crests were set approximately 4' above the channel invert upstream from the corresponding on-line weir. The length of Weir B was set to 125' and Weir D was set to 330'.

4.5.6 Islands and Flow Splits

No islands or flow splits occur in the Queen Creek Channel. Flow splits were modeled for the Meridian Channel utilizing the side weir and optimization routines within HEC-RAS. Several models were prepared for this area.

The first includes only the area of proposed improvements up to the Germann Road culvert. For this model it was assumed that there was no significant backwater from the future channel. This model was prepared to ensure that the proposed configuration of the channel would function once the downstream channel is built.

The second model assumes all flow continues downstream along the alignment of the existing small channel. This model shows significant overtopping over most of its length.

A third model was developed with weir lateral flow and optimization. This model reveals that flow does not continue north in the channel but is diverted out into Germann Road. It is important to note that due to zero flow in the channel downstream of the split, the flow optimization routine fails to converge. After examining the model it was discovered that

there is a obstruction on the channel just north of German Road, which prevents any runoff from flowing north in the channel.

A fourth model was generated to remove the obstruction and allow flow to continue north. This model reveals that approximately 70 cfs is conveyed to Pecos Road and the rest spills at or near Germann Road.

4.5.7 Ineffective Flow Areas

The ineffective flow area option of HEC-RAS was used when appropriate to reflect wetted areas that do not actually contribute to the conveyance of flow. This condition is most common upstream and downstream from culverts.

4.5.8 Supercritical Flow

The flow in these channels is subcritical.

4.5.9 Blocked Obstructions

The blocked obstructions option of HEC-RAS was not used for this model.

4.5.10 Special Modeling Considerations

Flow Regime

The model was run using the subcritical flow regime only. No evidence of supercritical flow was found.

Friction Slope Methodology

HEC-RAS has several options to calculate the friction slope in the channel. The default method is the average conveyance method. The model was run using the default value.

4.6 Problems Encountered During Modeling

4.6.1 Special Problems and Solutions

Structures Modeling

The Queen Creek Channel includes two skewed culverts. Both the Merrill and Queen Creek culverts cross these roads at 45 degrees. The skew option in HEC-RAS was not used because the upstream cross section was cut perpendicular to the culvert barrels. Therefore, adjustments to the cross section geometry are not required to compensate for the extra length of the channel as it would be needed if the cross-section would have been cut perpendicular to the roadway embankment.

HEC-RAS is a one-dimensional model and cannot model bends as occur at the inlet of both of these culverts. To compensate for this, the n-value along the outside of the bend was increased to 0.05.

Optimization of Flows

The limiting capacity of 520 cfs in the Rittenhouse Channel Extension was used as the basis for design of the park detention basin and channel system. An iterative process with the optimization option in HEC-RAS was used to model diversion of flow from the channel and into the basins as follows:.

1. Obtain the peak inflow of 1380 cfs from Concentration Point "PINAL" of the HEC-1 model and use it in the HEC-RAS model at Basin A (the entrance into the park).
2. Perform manual weir flow calculations at Basins B, C, and D to obtain initial flow diversions.
3. Input flow diversions from Step 2 into the HEC-1 model and rerun.
4. Model the resulting HEC-1 flow diversions in HEC-RAS as lateral weir structures.
5. Compare the HEC-RAS and HEC-1 results and adjust the stage/discharge parameters in the HEC-1 diversion records. Repeat Steps 4 and 5 until the channel flows match.

It is noted that the HEC-RAS model used for this analysis does not allow diverted flow to re-enter the system. Therefore, in order to maintain the design flow along the Queen Creek Channel, the detained flow had to be manually entered downstream of the detention basin system. This was accomplished by inserting the diverted flow of 1,570 cfs at cross-section 2859.763, the confluence of Merrill and Queen Creek channels. The resulting flow represents what would actually be carried in this channel reach.

4.6.2 Modeling Warning and Errors

There are no errors reported by the HEC-RAS models. Warnings were reviewed and do not appear to be problematic based on physical conditions.

4.7 Calibration

These are proposed channels and there is no data available to perform a calibration.

4.8 Final Results

4.8.1 Hydraulic Analysis Results

Queen Creek Channel

The Queen Creek Channel was modeled to maximize the cross-sectional area within the existing 70-foot drainage easement. This resulted in a channel depth of approximately five feet and freeboard of approximately two feet (almost twice what would be required). This depth is required at the upstream end to be able to drain the Sports Complex Basin, but farther downstream, the channel could be shallower (approximately four feet deep). However, the 5-foot depth will allow for future driveway culverts along Queen Creek Road to be placed without affecting the capacity of the channel; therefore, the 5-foot depth was left in the model. The hydraulic conditions of the Queen Creek Channel were modeled in the HEC-RAS plan called "Queen Creek Final."

The profile plots for the Queen Creek Channel are included in the 15% plan and profile sheets and the HEC-RAS models are included in the CD in **Attachment 2**.

East Park Sports Complex Channel

The East Park Sports Complex Channel was modeled by extending the Queen Creek Channel model and includes the control structures to divert flow to the retention basins within the park. The channel and control structures appear to function as intended, allowing a base flow to pass and diverting higher flows into the basins, thus reducing peak flows downstream. The amount that the flow is reduced by each of the basins was estimated based on the hydrology (HEC-1). As noted previously, the stage/discharge parameters for the HEC-1 were verified using the results from the HEC-RAS model.

On the conceptual design plans, the top-of-basin elevations are shown to be *below* the crest of the side weirs (specifically for Basin D). This configuration was used to ensure that the weir calculations properly represented true conditions, i.e., avoiding submerged weir flow.

In contrast the HEC-1 model assumes that the entire storage volume is *above* the crest of the side weir, i.e., the storage would act as online basins. This allows flow in the HEC-1

model to return to the channel through the weir, although this would not be possible as shown on the conceptual plans. This conservative assumption allows some leeway during final design in the event that actual conditions vary from assumed planning-level conditions.

The effect of this conservative approach resulted in the water surface elevation increasing in the channel upstream of the Basin D control structure to where it doesn't meet the freeboard requirement for approximately 2,000 feet upstream. To address this gap, the west bank of the channel would be raised to provide adequate freeboard on the street side. On the park side, providing the freeboard would not be as critical since any excess flow would spill into the park and eventually into one of the basins.

In order to provide adequate freeboard on the west side, the west bank would be raised by a maximum of 2 feet. However, during design, the side weir crest could be lowered with a corresponding decrease in channel water surface elevation. It is expected that this, in combination with optimizing the channel cross section, and basin volume may result in little or no additional space needed for the channel to meet both the freeboard and attenuation requirements.

To test this presumption, a sensitivity analysis was performed to evaluate the effects of lowering the weir and of modeling the basins as off line basins. The weir in the HEC-RAS model was lowered by 1.9 feet and adjustments were made to the control structures using the same weir parameters (length, weir coefficient, and approach channel configuration). This caused the water surface to drop as much as 2 feet near the weir and almost 1.2 feet near station 51+00. Although some level of submergence would be expected under this condition, an optimization exercise during final design would achieve a balance between weir crest, basin, and channel bank elevations.

The refined HEC-1 with the Basins B and D modeled as off line show that 18 acre feet volume in Basin B was not used. Also, the water surface in Basin D only reached 3.6 feet above the bottom of the basin (0.5 feet above the weir crest). Since Basin D is 5 feet deep, we didn't use all the available volume. The system could be further revised by taking more flow into Basin B which further reduces the volume required in Basin D and the amount of flow between Basin B and D, and reduces the flow that would need to be

diverted into Basin D. This would further improve the freeboard conditions in the channel upstream of Basin D. See **Attachment 3** for freeboard calculations.

The sensitivity analysis is documented in **Appendix B1** in a separate folder (Potential Final Design Refinements) on the project CD to demonstrate potential refinements during design that may reduce or even eliminate the need for raising the channel bank to meet freeboard requirements.

The profile plots for the East Park Sports Complex Channel are included in Conceptual plan and profile sheets and the HEC-RAS models are included in the CD in **Attachment 2**.

Meridian Channel

The Meridian Channel improvements were only modeled for the area upstream of Germann Road. Because of this, several different profiles were required to determine the hydraulic conditions of the channel. These conditions were modeled in the following HEC-RAS plans:

1. Meridian Unobstructed
2. Meridian No-Split
3. Meridian Split Obstructed
4. Meridian Weir without Obstruction
5. Meridian Channel Outflow Improvements

The first profile (Meridian Unobstructed plan) models the reach upstream of Germann Road assuming there is no significant backwater effect from the downstream channel. The downstream cross sections were removed and replaced with ones similar to those used on the upstream reach. This profile demonstrates that the channel can carry the flow once an adequate outfall channel is constructed.

The second profile (Meridian No-Split plan) includes a lateral weir with optimization to determine flows that would break away from the channel prior to the construction of the downstream outfall channel. This model reveals that most of the flow would overtop the channel and flow west in the vicinity of Germann Road. Also, it was discovered that there is an earthen obstruction (Meridian Split Obstructed plan), which appears to be a

driveway filled across the channel, just north of Germann Road. This prevents runoff from the proposed channel to flow north in the existing channel.

A profile (Meridian Weir without Obstruction plan) was created to remove this obstruction, which allows for approximately 70 cfs flowing north.

The final profile (Meridian Channel Outflow Improvements) was modeled to verify that flows from the Meridian Channel could be drained into the proposed Pecos Basin near Pecos Road and Meridian Road. The channel geometry downstream of the Germann Road structure was assumed to be a trapezoidal section 6 feet deep and a bottom width of 40 feet. The results showed that the three cross-sections upstream of Germann Road do not have sufficient freeboard. This is a localized issue caused by a bend in the channel which could be mitigated in the final design with additional grading.

The profile plots for the Meridian Channel are included in the Conceptual plans and profile sheets and the HEC-RAS models are included in the CD in **Attachment 2**.

4.8.2 Effects of Recommended Alternative on the Rittenhouse Channel

The improvements for the recommended alternative include the channels described above, the additional retention requirement, and the basin on the East Park Sports Complex. These improvements are intended to resolve capacity issues in the existing Rittenhouse Channel. **Table 4.8** shows the capacity of the existing channel, the flows under future conditions, and the flows under future conditions with proposed improvements. As shown in the table, the proposed alternative resolves the capacity issues along the Rittenhouse Channel.

Table 4.8 - Structure & Channel Capacity Flows

Location	Channel Design Capacity (cfs)	Concentration Point	Future Conditions 100-year Discharge (cfs)	Future Conditions with Recommended Improvements 100-year Discharge (cfs)
East of Ellsworth Rd	520	CPR18	910	470
Ellsworth Rd to near Hawes Rd alignment	810	CPR22	890	450
Near Hawes Rd alignment to Germann Rd	1050	CPR21	1520	600
Germann Rd to south of Pecos Rd	1400	CPR25	1480	640
Power Rd and Pecos Rd to EMF	1500	CPR24	1530	700

ATTACHMENT 1: HEC-RAS OUTPUT

Electronic version on CD

ATTACHMENT 2: CD

ATTACHMENT 3: FREEBOARD CALCULATIONS

Entellus

Entellus
Project: East Mesa ADMPU
Project Number: FCD2011C017

Sports Complex Channel

Conceptual Design

HEC-RAS X-Sect [ft]	Channel Invert Elevation [ft]	Ground Elevation Right Bank [ft]	Ground Elevation Left Bank [ft]	Flow [cfs]	Flow Depth [ft]	Velocity [fps]	Min Fb [ft]	FB (calc) [ft]	FB Required [ft]	Total Minimum Channel Depth [ft]	Top of Bank Elevation Required [ft]	Required Embankment Height Right Bank [ft]	Required Embankment Height Left Bank [ft]
7637.407	1424.2	1430.6	1430.8	1380.0	5.55	2.67	1.00	1.42	1.42	6.97	1431.15	0.51	0.31
7478.934	1423.9	1430.3	1430.5	1380.0	5.39	4.48	1.00	1.43	1.43	6.82	1430.68	0.34	0.19
7468.760				Inl Struct									
7458.934	1423.8	1430.4	1430.5	1380.0	5.32	4.63	1.00	1.41	1.41	6.73	1430.55	0.14	0.06
7158.933	1423.2	1429.7	1429.6	1380.0	5.62	2.62	1.00	1.43	1.43	7.05	1430.27	0.62	0.64
7063.376	1423.0	1429.5	1429.5	1380.0	5.39	4.74	1.00	1.43	1.43	6.82	1429.85	0.40	0.36
7058.376				Culvert									
6933.376	1422.8	1429.0	1429.0	1380.0	5.25	4.86	1.00	1.40	1.40	6.65	1429.42	0.47	0.46
6858.931	1422.6	1428.8	1428.9	1380.0	5.44	2.74	1.00	1.39	1.39	6.83	1429.45	0.62	0.57
6708.931	1422.3	1428.4	1428.5	1380.0	5.62	2.62	1.00	1.43	1.43	7.05	1429.37	1.01	0.91
6608.931				Lat Struct									
6558.930	1422.0	1427.8	1427.8	944.2	5.18	5.71	1.00	1.42	1.42	6.60	1428.62	0.80	0.83
6548.930				Inl Struct									
6538.930	1422.0	1427.9	1427.9	944.2	4.66	7.57	1.00	1.39	1.39	6.05	1428.03	0.15	0.17
6258.929	1421.4	1427.4	1427.4	944.2	4.05	2.76	1.00	1.04	1.04	5.09	1426.51	-0.84	-0.85
5958.928	1420.8	1426.4	1426.4	944.2	4.35	2.52	1.00	1.11	1.11	5.46	1426.28	-0.08	-0.09
5658.923	1420.2	1425.3	1425.3	944.2	4.66	2.60	1.00	1.19	1.19	5.85	1426.07	0.74	0.73
5414.045	1419.9	1424.6	1424.7	944.2	4.73	2.55	1.00	1.21	1.21	5.94	1425.86	1.27	1.15
5160.748	1419.6	1423.9	1424.2	944.2	4.82	2.49	1.00	1.23	1.23	6.05	1425.67	1.76	1.45
4877.038	1419.3	1423.8	1424.1	944.2	4.93	2.41	1.00	1.26	1.26	6.19	1425.47	1.71	1.35
4699.423	1419.1	1423.9	1424.2	944.2	5.01	2.35	1.00	1.27	1.27	6.28	1425.35	1.50	1.11
4594.423				Lat Struct									
4368.500	1418.7	1423.9	1424.2	327.1	4.25	6.81	1.00	1.24	1.24	5.49	1424.16	0.29	-0.08
4363.500				Culvert									
4343.499	1418.6	1423.9	1424.2	327.1	2.96	9.78	1.00	1.11	1.11	4.07	1422.71	-1.17	-1.52
4277.002	1418.5	1423.9	1424.2	327.1	2.45	1.79	1.00	0.62	1.00	3.45	1421.96	-1.94	-2.27
3976.984	1417.9	1423.7	1424.0	327.1	2.85	1.51	1.00	0.72	1.00	3.85	1421.78	-1.92	-2.22
3676.966	1417.3	1423.6	1423.8	327.1	3.16	2.41	1.00	0.81	1.00	4.16	1421.50	-2.10	-2.30

Cross Section	Required FB [ft]	FB Provided Below Grade Right Bank [ft]	FB Provided Below Grade Left Bank [ft]	FB Provided Above Grade Right Bank [ft]	FB Provided Above Grade Left Bank [ft]	Total Channel Width [ft]
7637.407	1.42	0.91	1.11	0.51	0.31	159
7478.934	1.43	1.09	1.24	0.34	0.19	155
7468.760	Inl Structure					
7458.934	1.41	1.27	1.35	0.14	0.06	152
7158.933	1.43	0.81	0.79	0.62	0.64	162
7063.376	1.43	1.03	1.07	0.40	0.36	156
7058.376	Culvert					
6933.376	1.40	0.93	0.94	0.47	0.46	155
6858.931	1.39	0.77	0.82	0.62	0.57	159
6708.931	1.43	0.42	0.52	1.01	0.91	166
6608.931	Lateral Weir					
6558.930	1.42	0.62	0.59	0.80	0.83	159
6548.930	Inl Structure					
6538.930	1.39	1.24	1.22	0.15	0.17	145
6258.929	1.04	1.88	1.89	0.00	0.00	131
5958.928	1.11	1.19	1.20	0.00	0.00	127
5658.923	1.19	0.45	0.46	0.74	0.73	149
5414.045	1.21	0.00	0.06	1.27	1.15	156
5160.748	1.23	0.00	0.00	1.76	1.45	162
4877.038	1.26	0.00	0.00	1.71	1.35	163
4699.423	1.27	0.00	0.16	1.50	1.11	161
4594.423	Lateral Structure					
4368.500	1.24	0.95	1.32	0.29	0.00	133
4363.500	Culvert					
4343.499	1.11	2.28	2.63	0.00	0.00	125
4277.002	1.00	2.94	3.27	0.00	0.00	127
3976.984	1.00	2.92	3.22	0.00	0.00	131
3676.966	1.00	3.10	3.30	0.00	0.00	136

Potential Design Refinements

HEC-RAS X-Sect [ft]	Flow [cfs]	Flow Depth [ft]	Velocity [fps]	Min Fb [ft]	FB (calc) [ft]	FB Required [ft]	Total Minimum Channel Depth [ft]	Top of Bank Elevation Required [ft]	Required Embankment Height Right Bank [ft]	Required Embankment Height Left Bank [ft]
7637.407	1380.0	5.55	2.67	1.00	1.42	1.42	6.97	1431.15	0.51	0.31
7478.934	1380.0	5.39	4.48	1.00	1.43	1.43	6.82	1430.68	0.34	0.19
7468.760	Inl Struct									
7458.934	1380.0	5.32	4.63	1.00	1.41	1.41	6.73	1430.55	0.14	0.06
7158.933	1380.0	5.62	2.62	1.00	1.43	1.43	7.05	1430.27	0.62	0.64
7063.376	1380.0	5.39	4.74	1.00	1.43	1.43	6.82	1429.85	0.40	0.36
7058.376	Culvert									
6933.376	1380.0	5.25	4.87	1.00	1.40	1.40	6.65	1429.42	0.47	0.46
6858.931	1380.0	5.44	2.74	1.00	1.39	1.39	6.83	1429.45	0.62	0.57
6708.931	1380.0	5.62	2.62	1.00	1.43	1.43	7.05	1429.37	1.01	0.91
6608.931	Lat Struct									
6558.930	944.2	5.19	5.71	1.00	1.42	1.42	6.61	1428.63	0.81	0.84
6548.930	Inl Struct									
6538.930	944.2	4.66	7.54	1.00	1.39	1.39	6.05	1428.03	0.15	0.17
6258.929	944.2	3.63	3.18	1.00	0.95	1.00	4.63	1426.05	-1.30	-1.31
5958.928	944.2	3.71	3.09	1.00	0.96	1.00	4.71	1425.53	-0.83	-0.84
5658.923	944.2	3.85	2.95	1.00	1.00	1.00	4.85	1425.07	-0.26	-0.27
5414.045	944.2	3.78	3.03	1.00	0.98	1.00	4.78	1424.70	0.11	-0.01
5160.748	944.2	3.63	3.18	1.00	0.95	1.00	4.63	1424.25	0.34	0.03
4877.038	944.2	3.34	3.54	1.00	0.88	1.00	4.34	1423.62	-0.14	-0.50
4699.423	944.2	2.90	4.20	1.00	0.79	1.00	3.90	1422.97	-0.88	-1.27
4594.423	Lat Struct									
4368.500	336.4	2.57	2.18	1.00	0.66	1.00	3.57	1422.24	-1.63	-2.00
4363.500	Culvert									
4343.499	336.4	2.42	2.31	1.00	0.63	1.00	3.42	1422.06	-1.82	-2.17
4277.002	336.4	2.50	1.80	1.00	0.64	1.00	3.50	1422.01	-1.89	-2.22
3976.984	336.4	2.90	1.52	1.00	0.73	1.00	3.90	1421.83	-1.87	-2.17
3676.966	336.4	3.20	2.44	1.00	0.82	1.00	4.20	1421.54	-2.06	-2.26

Cross Section	Required FB [ft]	FB Provided Below Grade Right Bank [ft]	FB Provided Below Grade Left Bank [ft]	FB Provided Above Grade Right Bank [ft]	FB Provided Above Grade Left Bank [ft]	Total Channel Width [ft]
7637.407	1.42	0.91	1.11	0.51	0.31	159
7478.934	1.43	1.09	1.24	0.34	0.19	155
7468.760	Inl Structure					
7458.934	1.41	1.27	1.35	0.14	0.06	152
7158.933	1.43	0.81	0.79	0.62	0.64	162
7063.376	1.43	1.03	1.07	0.40	0.36	156
7058.376	Culvert					
6933.376	1.40	0.93	0.94	0.47	0.46	155
6858.931	1.39	0.77	0.82	0.62	0.57	159
6708.931	1.43	0.42	0.52	1.01	0.91	166
6608.931	Lateral Weir					
6558.930	1.42	0.61	0.58	0.81	0.84	159
6548.930	Inl Structure					
6538.930	1.39	1.24	1.22	0.15	0.17	145
6258.929	1.00	2.30	2.31	0.00	0.00	131
5958.928	1.00	1.83	1.84	0.00	0.00	127
5658.923	1.00	1.26	1.27	0.00	0.00	121
5414.045	1.00	0.89	1.01	0.11	0.00	123
5160.748	1.00	0.66	0.97	0.34	0.03	128
4877.038	1.00	1.14	1.50	0.00	0.00	116
4699.423	1.00	1.88	2.27	0.00	0.00	120
4594.423	Lateral Structure					
4368.500	1.00	2.63	3.00	0.00	0.00	125
4363.500	Culvert					
4343.499	1.00	2.82	3.17	0.00	0.00	125
4277.002	1.00	2.89	3.22	0.00	0.00	127
3976.984	1.00	2.87	3.17	0.00	0.00	131
3676.966	1.00	3.06	3.26	0.00	0.00	136

Registered Professional Engineer (Civil)
CERTIFICATE NO. 46866
RYAN ANDREW SAUER
Date Signed 12/10/13
ARIZONA, U.S.A.
EXPIRES: 09/30/16

Registered Professional Engineer (Civil)
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Expires: 6/30/15

TECHNICAL MEMORANDUM – SEDIMENT YIELD ANALYSIS FOR QUEEN CREEK SPORTS COMPLEX BASIN

EAST MESA AREA DRAINAGE MASTER PLAN UPDATE

December, 2013

The purpose of this memorandum is to present the findings of the sediment yield analysis for the future Queen Creek Sports Complex basin to be located northeast of the intersection of Queen Creek Road and Merrill Road. The sediment yield follows procedures described in the Flood Control District of Maricopa County's (District) *River Mechanics Manual*. The implementation of the above-mentioned methodology was accomplished through *Drainage Design Management System for Windows* (DDMSW) computer program.

The sediment yield consists of two parts and is defined as the sum of the wash load and the total bed material load delivered to a point of interest. The Modified Universal Soil Loss Equation (MUSLE) method was utilized to estimate the sediment wash load of the project area. Parameters used to determine wash load consist of peak flow rate and runoff volume for a storm event of a particular return period, erosion control practice, cover and management data, and topographic characteristics of the watershed.

The Zeller-Fullerton total bed material load equation was used to estimate the total sediment bed load of the project area. The Zeller-Fullerton method is a regression sediment transport equation for a variety of channel bed and alluvial floodplain conditions. Parameters used to determine the total bed material load consist of hydraulic depth, flow velocity, roughness coefficient and soil gradation data. For a more detail description of the methodology utilized in this analysis refer to the *River Mechanics Manual.*

The sediment yield was estimated for the future and existing development conditions. The proposed Sports Complex Basin will receive flows from two offsite areas in Pinal County. These areas have been modeled in HEC-1 and are concentration points CPR10 and CPR9. Both of these concentration points are just upstream of the Sports Complex at Meridian Road.

The sediment yield was estimated for these two drainage areas. The first contributing area draining to concentration point CPR10 includes HEC-1 subbasins R1, R4, R7 and R10. The second contributing area draining to concentration point CPR9 includes subbasins R2, R3, R6 and R9. Both of the above referenced concentration points drain into the proposed Queen Creek Sport Complex basin. The future and the existing HEC-1 modeling results for the 100-, 50-, 25-, 10-, 5-, and 2-year return periods, 24-hour duration for the East Mesa ADMPU were utilized in the sediment yield analysis, and peak discharges and runoff volumes for CPR9 and CPR10 were taken from the output of the respective HEC-1 models.

In addition, the HEC-1 cross-section for routes R10R12 (corresponding to CPR10) and R9R11 (corresponding to CPR9) were used to estimate the hydraulic radius, average velocity and

channel width. Soil survey AZ661 was used to determine the soil erodibility factor for soils within Pinal County. Sediment gradation data used in this investigation was obtained from sieve analysis. Soil samples were collected under a different task of the East Mesa ADMPU project and the results are documented in the *Erosion Analysis Memorandum*. Sediment gradation data utilized to determine the sediment yield was taken from soil sample B4 which is located along Meridian Road between Ryan and Germann Roads.

The slope length (λ) which represents the length at which deposition starts to occur, is difficult to estimate for this watershed since the entire watershed slope is below the threshold when deposition is likely to occurs. Using aerial photography and topographic data it was concluded that the contributing area has a general ground slope of approximately 0.5 percent and a slope length of approximately 650 feet. This slope length was assumed to be the approximate length of the prevailing existing lots within the contributing drainage area. A sensitivity analysis was performed on the slope length, using lengths ranging from 150 feet up to 650 feet and it was determined that the Annual and 100-year sediment yield was not very sensitive to the slope length. A longer slope length assumption is slightly more conservative, so the longer length was utilized for this analysis.

The ***Table 1 - Sensitivity Analysis*** below compares the Annual Total Sediment Yield and the 100-year Total Sediment yield for three slope lengths: 650 ft, 325 ft & 150 ft.

Location	Annual Sediment Yield (Future Conditions) [ac-ft]			100-Year Sediment Yield (Future Conditions) [ac-ft]		
	λ=650 ft	λ=325 ft	λ=150 ft	λ=650 ft	λ=325 ft	λ=150 ft
CPR10	0.102	0.093	0.083	1.216	1.105	0.994
CPR9	0.096	0.090	0.084	0.690	0.632	0.574

Table 1 – Sensitivity Analysis

A summary of the Annual Sediment Yield results and the 100-Year Sediment Yield results at both CPR10 and CPR9 for a slope length of 650 ft are presented in ***Table 2 – Sediment Yield Results*** below. Results show that the total sediment yield is higher for the future conditions model. In addition, DDMSW models and output files are included as attachments to this memorandum.

Location	Development Condition	Annual Sediment Yield [ac-ft]			100-Year Sediment Yield [ac-ft]		
		Wash Load	Bed Load	Total Yield	Wash Load	Bed Load	Total Yield
CPR10	Existing	0.082	0.008	0.090	0.838	0.095	0.933
CPR9		0.035	0.007	0.042	0.219	0.040	0.259
CPR10	Future	0.052	0.050	0.102	0.629	0.587	1.216
CPR9		0.036	0.060	0.096	0.328	0.362	0.690

Table 2 – Sediment Yield Results

Sediment Yield Analysis Review Summary

Memo From JEF

JE FULLER
HYDROLOGY & GEOMORPHOLOGY, INC.

DEFINE | COMMUNICATE | SOLVE

Memorandum

DATE: December 9, 2013
TO: Ryan Sauer – Entellus
FROM: Mike Kellogg, RG, CFM
RE: EMADMP Sediment Yield Analysis Review

Mr. Sauer,

This memorandum comprises the summary of my review of the Sediment Yield Analysis for the EMADMP. The following data was provided for review:

- *Draft Sediment Yield Analysis* technical analysis dated December 2013
- DDMSW database files for:
  - Existing Conditions
  - Future Conditions
- Shapefiles of the following:
  - Existing Land Use
  - Future Land Use
  - NRCS Soils
  - Drainage Basins
- DDMSW Output Tables

Data used in the analysis that was not provided, thus not reviewed:

- HEC-1 input or output files
- Project topography
- Sediment sample sieve analyses

Conclusions

The revised DDMSW database files and technical memorandum provided to JE Fuller Hydrology & Geomorphology, Inc. (JEF) on December 9th 2013 were also reviewed on December 9th. Based on the data sets provided, the DDMSW analysis was done correctly and the sediment yield estimates are reasonable.

Sincerely,

Mike Kellogg, RG, CFM

Soil Samples

Aerial Photograph Source: FCDMC, 2012.
Note: Dimensions directions and locations are approximate.

EAST MESA
AREA DRAINAGE
MASTER PLAN UPDATE
FCD 2011C017

LEGEND

B-12 Sample Location

NORTH

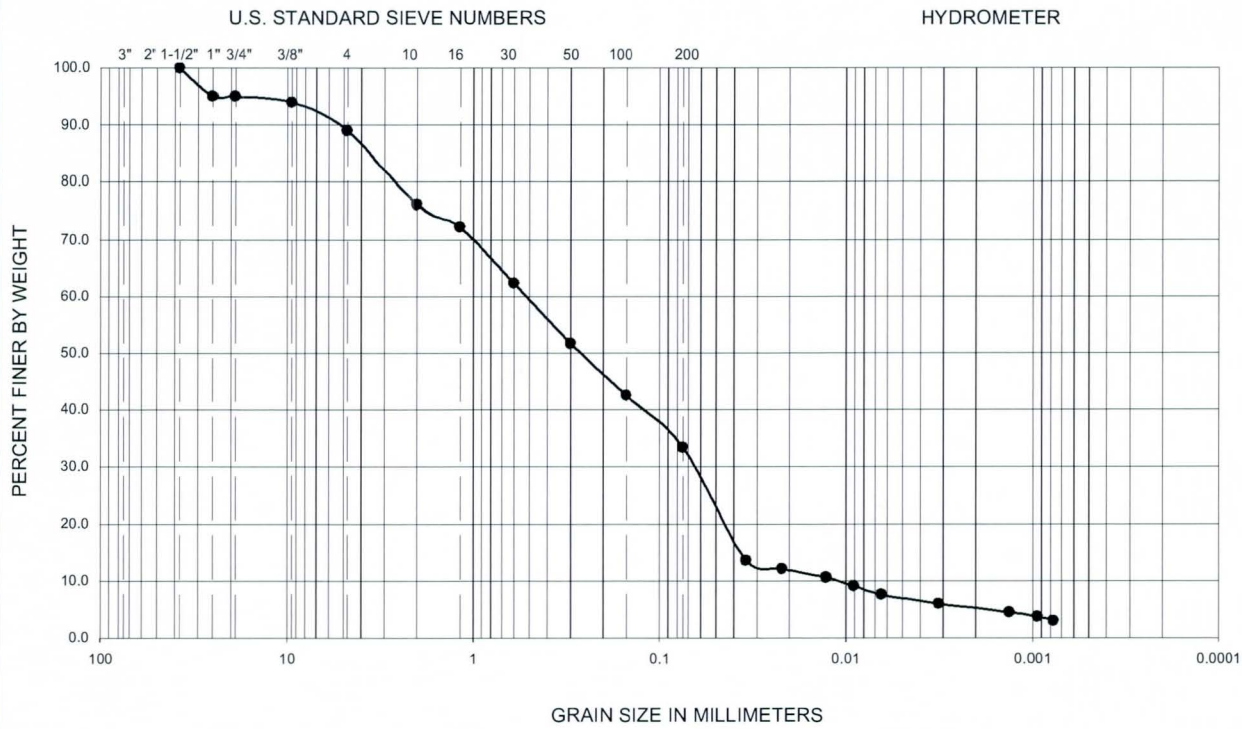
0 6000
Approximate Scale:

Entellus
2255 N. 44th Street Suite 125
Phoenix, Arizona 85008-3299
Tel. 602.244.2566
Fax. 602.244.8947
Web. www.entellus.com

epg
Ninyo & Moore
JE FULLER

SAMPLE LOCATIONS

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

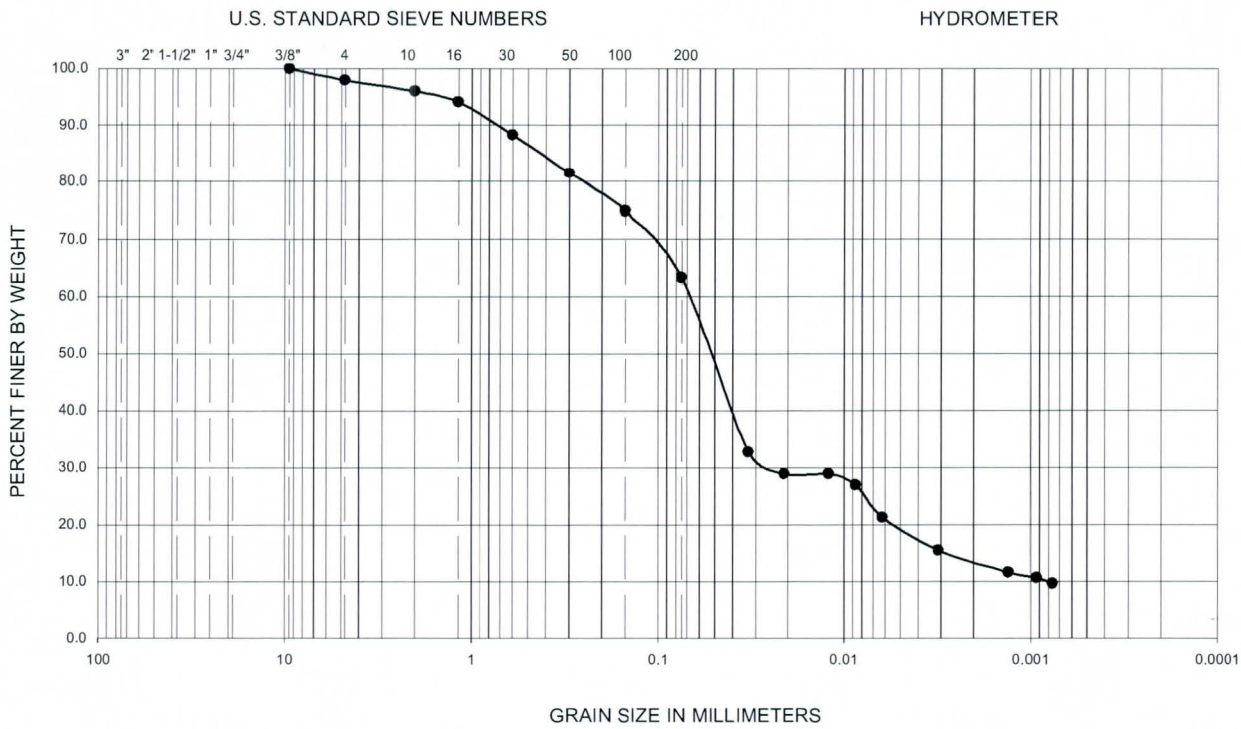


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{50}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-1	0-1.5	--	--	--	--	--	0.260	--	--	33	SC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	EAST MESA AREA DRAINAGE MASTER PLAN UPDATE MARICOPA AND PINAL COUNTIES, ARIZONA	A-1
603640001 / 7/12	CONTRACT FCD 2011C017; ENTELLUS PROJECT NO. 310.057; N&M TASK NO. 3.3.3.12	

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

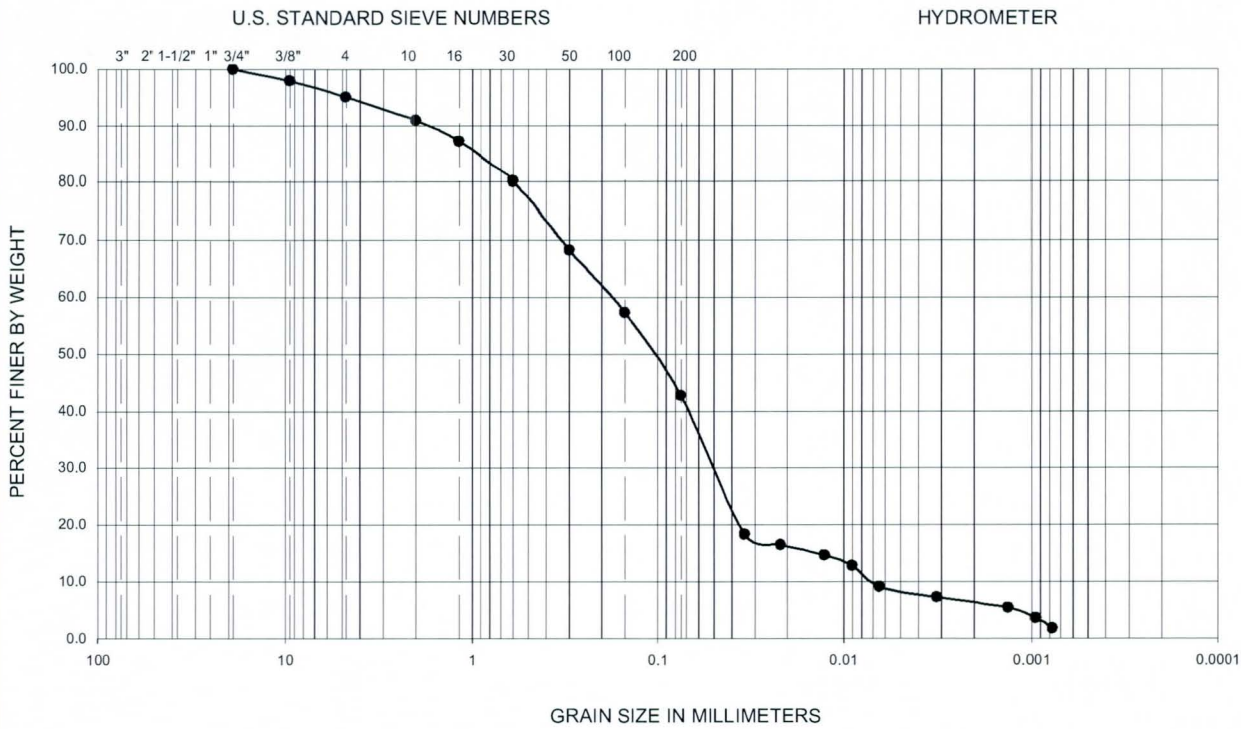


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{50}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-2	0-1	--	--	--	--	--	0.052	--	--	63	CL

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	EAST MESA AREA DRAINAGE MASTER PLAN UPDATE MARICOPA AND PINAL COUNTIES, ARIZONA	A-2
603640001 / 7/12	CONTRACT FCD 2011C017; ENTELLUS PROJECT NO. 310.057; N&M TASK NO. 3.3.3.12	

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

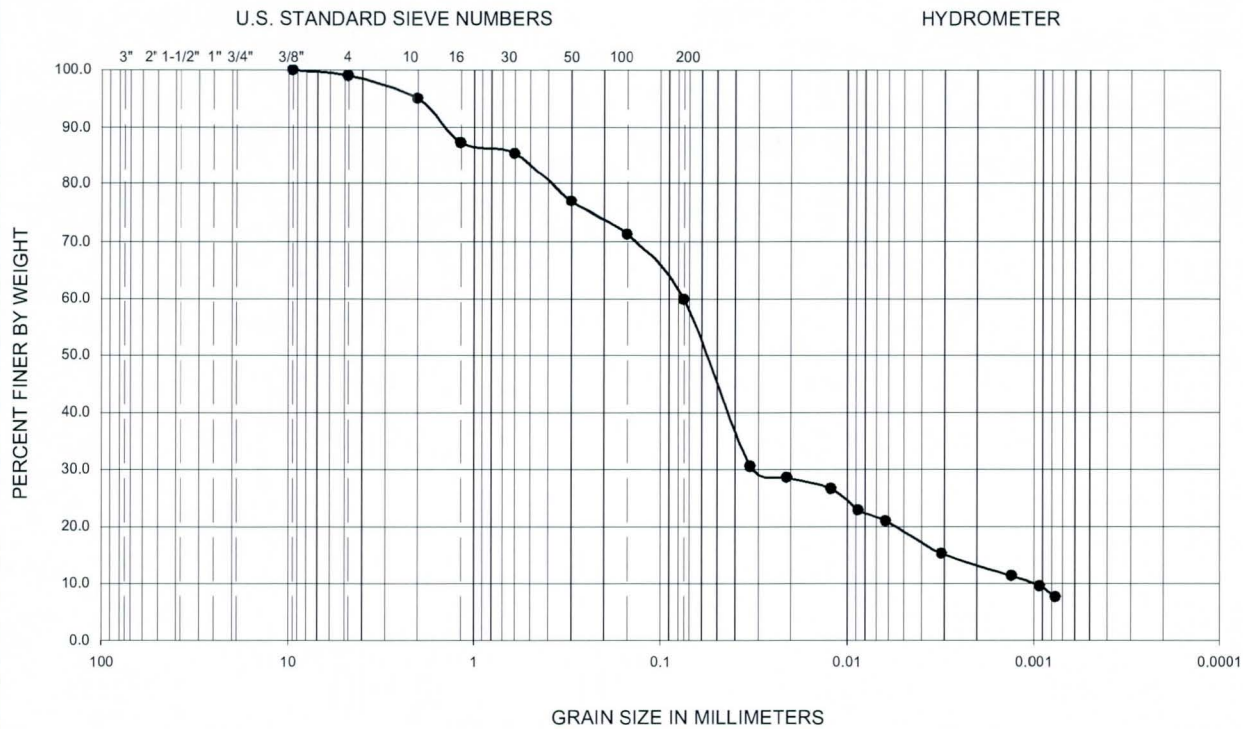


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{50}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-3	0-1	--	--	--	--	--	0.105	--	--	43	SC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	EAST MESA AREA DRAINAGE MASTER PLAN UPDATE MARICOPA AND PINAL COUNTIES, ARIZONA	A-3
603640001 / 7/12	CONTRACT FCD 2011C017; ENTELLUS PROJECT NO. 310.057; N&M TASK NO. 3.3.3.12	

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

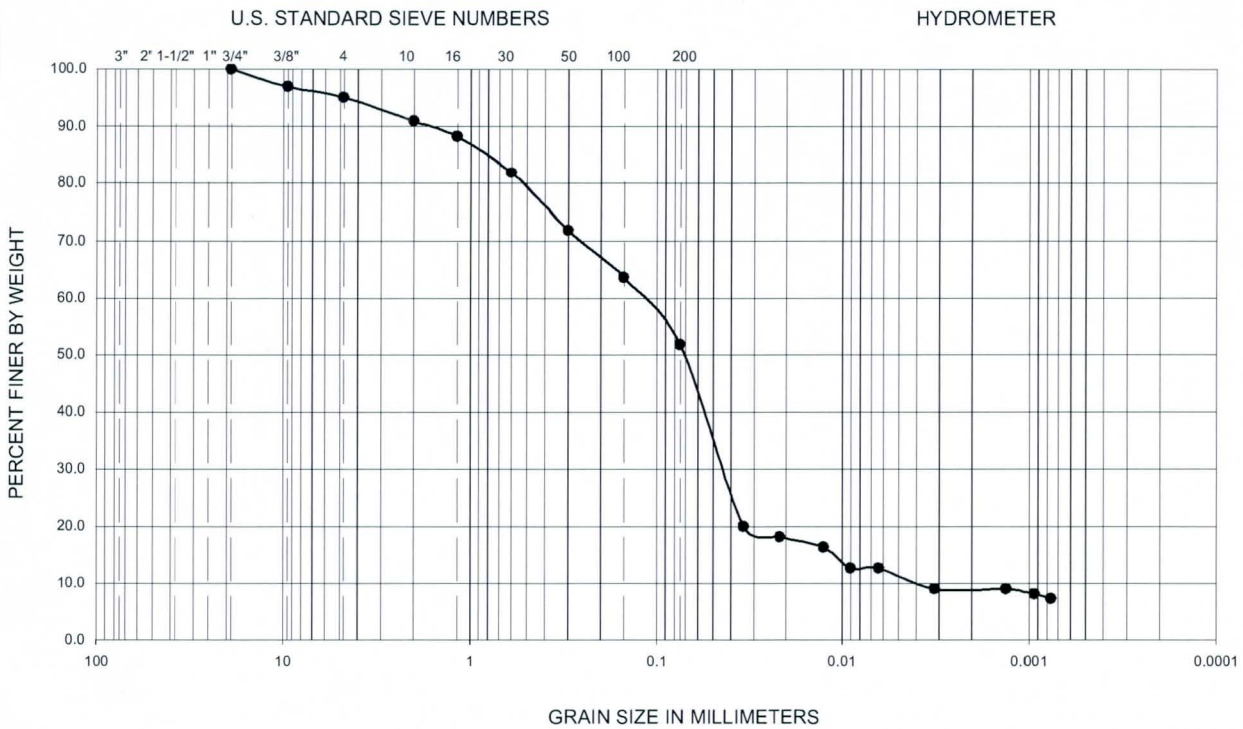


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{50}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-4	0-1	--	--	--	--	--	0.056	--	--	60	CL

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. 603640001 / DATE 7/12	EAST MESA AREA DRAINAGE MASTER PLAN UPDATE MARICOPA AND PINAL COUNTIES, ARIZONA CONTRACT FCD 2011C017; ENTELLUS PROJECT NO. 310.057; N&M TASK NO. 3.3.3.12	A-4

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

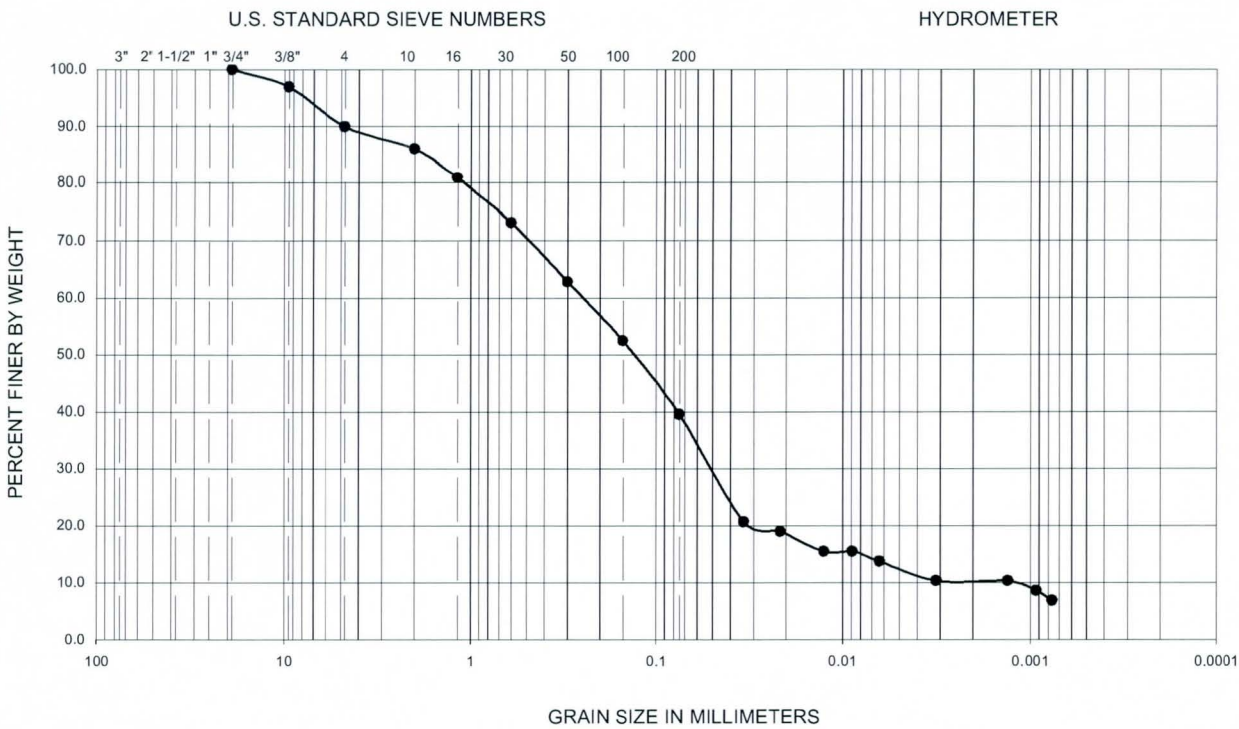


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{50}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-5	0-1	--	--	--	--	--	0.071	--	--	52	ML

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. 603640001 / DATE 7/12	EAST MESA AREA DRAINAGE MASTER PLAN UPDATE MARICOPA AND PINAL COUNTIES, ARIZONA CONTRACT FCD 2011C017; ENTELLUS PROJECT NO. 310.057; N&M TASK NO. 3.3.3.12	A-5

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

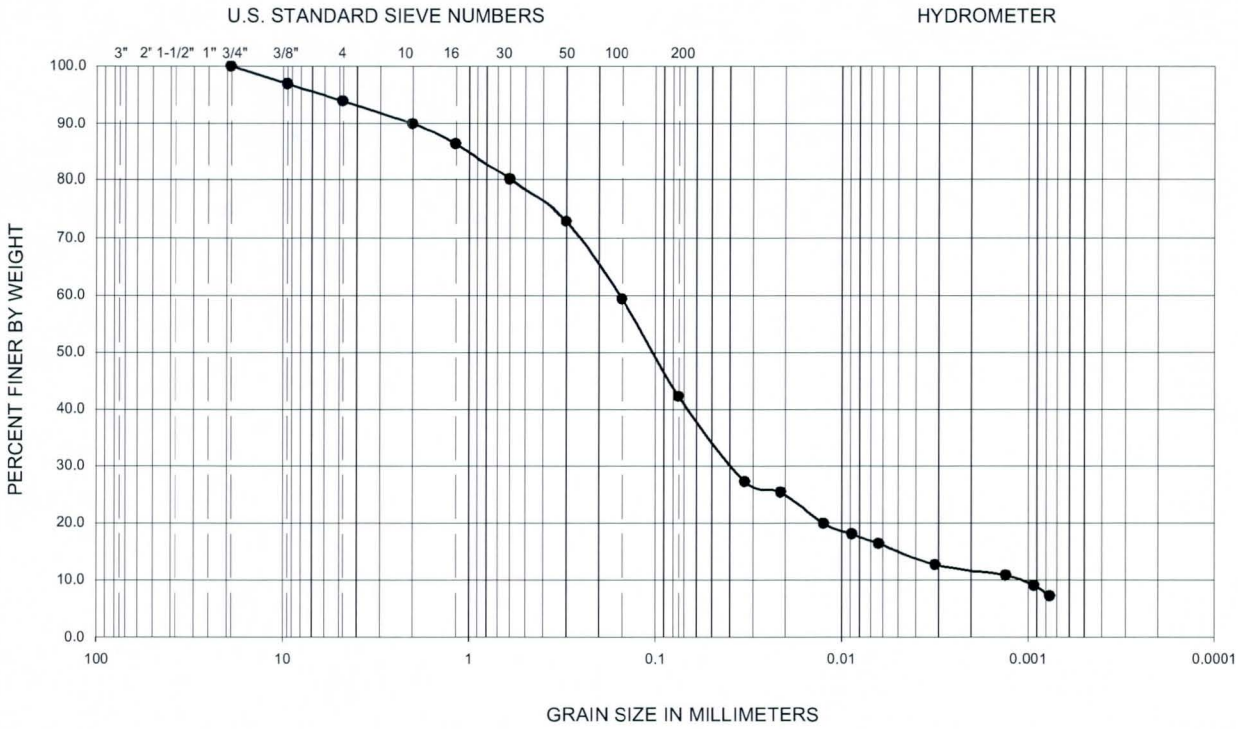


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{50}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-6	0-1	--	--	--	--	--	0.130	--	--	40	SC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	EAST MESA AREA DRAINAGE MASTER PLAN UPDATE MARICOPA AND PINAL COUNTIES, ARIZONA	A-6
603640001 / 7/12	CONTRACT FCD 2011C017; ENTELLUS PROJECT NO. 310.057; N&M TASK NO. 3.3.3.12	

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

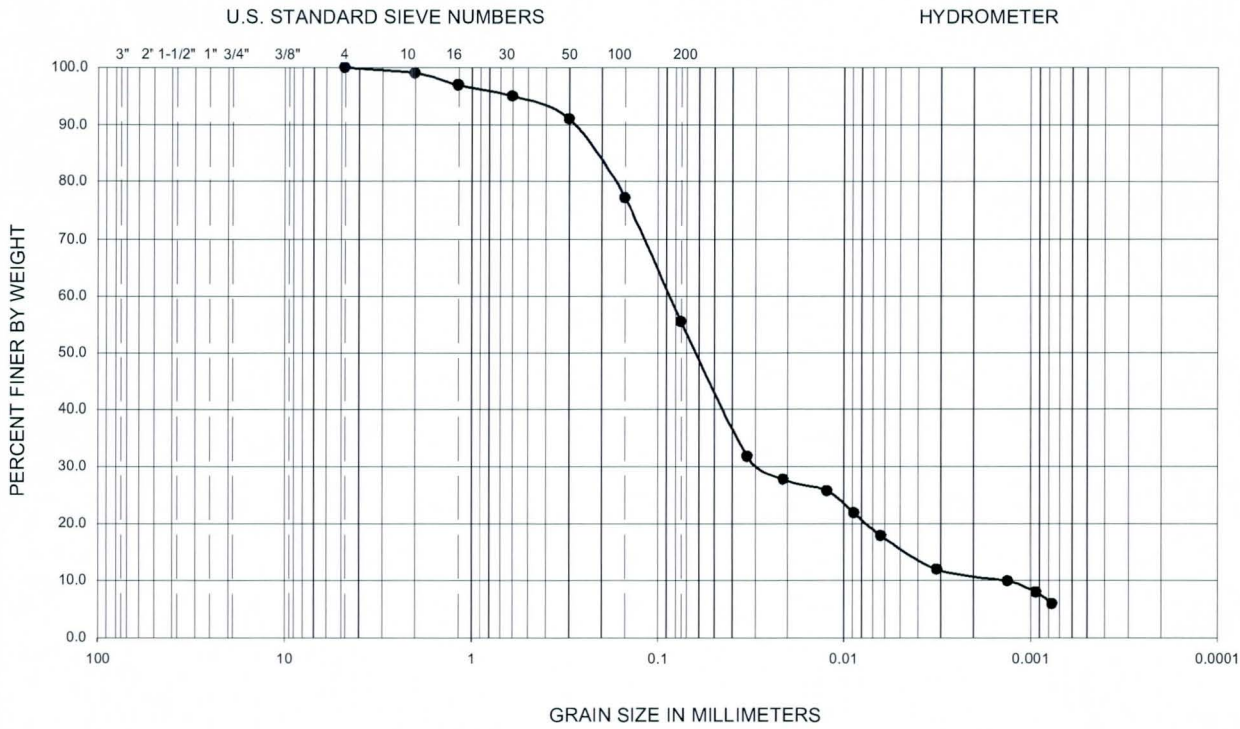


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{50}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-7	0-1	--	--	--	--	--	0.105	--	--	42	SC

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	EAST MESA AREA DRAINAGE MASTER PLAN UPDATE MARICOPA AND PINAL COUNTIES, ARIZONA	A-7
603640001 / 7/12	CONTRACT FCD 2011C017; ENTELLUS PROJECT NO. 310.057; N&M TASK NO. 3.3.3.12	

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_{50}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-8	0-1	--	--	--	--	--	0.061	--	--	55	ML

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	EAST MESA AREA DRAINAGE MASTER PLAN UPDATE MARICOPA AND PINAL COUNTIES, ARIZONA	A-8
603640001 / 7/12	CONTRACT FCD 2011C017; ENTELLUS PROJECT NO. 310.057; N&M TASK NO. 3.3.3.12	

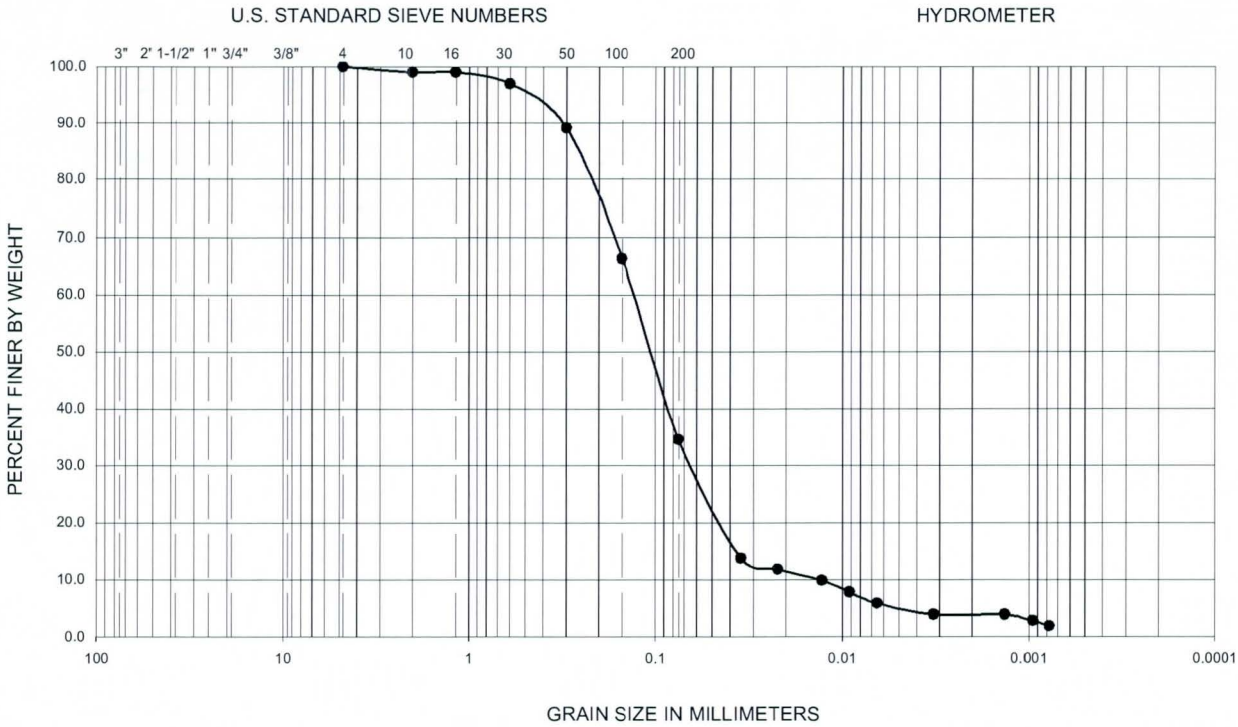
GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{50}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-9	0.3-1.3	--	--	--	--	--	0.081	--	--	47	SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	EAST MESA AREA DRAINAGE MASTER PLAN UPDATE MARICOPA AND PINAL COUNTIES, ARIZONA	A-9
603640001 / 7/12	CONTRACT FCD 2011C017; ENTELLUS PROJECT NO. 310.057; N&M TASK NO. 3.3.3.12	

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

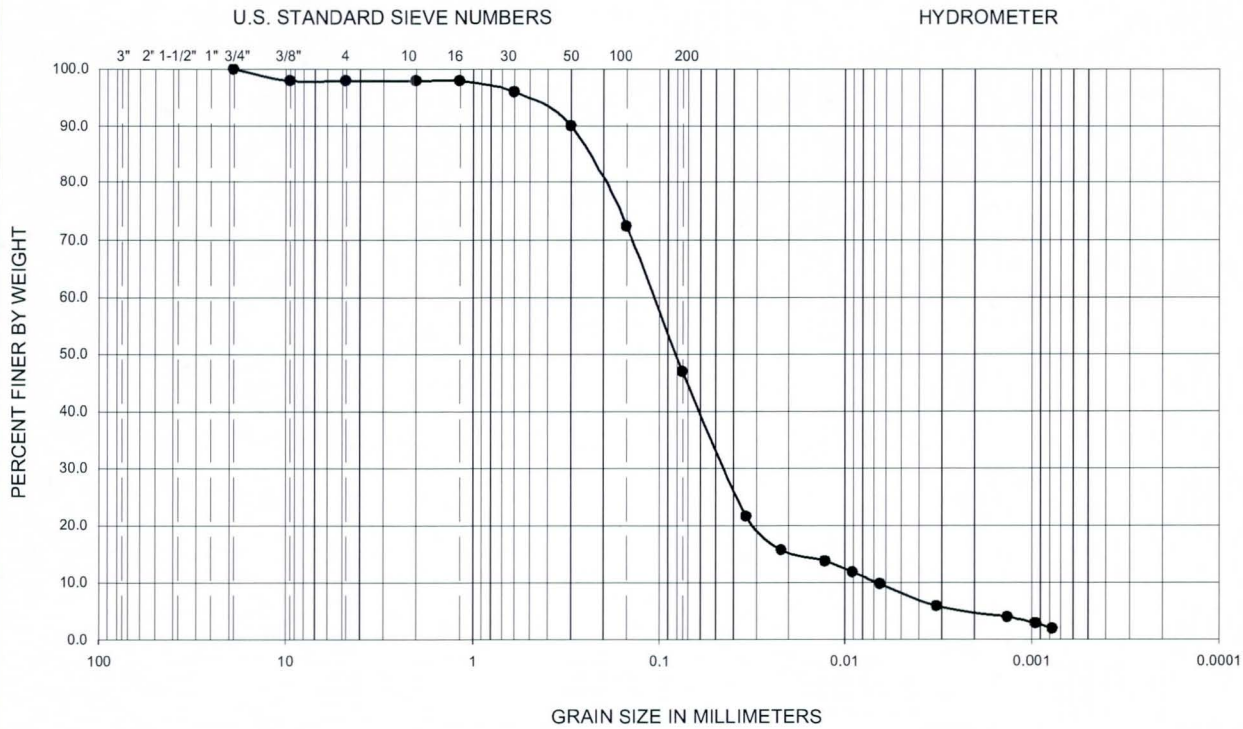


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{50}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-10	0-1	--	--	--	--	--	0.110	--	--	35	SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	EAST MESA AREA DRAINAGE MASTER PLAN UPDATE MARICOPA AND PINAL COUNTIES, ARIZONA	A-10
603640001 / 7/12	CONTRACT FCD 2011C017; ENTELLUS PROJECT NO. 310.057; N&M TASK NO. 3.3.3.12	

GRAVEL		SAND			FINES	
Coarse	Fine	Coarse	Medium	Fine	SILT	CLAY

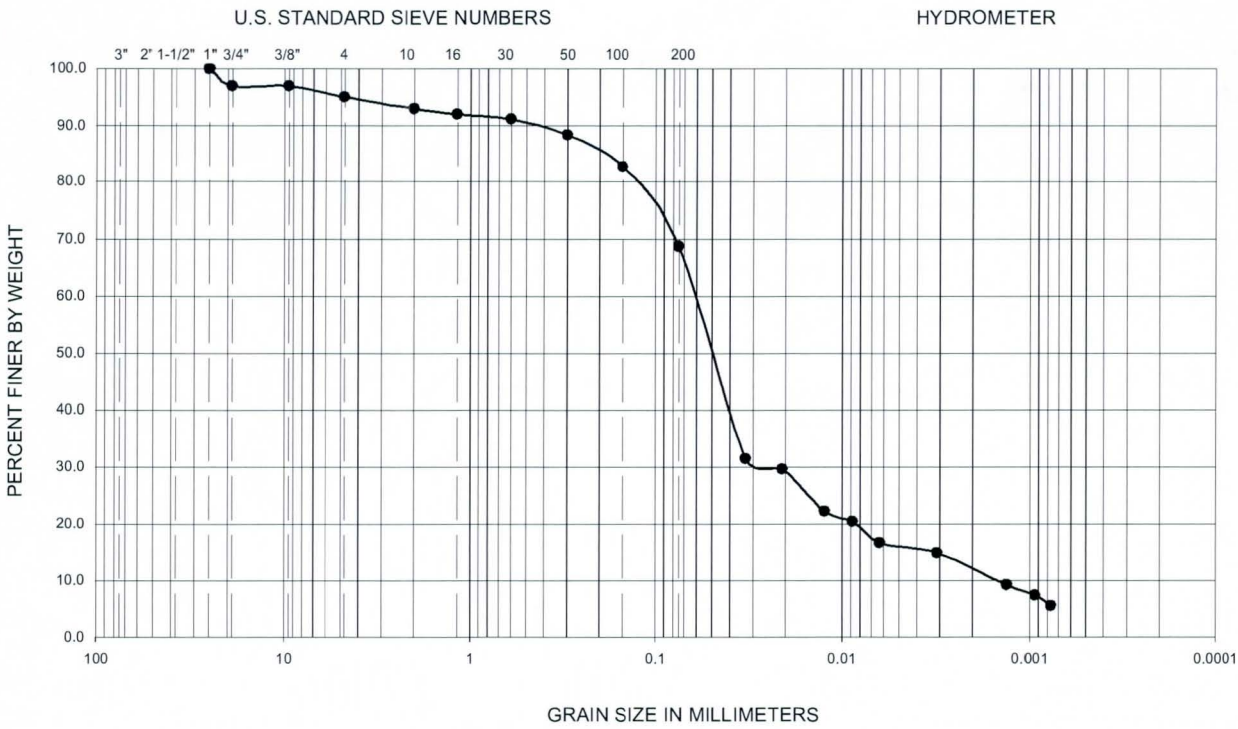


Symbol	Sample Location	Depth (ft)	Liquid Limit	Plastic Limit	Plasticity Index	D_{10}	D_{30}	D_{50}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-11	0-1	--	--	--	--	--	0.081	--	--	47	SM

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	EAST MESA AREA DRAINAGE MASTER PLAN UPDATE MARICOPA AND PINAL COUNTIES, ARIZONA	A-11
603640001 / 7/12	CONTRACT FCD 2011C017; ENTELLUS PROJECT NO. 310.057; N&M TASK NO. 3.3.3.12	

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_{50}	C_u	C_c	Passing No. 200 (%)	USCS
●	B-12	0-1	--	--	--	--	--	0.050	--	--	69	ML

PERFORMED IN GENERAL ACCORDANCE WITH ASTM D 422

Ninyo & Moore	GRADATION TEST RESULTS	FIGURE
PROJECT NO. / DATE	EAST MESA AREA DRAINAGE MASTER PLAN UPDATE MARICOPA AND PINAL COUNTIES, ARIZONA	A-12
603640001 / 7/12	CONTRACT FCD 2011C017; ENTELLUS PROJECT NO. 310.057; N&M TASK NO. 3.3.3.12	

DDMSW Output

Existing Conditions

Flood Control District of Maricopa County
Drainage Design Management System
RIVER MECHANICS - SOILS
Project Reference: EXEMADMP

Sediment Area ID	Book Number	Map Unit	Soil ID	Area (sq mi)	Area (%)	Erodibility Factor (K)	Specific Weight (lb/cf)
Major Basin ID: 01							
CPR10		661	66126	1.0357	23.2	0.32	83.00
		661	66131	0.3746	8.4	0.24	89.30
		661	66133	0.0118	0.3	0.24	89.30
		661	66166	0.0114	0.3	0.32	89.30
	655	Gf	6553231	0.1332	3.0	0.28	79.19
	655	Gm	6553245	2.5788	57.8	0.32	79.19
	655	Vf	6556231	0.0452	1.0	0.20	90.08
	655	AnA	655204720	0.2688	6.0	0.24	87.66
				4.4595	**100.00**		
CPR9		661	66124	0.0080	0.4	0.32	83.00
		661	66126	0.0674	3.1	0.32	83.00
		661	66131	0.0128	0.6	0.24	89.30
	655	Co	6552449	0.1819	8.3	0.32	79.19
	655	Gm	6553245	1.6850	77.1	0.32	79.19
	655	AnA	655204720	0.2302	10.5	0.24	87.66
				2.1853	**100.00**		

Physical Soil Properties

Eastern Pinal and Southern Gila Counties, Arizona

[Entries under "Erosion Factors--T" apply to the entire profile. Entries under "Wind Erodibility Group" and "Wind Erodibility Index" apply only to the surface layer. Absence of an entry indicates that data were not estimated]

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensi-bility	Organic matter	Erosion factors			Wind erodi-bility group	Wind erodi-bility index
										Kw	Kf	T		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
205:														
Denure	0-2	---	---	5-15	1.35-1.50	14.00-42.00	0.08-0.13	0.0-2.9	0.5-1.0	.24	.24	5	3	86
	2-14	---	---	5-15	1.35-1.50	14.00-42.00	0.08-0.13	0.0-2.9	0.1-0.5	.24	.24			
	14-29	---	---	5-15	1.35-1.50	14.00-42.00	0.08-0.13	0.0-2.9	0.1-0.5	.24	.24			
	29-51	---	---	5-15	1.35-1.50	14.00-42.00	0.08-0.13	0.0-2.9	0.1-0.5	.20	.24			
	51-60	---	---	10-25	1.25-1.40	14.00-42.00	0.13-0.18	0.0-2.9	0.1-0.5	.32	.32			
215:														
Mohall	0-3	---	---	5-15	1.35-1.50	14.00-42.00	0.08-0.13	0.0-2.9	0.5-1.0	.24	.24	3	3	86
	3-15	---	---	27-35	1.25-1.40	1.40-4.00	0.14-0.19	3.0-5.9	0.1-0.5	.32	.32			
	15-30	---	---	27-35	1.25-1.40	1.40-4.00	0.14-0.19	3.0-5.9	0.1-0.5	.32	.32			
	30-60	---	---	27-35	1.25-1.40	1.40-4.00	0.17-0.21	3.0-5.9	0.1-0.5	.32	.32			
345:														
Dateland	0-6	---	---	10-15	1.25-1.40	14.00-42.00	0.13-0.18	0.0-2.9	0.0-0.5	.32	.32	5	4L	86
	6-17	---	---	10-20	1.25-1.40	14.00-42.00	0.13-0.18	0.0-2.9	0.0-0.5	.32	.32			
	17-32	---	---	10-20	1.25-1.40	14.00-42.00	0.13-0.18	0.0-2.9	0.0-0.5	.32	.32			
	32-70	---	---	5-20	1.35-1.50	14.00-42.00	0.08-0.15	0.0-2.9	0.0-0.5	.28	.28			
570:														
Contine	0-2	---	---	20-27	1.25-1.40	4.00-14.00	0.13-0.18	0.0-2.9	0.5-1.0	.32	.32	3	4	86
	2-25	---	---	30-40	1.25-1.40	1.40-4.00	0.17-0.21	3.0-5.9	0.1-0.5	.32	.32			
	25-35	---	---	40-55	1.15-1.30	0.42-1.40	0.14-0.16	6.0-7.5	0.1-0.5	.32	.32			
	35-60	---	---	40-55	1.15-1.30	0.42-1.40	0.14-0.16	6.0-7.5	0.1-0.5	.32	.32			
595:														
Denure	0-2	---	---	5-15	1.35-1.50	14.00-42.00	0.08-0.13	0.0-2.9	0.5-1.0	.24	.24	5	3	86
	2-15	---	---	5-18	1.35-1.50	14.00-42.00	0.08-0.13	0.0-2.9	0.1-0.5	.24	.24			
	15-37	---	---	5-18	1.35-1.50	14.00-42.00	0.08-0.13	0.0-2.9	0.1-0.5	.24	.24			
	37-60	---	---	5-18	1.35-1.50	14.00-42.00	0.07-0.10	0.0-2.9	0.1-0.5	.15	.24			

This report shows only the major soils in each map unit. Others may exist.

Physical Soil Properties

Eastern Pinal and Southern Gila Counties, Arizona

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensi-bility	Organic matter	Erosion factors			Wind erodi-bility group	Wind erodi-bility index
										Kw	Kf	T		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
595:														
Mohall	0-2	---	---	5-15	1.35-1.50	14.00-42.00	0.08-0.13	0.0-2.9	0.5-1.0	.24	.24	3	3	86
	2-15	---	---	20-27	1.25-1.40	4.00-14.00	0.13-0.18	3.0-5.9	0.1-0.5	.32	.32			
	15-27	---	---	20-27	1.25-1.40	4.00-14.00	0.13-0.18	3.0-5.9	0.1-0.5	.32	.32			
	27-51	---	---	5-20	1.35-1.50	14.00-42.00	0.08-0.13	0.0-2.9	0.1-0.5	.24	.24			
	51-60	---	---	5-15	1.35-1.50	14.00-42.00	0.07-0.10	0.0-2.9	0.1-0.5	.15	.24			

Physical Soil Properties

This table shows estimates of some physical characteristics and features that affect soil behavior. These estimates are given for the layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Depth to the upper and lower boundaries of each layer is indicated.

Particle size is the effective diameter of a soil particle as measured by sedimentation, sieving, or micrometric methods. Particle sizes are expressed as classes with specific effective diameter class limits. The broad classes are sand, silt, and clay, ranging from the larger to the smaller.

Sand as a soil separate consists of mineral soil particles that are 0.05 millimeter to 2 millimeters in diameter. The estimated sand content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

Silt as a soil separate consists of mineral soil particles that are 0.002 to 0.05 millimeter in diameter. The estimated silt content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

Clay as a soil separate consists of mineral soil particles that are less than 0.002 millimeter in diameter. The estimated clay content of each soil layer is given as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of sand, silt, and clay affects the physical behavior of a soil. Particle size is important for engineering and agronomic interpretations, for determination of soil hydrologic qualities, and for soil classification.

The amount and kind of clay affect the fertility and physical condition of the soil and the ability of the soil to adsorb cations and to retain moisture. They influence shrink-swell potential, saturated hydraulic conductivity (Ksat), plasticity, the ease of soil dispersion, and other soil properties. The amount and kind of clay in a soil also affect tillage and earthmoving operations.

Moist bulk density is the weight of soil (ovendry) per unit volume. Volume is measured when the soil is at field moisture capacity, that is, the moisture content at 1/3- or 1/10-bar (33kPa or 10kPa) moisture tension. Weight is determined after the soil is dried at 105 degrees C. In the table, the estimated moist bulk density of each soil horizon is expressed in grams per cubic centimeter of soil material that is less than 2 millimeters in diameter. Bulk density data are used to compute shrink-swell potential, available water capacity, total pore space, and other soil properties. The moist bulk density of a soil indicates the pore space available for water and roots. Depending on soil texture, a bulk density of more than 1.4 can restrict water storage and root penetration. Moist bulk density is influenced by texture, kind of clay, content of organic matter, and soil structure.

Saturated hydraulic conductivity refers to the ability of a soil to transmit water or air. The term "permeability" indicates saturated hydraulic conductivity (Ksat). The estimates in the table indicate the rate of water movement, in micrometers per second (um/sec), when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Ksat is considered in the design of soil drainage systems and septic tank absorption fields.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each soil layer. The capacity varies, depending on soil properties that affect retention of water. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Linear extensibility refers to the change in length of an unconfined clod as moisture content is decreased from a moist to a dry state. It is an expression of the volume change between the water content of the clod at 1/3- or 1/10-bar tension (33kPa or 10kPa tension) and oven dryness. The volume change is reported in the table as percent change for the whole soil. The amount and type of clay minerals in the soil influence volume change.

Linear extensibility is used to determine the shrink-swell potential of soils. The shrink-swell potential is low if the soil has a linear extensibility of less than 3 percent; moderate if 3 to 6 percent; high if 6 to 9 percent; and very high if more than 9 percent. If the linear extensibility is more than 3, shrinking and swelling can cause damage to buildings, roads, and other structures and to plant roots. Special design commonly is needed.

Organic matter is the plant and animal residue in the soil at various stages of decomposition. The estimated content of organic matter is expressed as a percentage, by weight, of the soil material that is less than 2 millimeters in diameter.

The content of organic matter in a soil can be maintained by returning crop residue to the soil. Organic matter has a positive effect on available water capacity, water infiltration, soil organism activity, and tilth. It is a source of nitrogen and other nutrients for crops and soil organisms.

Physical Soil Properties

Erosion factors are shown in the table as the K factor (Kw and Kf) and the T factor. Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) and the Revised Universal Soil Loss Equation (RUSLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter and on soil structure and Ksat. Values of K range from 0.02 to 0.69. Other factors being equal, the higher the value, the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor Kw indicates the erodibility of the whole soil. The estimates are modified by the presence of rock fragments.

Erosion factor Kf indicates the erodibility of the fine-earth fraction, or the material less than 2 millimeters in size.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind and/or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their susceptibility to wind erosion in cultivated areas. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible. The groups are described in the National Soil Survey Handbook.

Wind erodibility index is a numerical value indicating the susceptibility of soil to wind erosion, or the tons per acre per year that can be expected to be lost to wind erosion. There is a close correlation between wind erosion and the texture of the surface layer, the size and durability of surface clods, rock fragments, organic matter, and a calcareous reaction. Soil moisture and frozen soil layers also influence wind erosion.

Flood Control District of Maricopa County
Drainage Design Management System
RIVER MECHANICS - SEDIMENT
Project Reference: EXEMADMP

		Q (cfs)	Volume (ac-ft)	Wash Load (ac-ft)	Bed Load (ac-ft)	Total Yield (ac-ft)
ID: CPR10	**2 Year:**	36	14.00	0.024	0.002	0.026
Return Periods for Analysis: All	**5 Year:**	137	36.00	0.087	0.007	0.094
	10 Year:	282	69.00	0.188	0.017	0.205
	25 Year:	775	116.00	0.444	0.040	0.484
	50 Year:	1,092	156.00	0.635	0.064	0.699
	100 Year:	1,379	203.00	0.838	0.095	0.933
	Design:	-	-	-	-	-
	Annual:			0.082	0.008	0.090
ID: CPR9	**2 Year:**	32	17.00	0.018	0.004	0.022
Return Periods for Analysis: All	**5 Year:**	94	38.00	0.050	0.009	0.059
	10 Year:	152	56.00	0.082	0.014	0.096
	25 Year:	239	80.00	0.129	0.023	0.152
	50 Year:	314	100.00	0.170	0.031	0.201
	100 Year:	399	123.00	0.219	0.040	0.259
	Design:	-	-	-	-	-
	Annual:			0.035	0.007	0.042

Sediment Area ID	Area (sq mi)	SDR (%)	Soil and Erosion Factors: Soil Erodibility Factor (K)	Erosion Control Factor (P)	Specific Weight (lb/cu ft)	Land Use Factors: Effects of Canopy Cover (Ci)	Effects of Vegetation (Cii)	Effects of Tillage (Ciii)	Cover Management Factor (C)	Percent Impervious (%)	Topographic Factors: Slope Length (ft)	Slope (%)	Topographic Factor (LS)
ID: CPR10			**Specific Weight Method: Channel Bed Material Soil Sample**					**Bed Material Soil Sample D10 (mm): 0.00**					
CPR10	4.4600	52.6	0.31	1.0	39.18	0.80	0.90	0.36	0.26	7	650	0.50	0.17
ID: CPR9			**Specific Weight Method: Channel Bed Material Soil Sample**					**Bed Material Soil Sample D10 (mm): 0.00**					
CPR9	2.1900	56.3	0.31	1.0	39.18	0.66	0.84	0.30	0.17	8	650	0.50	0.17

Flood Control District of Maricopa County
Drainage Design Management System
RIVER MECHANICS - BED LOAD
Project Reference: EXEMADMP

	Slope (ft/ft)	Manning's n	D16 (mm)	D50 (mm)	D84 (mm)		Average Velocity (ft/sec)	Hydraulic Depth (ft)	Normal Depth (ft)	Average Width (ft)	Bed Load per Foot, qs (cfs/ft)	Bed Load (cfs)
ID: CPR10	0.002600	0.070	0.003	0.056	0.500	**2 Year:**	0.39	0.22	0.43	214.67	-	0.01
Cross Section ID: R10R12						**5 Year:**	0.48	0.30	0.72	396.42	-	0.03
						10 Year:	0.57	0.38	0.91	543.67	-	0.07
						25 Year:	0.72	0.55	1.26	854.28	-	0.27
						50 Year:	0.79	0.63	1.41	980.34	-	0.45
						100 Year:	0.85	0.69	1.52	1,067.34	-	0.65
						Design:	-	-	-	-	-	-
ID: CPR9	0.003000	0.070	0.003	0.056	0.500	**2 Year:**	0.40	0.20	0.40	200.00	-	0.01
Cross Section ID: R9R11						**5 Year:**	0.49	0.27	0.61	314.49	-	0.02
						10 Year:	0.52	0.31	0.73	400.42	-	0.04
						25 Year:	0.58	0.35	0.84	490.56	-	0.07
						50 Year:	0.61	0.38	0.92	559.51	-	0.10
						100 Year:	0.64	0.42	1.00	623.44	-	0.13
						Design:	-	-	-	-	-	-

Section ID	Flow Type	Entire Section Q (cfs)	Slope (f/f)	Man'g N	W.P. (ft)	Hyd Depth (ft)	Area (sq ft)	Max Depth (ft)	Vel (f/s)	Channel Section Hyd Depth (ft)	Vel (ft/sec)	Froude Num
R10R12	Design	1379	0.002600	0.070	2,366.78	0.69	1630.59	1.52	0.85	0.69	0.85	0.18
	Dominant	282	0.002600	0.070	1,320.12	0.38	498.35	.91	0.57	0.38	0.57	0.16
R9R11	Design	399	0.003000	0.070	1,500.12	0.42	625.25	1.00	0.64	0.42	0.64	0.17
	Dominant	152	0.003000	0.070	960.12	0.31	293.15	.73	0.52	0.31	0.52	0.16

Sediment Area ID	Land Use Code	Area (sq mi)	Area (%)	Effects of Canopy Cover (Ci)	Effects of Vegetation (Cii)	Effects of Tillage (Ciii)	Percent Impervious (%)
Major Basin ID: 01							
CPR10	110	1.0066	22.6	.84	.92	.38	5
	120	0.0001		.84	.92	.38	5
	130	0.1307	2.9	.73	.87	.33	15
	150	0.0001		.73	.87	.33	30
	160	0.5891	13.2	.73	.87	.33	40
	300	0.0330	0.7	.67	.84	.30	55
	530	0.0001		.59	.81	.26	80
	720	0.0727	1.6	.51	.78	.23	5
	750	0.4051	9.1	.53	.79	.24	-
	900	2.2222	49.8	.86	.93	.39	-
		4.4597	**99.9**				
CPR9	110	0.4798	22.0	.84	.92	.38	5
	130	0.5005	22.9	.73	.87	.33	15
	520	0.1489	6.8	.56	.80	.25	45
	720	0.0001		.51	.78	.23	5
	750	0.9704	44.4	.53	.79	.24	-
	900	0.0856	3.9	.86	.93	.39	-
		2.1853	**100.0**				

DDMSW Output

Future Conditions

Sediment Area ID	Book Number	Map Unit	Soil ID	Area (sq mi)	Area (%)	Erodibility Factor (K)	Specific Weight (lb/cf)
Major Basin ID: 01							
CPR10		661	66126	1.0357	23.2	0.32	83.00
		661	66131	0.3746	8.4	0.24	89.30
		661	66133	0.0118	0.3	0.24	89.30
		661	66166	0.0114	0.3	0.32	89.30
	655	Gf	6553231	0.1332	3.0	0.28	79.19
	655	Gm	6553245	2.5788	57.8	0.32	79.19
	655	Vf	6556231	0.0452	1.0	0.20	90.08
	655	AnA	655204720	0.2688	6.0	0.24	87.66
				4.4595	**100.00**		
CPR9		661	66124	0.0080	0.4	0.32	83.00
		661	66126	0.0674	3.1	0.32	83.00
		661	66131	0.0128	0.6	0.24	89.30
	655	Co	6552449	0.1819	8.3	0.32	79.19
	655	Gm	6553245	1.6850	77.1	0.32	79.19
	655	AnA	655204720	0.2302	10.5	0.24	87.66
				2.1853	**100.00**		

Physical Soil Properties

Eastern Pinal and Southern Gila Counties, Arizona

[Entries under "Erosion Factors--T" apply to the entire profile. Entries under "Wind Erodibility Group" and "Wind Erodibility Index" apply only to the surface layer. Absence of an entry indicates that data were not estimated]

Map symbol and soil name	Depth	Sand	Silt	Clay	Moist bulk density	Saturated hydraulic conductivity	Available water capacity	Linear extensi-bility	Organic matter	Erosion factors			Wind erodi-bility group	Wind erodi-bility index
										Kw	Kf	T		
	In	*Pct*	*Pct*	*Pct*	*g/cc*	*micro m/sec*	*In/In*	*Pct*	*Pct*					
205:														
Denure	0-2	---	---	5-15	1.35-1.50	14.00-42.00	0.08-0.13	0.0-2.9	0.5-1.0	.24	.24	5	3	86
	2-14	---	---	5-15	1.35-1.50	14.00-42.00	0.08-0.13	0.0-2.9	0.1-0.5	.24	.24			
	14-29	---	---	5-15	1.35-1.50	14.00-42.00	0.08-0.13	0.0-2.9	0.1-0.5	.24	.24			
	29-51	---	---	5-15	1.35-1.50	14.00-42.00	0.08-0.13	0.0-2.9	0.1-0.5	.20	.24			
	51-60	---	---	10-25	1.25-1.40	14.00-42.00	0.13-0.18	0.0-2.9	0.1-0.5	.32	.32			
215:														
Mohall	0-3	---	---	5-15	1.35-1.50	14.00-42.00	0.08-0.13	0.0-2.9	0.5-1.0	.24	.24	3	3	86
	3-15	---	---	27-35	1.25-1.40	1.40-4.00	0.14-0.19	3.0-5.9	0.1-0.5	.32	.32			
	15-30	---	---	27-35	1.25-1.40	1.40-4.00	0.14-0.19	3.0-5.9	0.1-0.5	.32	.32			
	30-60	---	---	27-35	1.25-1.40	1.40-4.00	0.17-0.21	3.0-5.9	0.1-0.5	.32	.32			
345:														
Dateland	0-6	---	---	10-15	1.25-1.40	14.00-42.00	0.13-0.18	0.0-2.9	0.0-0.5	.32	.32	5	4L	86
	6-17	---	---	10-20	1.25-1.40	14.00-42.00	0.13-0.18	0.0-2.9	0.0-0.5	.32	.32			
	17-32	---	---	10-20	1.25-1.40	14.00-42.00	0.13-0.18	0.0-2.9	0.0-0.5	.32	.32			
	32-70	---	---	5-20	1.35-1.50	14.00-42.00	0.08-0.15	0.0-2.9	0.0-0.5	.28	.28			
570:														
Contine	0-2	---	---	20-27	1.25-1.40	4.00-14.00	0.13-0.18	0.0-2.9	0.5-1.0	.32	.32	3	4	86
	2-25	---	---	30-40	1.25-1.40	1.40-4.00	0.17-0.21	3.0-5.9	0.1-0.5	.32	.32			
	25-35	---	---	40-55	1.15-1.30	0.42-1.40	0.14-0.16	6.0-7.5	0.1-0.5	.32	.32			
	35-60	---	---	40-55	1.15-1.30	0.42-1.40	0.14-0.16	6.0-7.5	0.1-0.5	.32	.32			
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Denure	0-2	---	---	5-15	1.35-1.50	14.00-42.00	0.08-0.13	0.0-2.9	0.5-1.0	.24	.24	5	3	86
	2-15	---	---	5-18	1.35-1.50	14.00-42.00	0.08-0.13	0.0-2.9	0.1-0.5	.24	.24			
	15-37	---	---	5-18	1.35-1.50	14.00-42.00	0.08-0.13	0.0-2.9	0.1-0.5	.24	.24			
	37-60	---	---	5-18	1.35-1.50	14.00-42.00	0.07-0.10	0.0-2.9	0.1-0.5	.15	.24			

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Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind and/or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their susceptibility to wind erosion in cultivated areas. The soils assigned to group 1 are the most susceptible to wind erosion, and those assigned to group 8 are the least susceptible. The groups are described in the National Soil Survey Handbook.

Wind erodibility index is a numerical value indicating the susceptibility of soil to wind erosion, or the tons per acre per year that can be expected to be lost to wind erosion. There is a close correlation between wind erosion and the texture of the surface layer, the size and durability of surface clods, rock fragments, organic matter, and a calcareous reaction. Soil moisture and frozen soil layers also influence wind erosion.

Flood Control District of Maricopa County
Drainage Design Management System
RIVER MECHANICS - SEDIMENT
Project Reference: FUTEMADMPU

		Q (cfs)	Volume (ac-ft)	Wash Load (ac-ft)	Bed Load (ac-ft)	Total Yield (ac-ft)
ID: CPR10	**2 Year:**	52	8.00	0.019	0.020	0.039
Return Periods for Analysis: All	**5 Year:**	180	17.00	0.058	0.063	0.121
	10 Year:	274	32.00	0.105	0.132	0.237
	25 Year:	589	58.00	0.224	0.145	0.369
	50 Year:	853	103.00	0.380	0.269	0.649
	100 Year:	1,384	156.00	0.629	0.587	1.216
	Design:	-	-	-	-	-
	Annual:			0.052	0.050	0.102
ID: CPR9	**2 Year:**	52	8.00	0.018	0.028	0.046
Return Periods for Analysis: All	**5 Year:**	114	20.00	0.048	0.089	0.137
	10 Year:	162	32.00	0.076	0.154	0.230
	25 Year:	233	62.00	0.134	0.236	0.370
	50 Year:	337	88.00	0.201	0.285	0.486
	100 Year:	609	117.00	0.328	0.362	0.690
	Design:	-	-	-	-	-
	Annual:			0.036	0.060	0.096

Flood Control District of Maricopa County
Drainage Design Management System
RIVER MECHANICS - BED LOAD
Project Reference: FUTEMADMPU

	Slope (ft/ft)	Manning's n	D16 (mm)	D50 (mm)	D84 (mm)		Average Velocity (ft/sec)	Hydraulic Depth (ft)	Normal Depth (ft)	Average Width (ft)	Bed Load per Foot, qs (cfs/ft)	Bed Load (cfs)
ID: CPR10	0.002600	0.035	0.003	0.056	0.500	**2 Year:**	2.22	1.06	1.80	13.01	0.01	0.13
Cross Section ID: R10R12						**5 Year:**	3.07	1.70	3.05	19.22	0.04	0.67
						10 Year:	3.39	2.00	3.64	22.21	0.05	1.13
						25 Year:	3.23	1.85	5.21	35.00	0.04	1.48
						50 Year:	3.40	1.98	5.82	43.11	0.05	2.23
						100 Year:	4.02	2.55	6.52	52.80	0.10	5.21
						Design:	-	-	-	-	-	-
ID: CPR9	0.003000	0.035	0.003	0.056	0.500	**2 Year:**	2.45	1.11	1.76	12.06	0.02	0.18
Cross Section ID: R9R11						**5 Year:**	3.02	1.51	2.51	15.04	0.03	0.51
						10 Year:	3.29	1.73	2.94	16.75	0.05	0.78
						25 Year:	3.24	1.67	3.58	20.09	0.04	0.89
						50 Year:	3.24	1.66	4.21	24.71	0.04	1.09
						100 Year:	3.41	1.79	5.10	35.02	0.05	1.89
						Design:	-	-	-	-	-	-

Sediment Area ID	Area (sq mi)	SDR (%)	Soil and Erosion Factors: Soil Erodibility Factor (K)	Erosion Control Factor (P)	Specific Weight (lb/cu ft)	Land Use Factors: Effects of Canopy Cover (Ci)	Effects of Vegetation (Cii)	Effects of Tillage (Ciii)	Cover Management Factor (C)	Percent Impervious (%)	Topographic Factors: Slope Length (ft)	Slope (%)	Topographic Factor (LS)
ID: CPR10			**Specific Weight Method: Channel Bed Material Soil Sample**					**Bed Material Soil Sample D10 (mm): 0.00**					
CPR10	4.4600	52.6	0.31	1.0	39.18	0.73	0.87	0.33	0.21	-	650	0.50	0.17
ID: CPR9			**Specific Weight Method: Channel Bed Material Soil Sample**					**Bed Material Soil Sample D10 (mm): 0.00**					
CPR9	2.1900	56.3	0.31	1.0	39.18	0.70	0.86	0.31	0.19	-	650	0.50	0.17

Flood Control District of Maricopa County
Drainage Design Management System
RIVER MECHANICS - CROSS SECTION HYDRAULICS
Project Reference: FUTEMADMPU

Section ID	Flow Type	Entire Section Q (cfs)	Slope (f/f)	Man'g N	W.P. (ft)	Hyd Depth (ft)	Area (sq ft)	Max Depth (ft)	Vel (f/s)	Channel Section Hyd Depth (ft)	Vel (ft/sec)	Froude Num
R10R12	Design	1384	0.002600	0.035	136.92	2.55	344.70	6.52	4.02	2.55	4.02	0.44
	Dominant	274	0.002600	0.035	41.12	2.00	80.80	3.64	3.39	2.00	3.39	0.42
R9R11	Design	609	0.003000	0.035	101.06	1.79	178.50	5.10	3.41	1.79	3.41	0.45
	Dominant	162	0.003000	0.035	29.24	1.73	49.28	2.94	3.29	1.73	3.29	0.44

Sediment Area ID	Land Use Code	Area (sq mi)	Area (%)	Effects of Canopy Cover (Ci)	Effects of Vegetation (Cii)	Effects of Tillage (Ciii)	Percent Impervious (%)
Major Basin ID: 01							
CPR10	140	4.3189	96.9	.73	.87	.33	30
	160	0.0109	0.2	.73	.87	.33	40
	230	0.0937	2.1	.59	.81	.26	80
	310	0.0134	0.3	.59	.81	.26	80
	900	0.0224	0.5	.86	.93	.39	-
		4.4593	**100.0**				
CPR9	140	1.4363	65.7	.73	.87	.33	30
	160	0.2376	10.9	.73	.87	.33	40
	230	0.0461	2.1	.59	.81	.26	80
	300	0.0032	0.1	.67	.84	.30	55
	310	0.3136	14.4	.59	.81	.26	80
	520	0.1484	6.8	.56	.80	.25	45
		2.1852	**100.0**				

APPENDIX C. CONCEPTUAL DESIGN PLANS

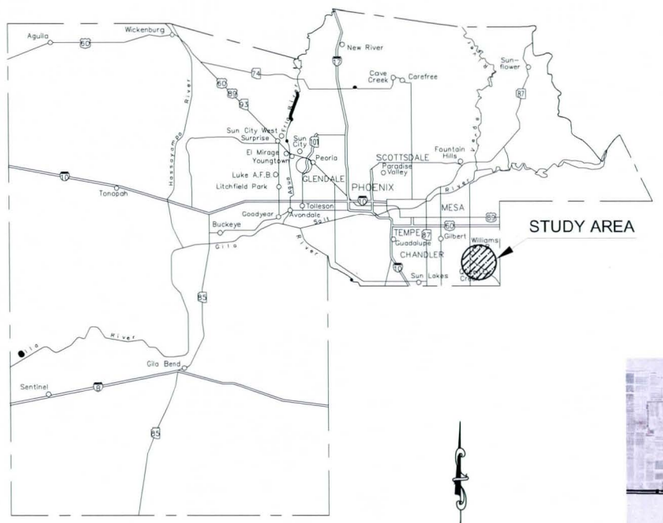
FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

EAST MESA

AREA DRAINAGE MASTER PLAN UPDATE

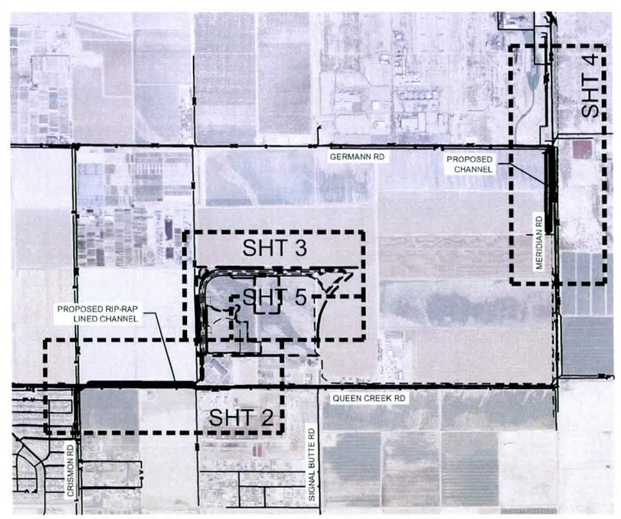
CONTRACT F.C.D. 2011C017

CONCEPTUAL PLANS FOR RECOMMENDED ALTERNATIVE



LOCATION MAP

MARICOPA COUNTY
Not to Scale



INDEX MAP

SHEET DESCRIPTION	NUMBER OF SHEETS
COVER SHEET	1
DRAINAGE PLAN & PROFILE	2-3-4
TYPICAL QUEEN CREEK CHANNEL LANDSCAPE PLAN	5
EAST PARK BASIN/SPORT COMPLEX CONCEPTUAL PLAN	6

NORTH

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Date Signed 1/28/14
ARIZONA, U.S.A.

Expires 12/31/2015

EAST MESA
AREA DRAINAGE MASTER PLAN UPDATE

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

COVER SHEET

SHEET 1 OF 6

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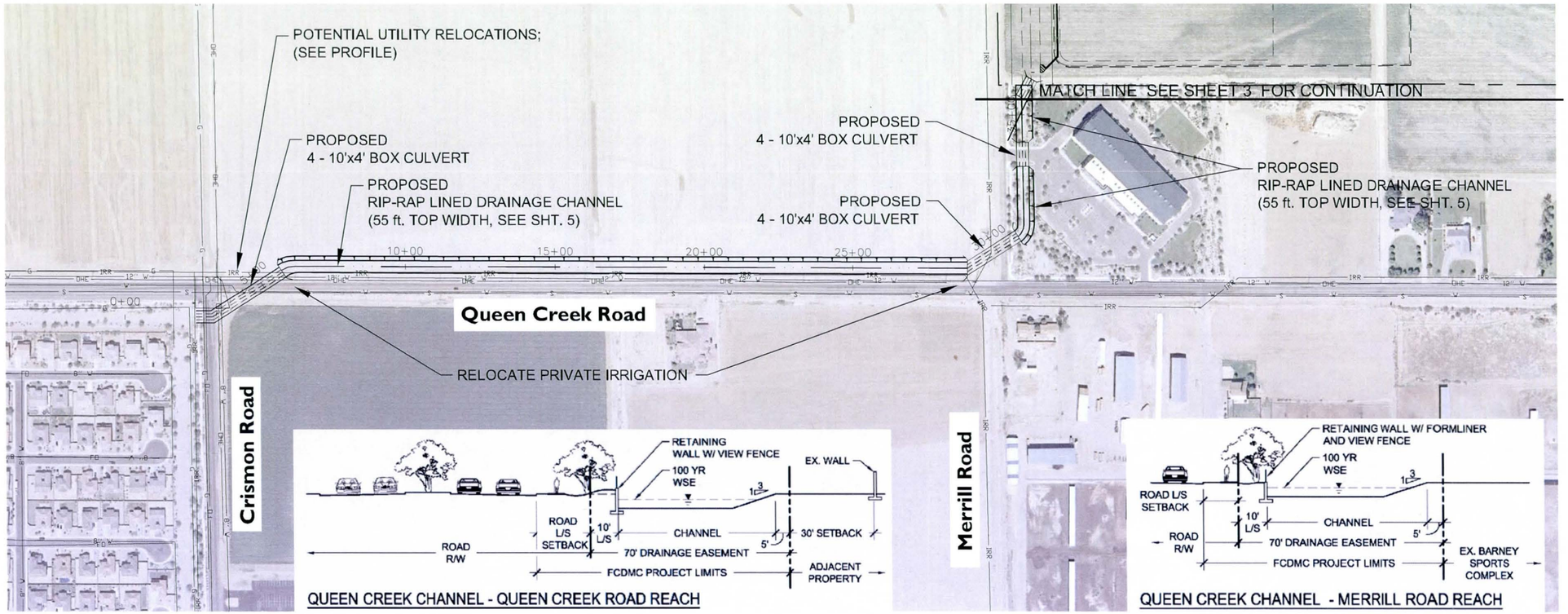

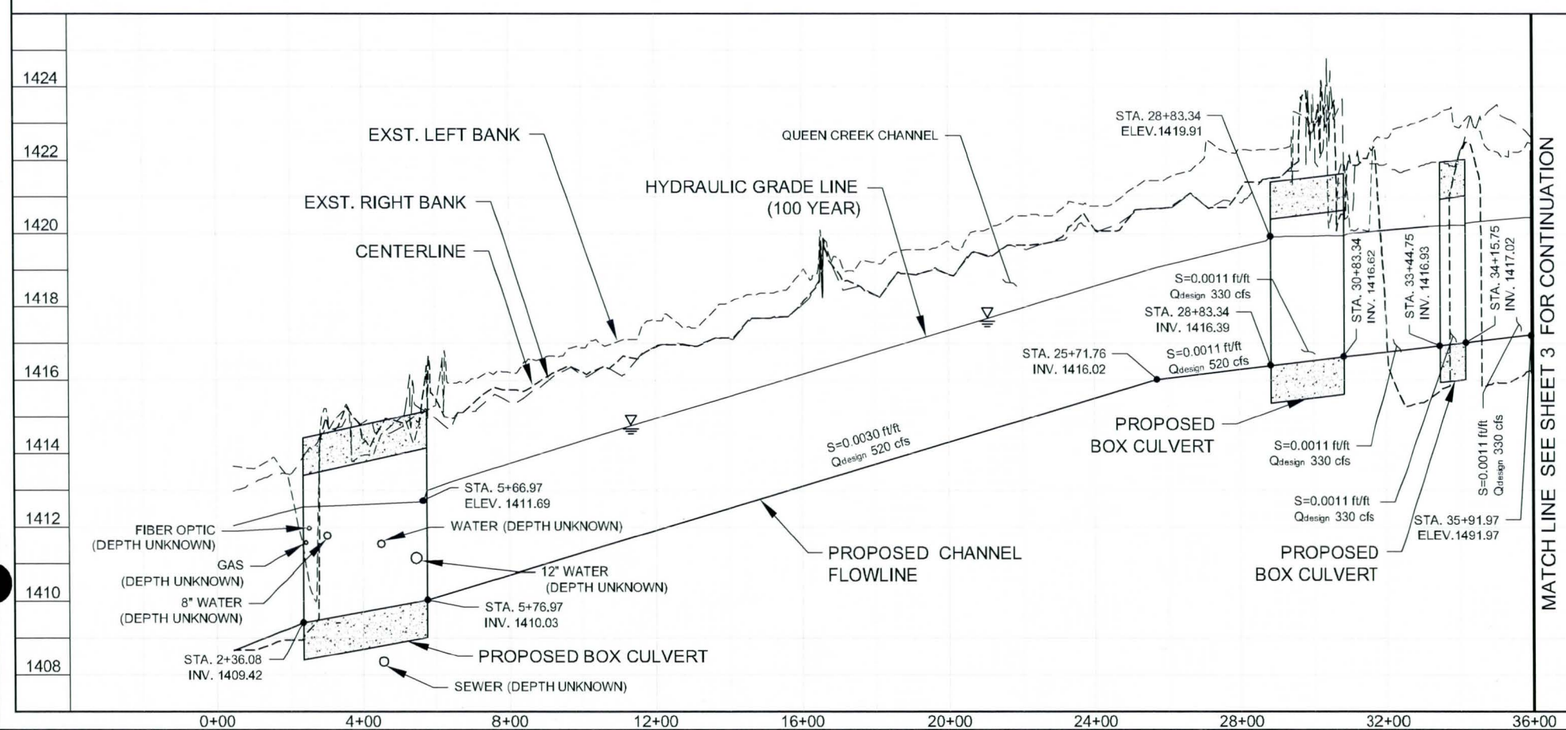

LEGEND

- PROPOSED CHANNEL
- PROPOSED CULVERT
- STREET CENTERLINE
- PARCEL BOUNDARY
- EXISTING WATER
- EXISTING SEWER
- EXISTING SEWER FORCE MAIN
- EXISTING GAS
- EXISTING STORM DRAIN
- EXISTING IRRIGATION
- EXISTING UNDERGROUND ELECTRIC
- EXISTING OVERHEAD ELECTRIC
- EXISTING FIBER OPTIC
- EXISTING TELEPHONE

NORTH

200 100 0 200 400

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EAST MESA
AREA DRAINAGE MASTER PLAN UPDATE

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

QUEEN CREEK DRAINAGE CHANNEL
PLAN & PROFILE

SHEET 2 OF 6

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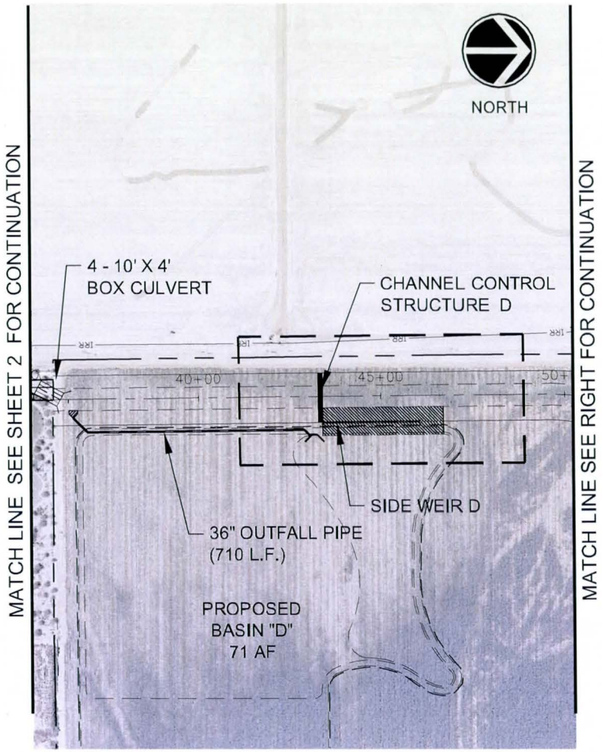
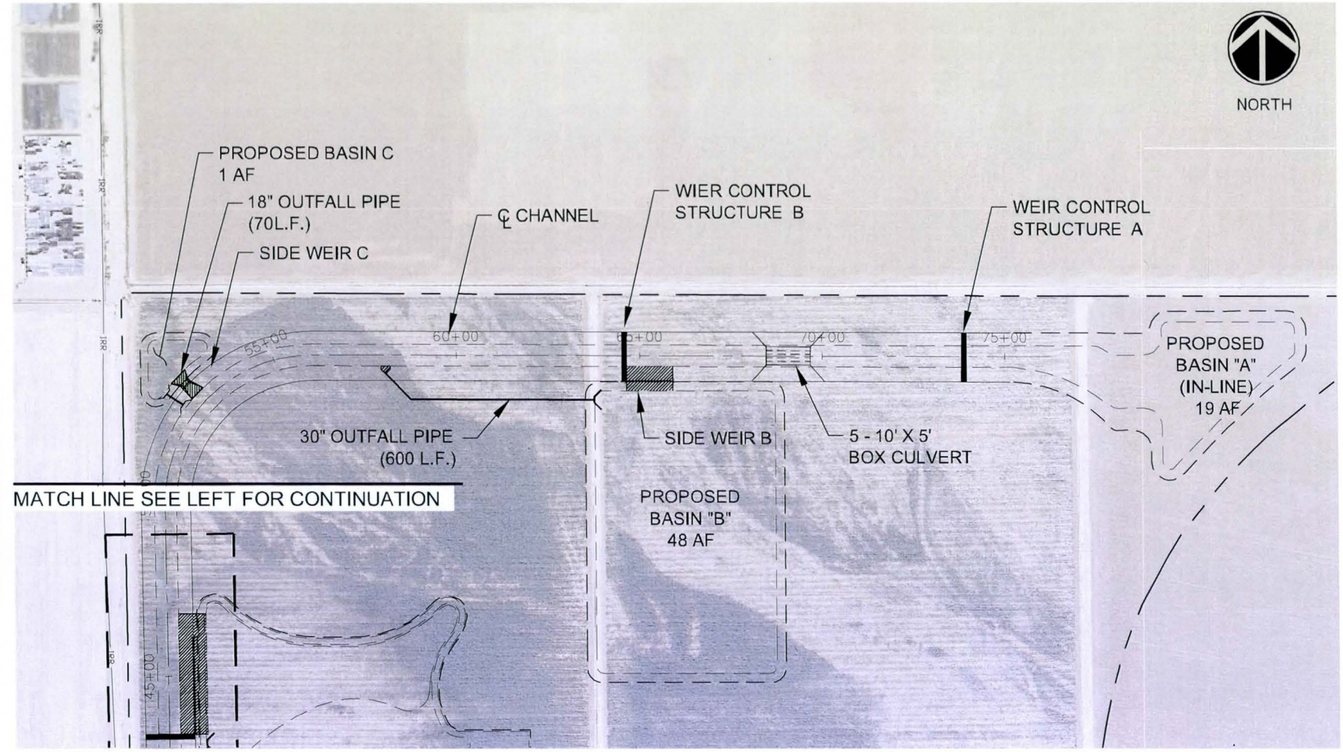
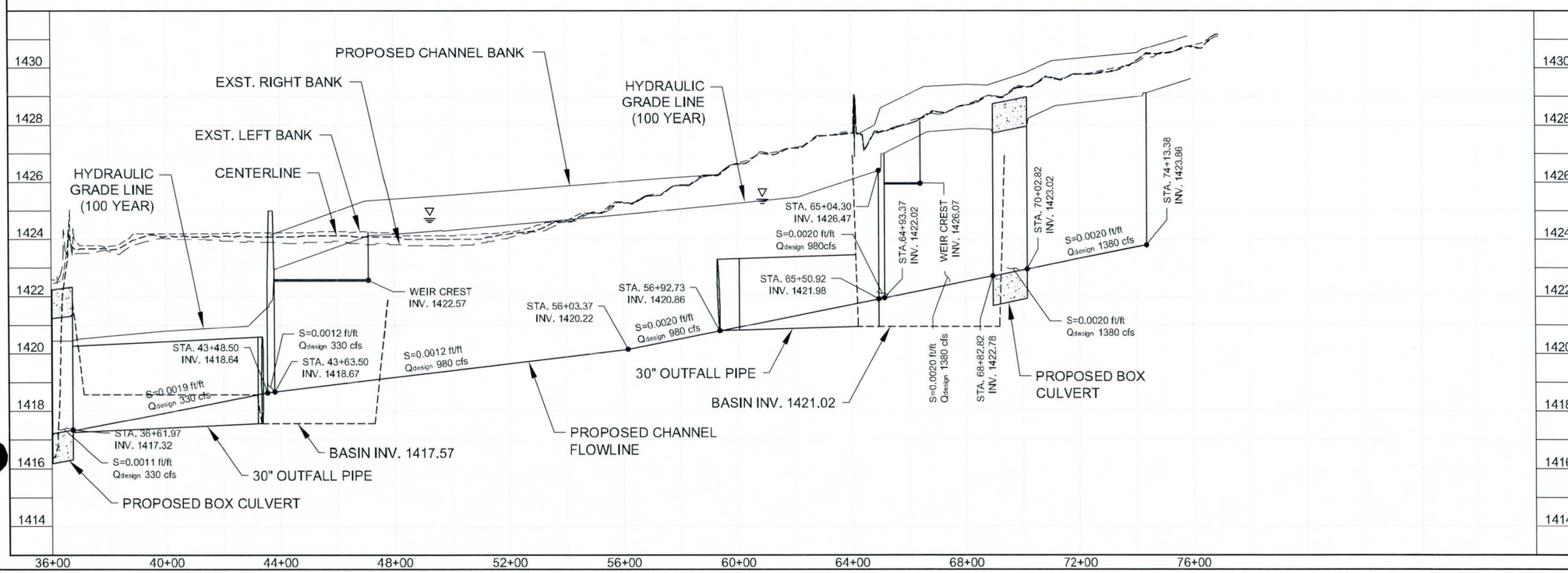
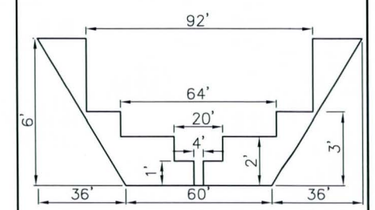




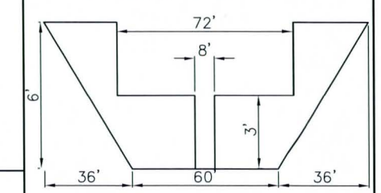


LEGEND

- PROPOSED CHANNEL
- PROPOSED CULVERT
- STREET CENTERLINE
- PARCEL BOUNDARY
- EXISTING WATER
- EXISTING SEWER
- EXISTING SEWER FORCE MAIN
- EXISTING GAS
- EXISTING STORM DRAIN
- EXISTING IRRIGATION
- EXISTING UNDERGROUND ELECTRIC
- EXISTING OVERHEAD ELECTRIC
- EXISTING FIBER OPTIC
- EXISTING TELEPHONE



WEIR CONTROL STRUCTURE A



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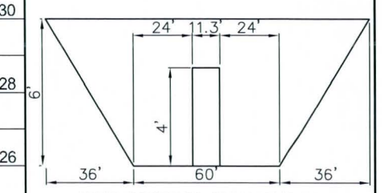

WEIR CONTROL STRUCTURE D

NORTH

200 100 0 200 400

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EAST MESA
AREA DRAINAGE MASTER PLAN UPDATE

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

EAST PARK DRAINAGE CHANNEL
PLAN & PROFILE

SHEET 3 OF 6

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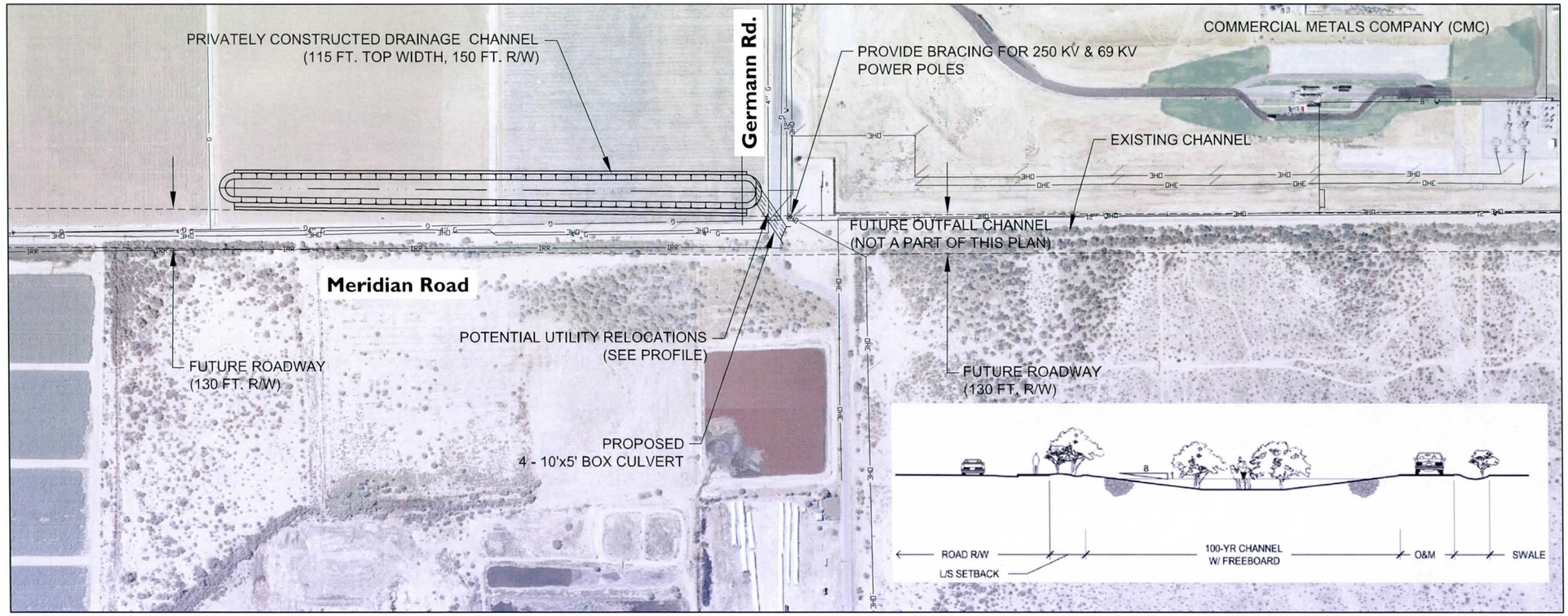

LEGEND

- PROPOSED CHANNEL
- PROPOSED CULVERT
- STREET CENTERLINE
- PARCEL BOUNDARY
- EXISTING WATER
- EXISTING SEWER
- EXISTING SEWER FORCE MAIN
- EXISTING GAS
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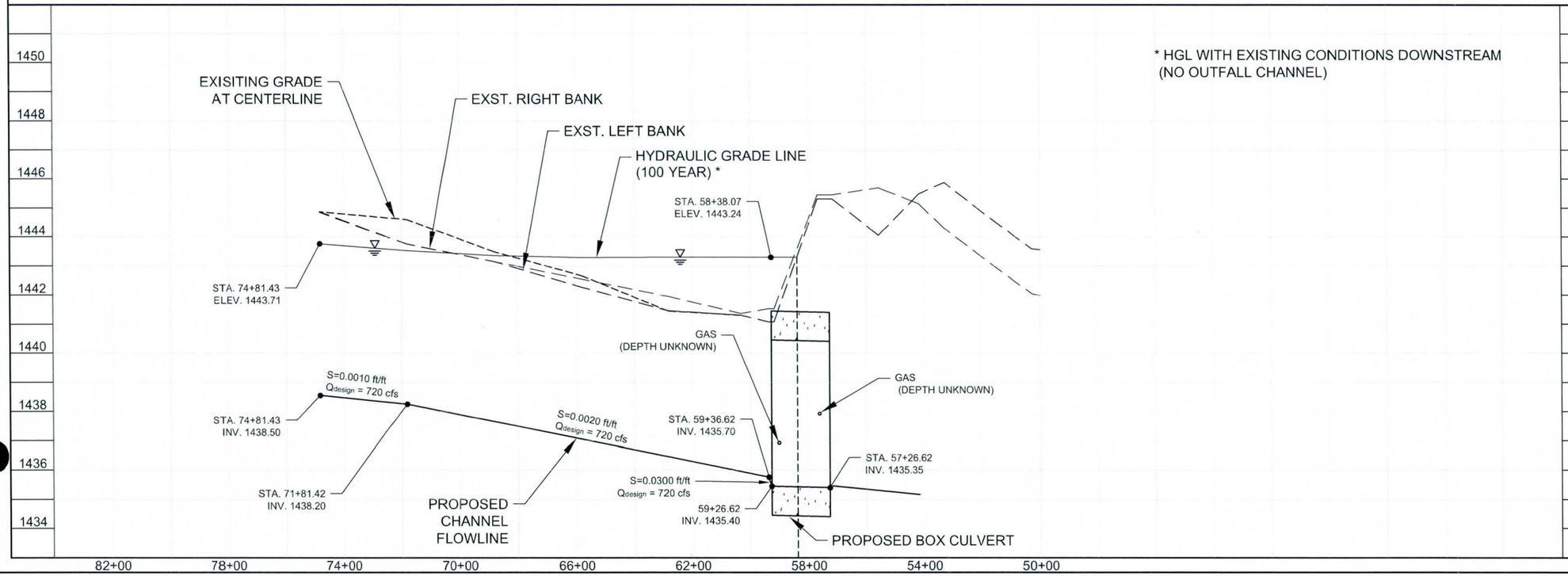
- EXISTING IRRIGATION
- EXISTING UNDERGROUND ELECTRIC
- EXISTING OVERHEAD ELECTRIC
- EXISTING FIBER OPTIC
- EXISTING TELEPHONE

NOTE:
IMPROVEMENTS SHOWN ARE TO BE PRIVATELY FUNDED AND CONSTRUCTED BY OTHERS.



NORTH

200 100 0 200 400

Registered Professional Engineer (Civil) CERTIFICATE NO. 29737 HERNAN A. ARISTIZABAL Date Signed 1/28/14 ARIZONA, U.S.A.
Expires 12/31/2015

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EAST MESA
AREA DRAINAGE MASTER PLAN UPDATE

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

MERIDIAN RD DRAINAGE CHANNEL
PLAN & PROFILE

SHEET 4 OF 6

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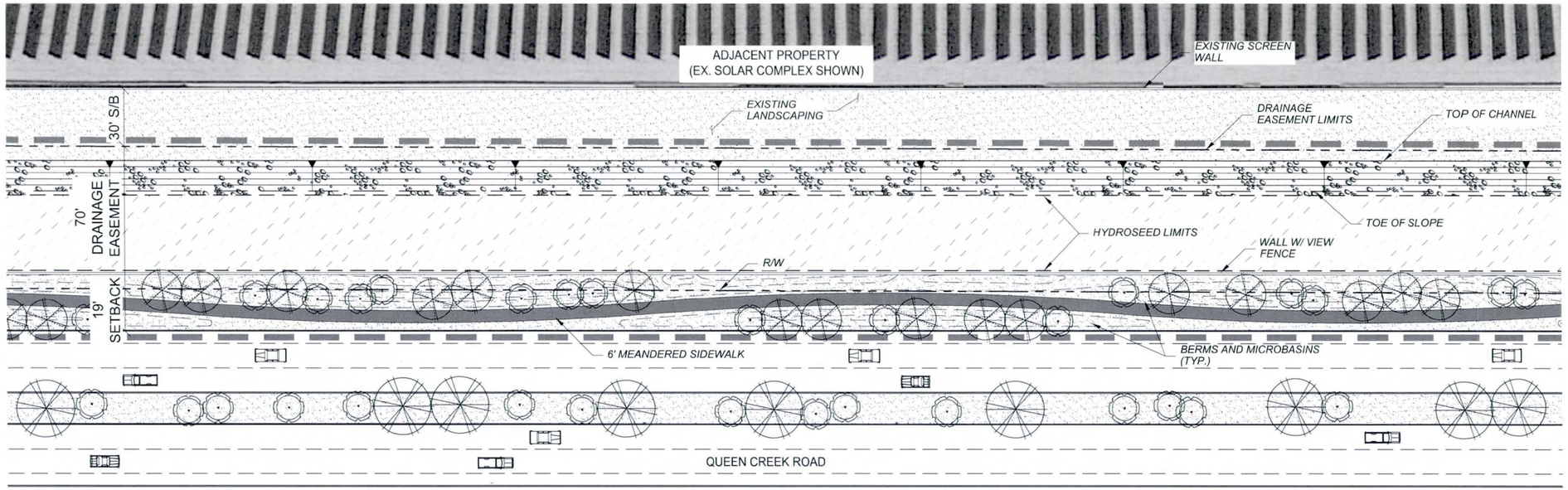
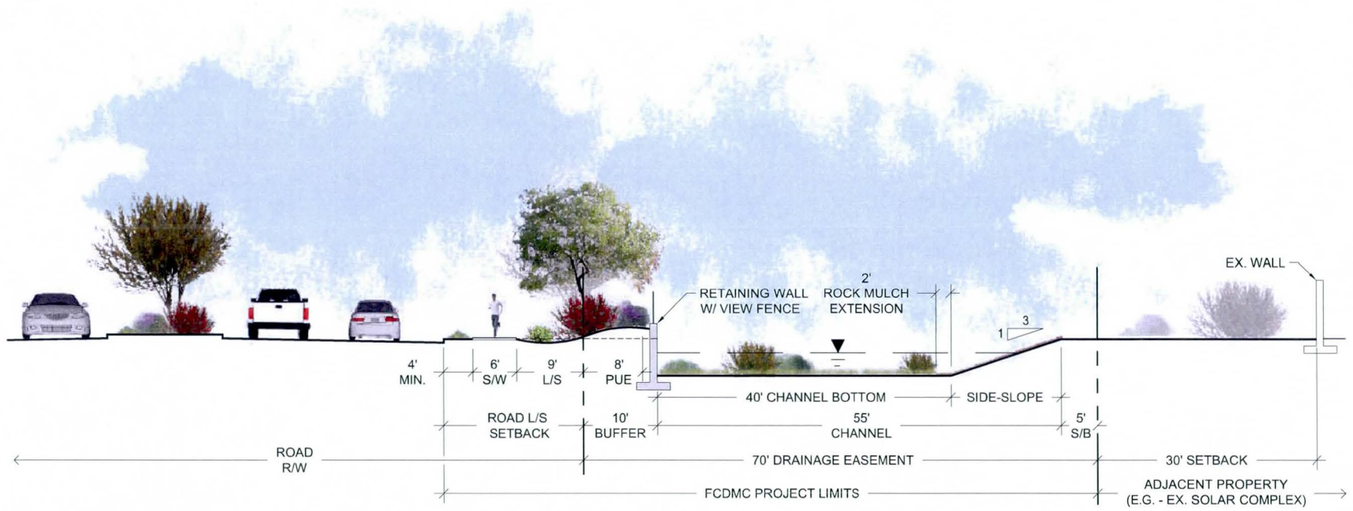


QUEEN CREEK CHANNEL CONCEPTUAL LANDSCAPE PLAN

SCALE: 1" = 60'-0"

30' 15' 0 30' 60'

NORTH



TYPICAL SECTION

SCALE: 1" = 20' - 0"

PLANT PALETTE

SYMBOL	BOTANICAL NAME / *COMMON NAME*	NOTES
	ACACIA ANEURA *MULGA ACACIA*	50% 15-GAL/ 50% 24" BOX
	CHILOPSIS LINEARIS *DESERT WILLOW*	50% 15-GAL/ 50% 24" BOX

ACCENTS

- DASYLIRION WHEELERI *DESERT SPOON*
- HESPERALOE PARVIFLORA *RED YUCCA*
- YUCCA BACCATA *BANANA YUCCA*

SHRUBS

- ENCELIA FARINOSA *BRITTLEBUSH*
- JUSTICA CALIFORNICA *CHUPAROSA*
- LANTANA SP. *LANTANA*
- LEUCOPHYLLUM PRUINOSUM *SIERRA BOUQUET SAGE*
- SIMMONDSIA CHINENSIS *JOJOBA*

GROUND COVERS

HYDROSEED

INERT MATERIALS

3" ROCK MULCH COLOR TO MATCH D.G.

DECOMPOSED GRANITE MATCH ADJACENT EXISTING

PROJECT LIMITS

QUEEN CREEK CHANNEL

DESIGN GUIDELINES, THEMES, AND LANDSCAPE GUIDANCE FOR THE QUEEN CREEK CHANNEL.

Design Concept

The Queen Creek Channel serves as the outfall for the East Park Sports Complex Basin, conveying storm-water from the basin along the north side of Queen Creek Road. The Queen Creek Channel serves as a transitional element between two land uses with residential properties to the immediate south and industrial sites such as a large solar panel complex on the north.

The Queen Creek Channel shall be designed in order to accomplish the following objectives:

Objective 1: Accomplish the storm water mitigation requirements of the East Mesa Area Drainage Master Plan Update (See civil plans and models).

Objective 2: Provide screening of the hardened channel sections and serve as visual mitigation for suburban residents to the south looking north to the industrial sites.

Objective 3: Incorporate multi-purpose storm water management techniques such as street run-off harvesting into water harvesting micro-basins.

The adjacent plan and section illustrate a typical reach of this channel. Design of the channel shall include a vertical wall to the road side to allow for additional landscape buffering. Extending the wall height an additional two feet above the height needed for flood conveyance freeboard allows for additional berming which will be more effective in screening the channel. A view fence-type wall should also be incorporated into the design to provide security as well as added aesthetics. Where visible, the channel wall should include a formliner and paint for aesthetics.

The Town of Queen Creek's *Zoning Ordinance Section 5.2 - Fencing* should be referenced in the final design of the view fence and wall. Landscape materials and densities should be in accordance with *Section 5.3 - Landscape*, and include an automatic irrigation system in accordance with zoning requirements. Street run-off water harvesting should augment irrigation system to provide natural irrigation to the vegetation in the right-of-way.

Channel Design Criteria

LANDSCAPE DESIGN THEME:
ENHANCED DESERT

FLOOD PROTECTION STRUCTURAL METHOD:
ENHANCED HARD

MULTI-USE FUNCTION:
6-FOOT WIDE MEANDERED SIDEWALK

BUFFER:
5 FEET INSIDE, 10 FEET ROAD SIDE

SIDE SLOPES:
3:1/VERTICAL WALL

LANDSCAPE REQUIREMENT:
(1) TREE AND (10) SHRUBS/ 500 SQ. FT. OF LANDSCAPE SETBACK, D.G., AND IRRIGATION.
3" ROCK MULCH FOR EROSION CONTROL ON SIDE-SLOPES, EXTENDED 2' ONTO CHANNEL BOTTOM.
HYDROSEED CHANNEL BOTTOM.

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EAST MESA
AREA DRAINAGE MASTER PLAN UPDATE

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

TYPICAL QUEEN CREEK CHANNEL
LANDSCAPE PLAN

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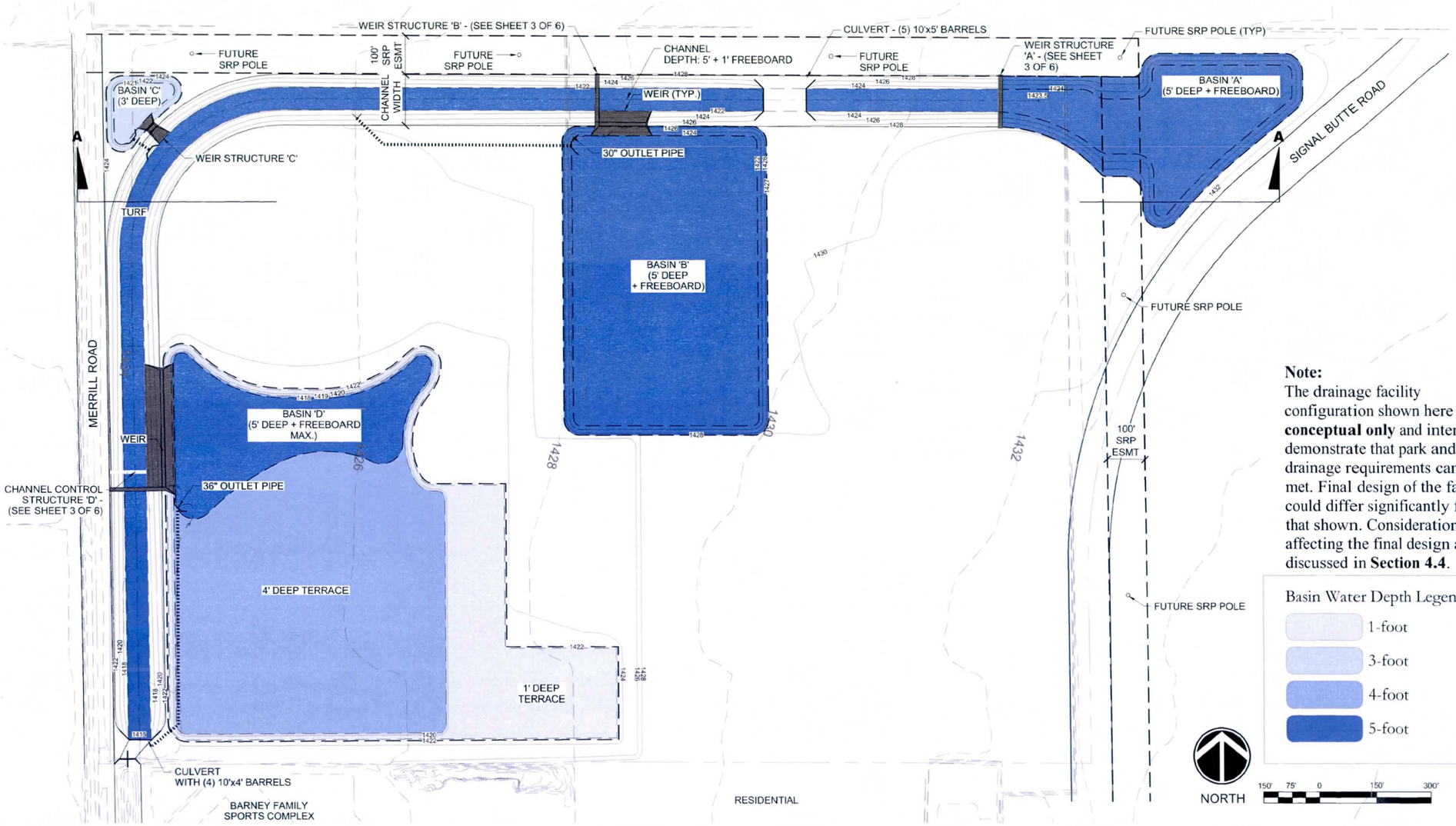
Jan 29, 2014 - 8



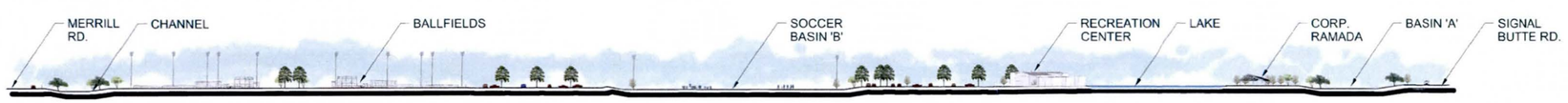
Note:
The drainage facility configuration shown here is **conceptual only** and intended to demonstrate that park and drainage requirements can be met. Final design of the facilities could differ significantly from that shown. Considerations affecting the final design are discussed in **Section 4.4**.

Basin Water Depth Legend

- 1-foot
- 3-foot
- 4-foot
- 5-foot

CONCEPTUAL PLAN VIEW

SCALE: 1" = 300'



SECTION A - A

SCALE: 1" = 300'

TOWN OF QUEEN CREEK **CONCEPTUAL** EAST PARK SPORTS COMPLEX BASIN

DESIGN GUIDELINES, THEMES, AND LANDSCAPE GUIDANCE FOR THE CO-LOCATION OF A REGIONAL DETENTION BASIN WITH THE EAST PARK SPORTS COMPLEX.

Design Concept

The Town-owned property northwest of the intersection of Signal Butte Road and Queen Creek Road has been master planned as a 90-plus acre sports complex intended to accommodate the following programmed facilities:

- Eight ball fields - highest priority
  (Four max. may be inundated)
- Five to nine soccer fields
  (One all-weather, remaining to be inundated)
- 25,000 sq. ft. recreation center that anchors an active core area to include basketball, tennis, and volleyball courts around a three-acre lake that also serves as a source for irrigation of the park turf
  (Non-inundated)
- Multiple playgrounds
  (Non-inundated)

A minimum of 140 ac. ft. of flood storage capacity has been integrated into the park concept as part of the regional flood mitigation plan.

The plan and section illustrate how a network of basins connected by a conveyance channel accomplishes the flood mitigation needs of the project. Smaller storm events will be contained within the channel and would not affect other Park facilities.

Basin Design Criteria

LANDSCAPE DESIGN THEME:
DESERT PARK

FLOOD PROTECTION STRUCTURAL METHOD:
SEMI-SOFT OR ENHANCED SEMI-HARD

MULTI-USE FUNCTION:
ACTIVE RECREATION SPORTS COMPLEX

BUFFER:
40-FOOT PREFERRED, 10-FOOT MINIMUM

SIDE SLOPES:
6:1 PREFERRED, 5:1 MAXIMUM FOR TURF MAINTENANCE

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Date Signed 1-28-20 14
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EAST MESA
AREA DRAINAGE MASTER PLAN UPDATE

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

EAST PARK BASIN/
SPORTS COMPLEX CONCEPTUAL PLAN

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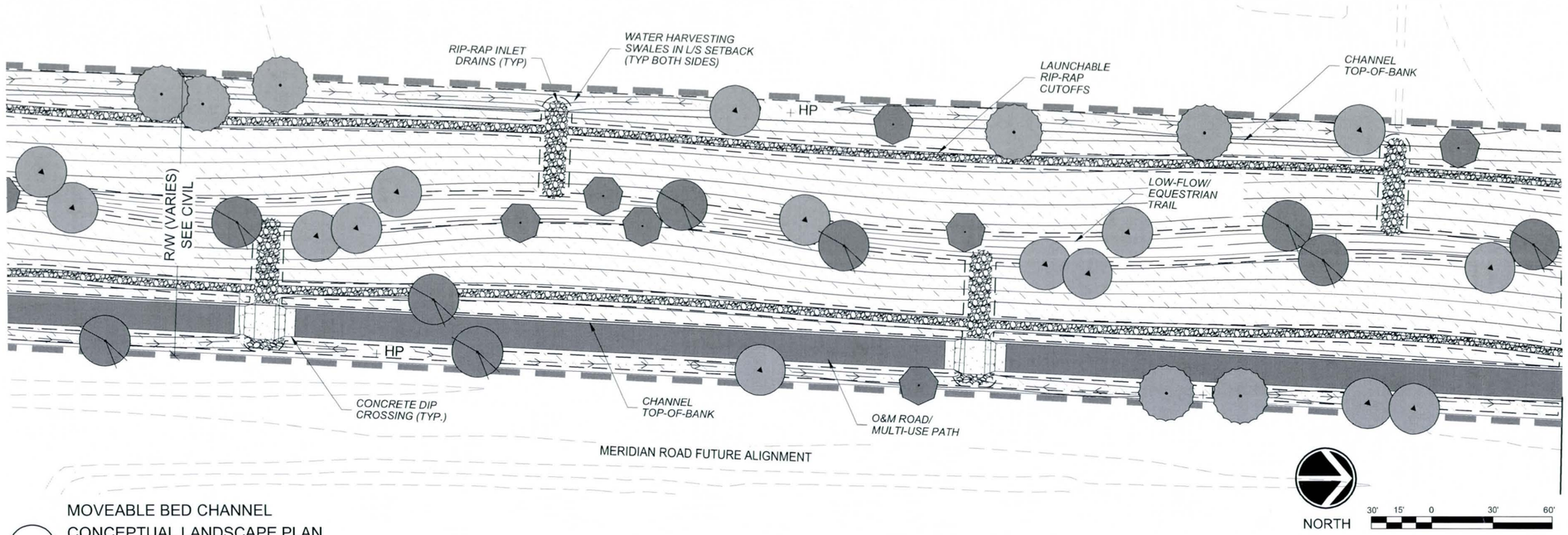
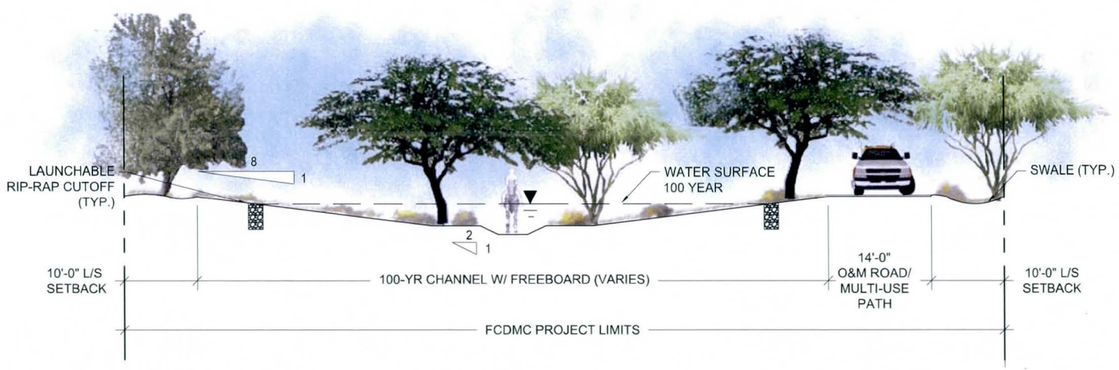
Mar 13, 2014



MOVEABLE BED CHANNEL
CONCEPTUAL LANDSCAPE PLAN

SCALE: 1" = 60'-0"



TYPICAL SECTION

SCALE: 1" = 20' - 0"

PLANT PALETTE

SYMBOL	BOTANICAL NAME / *COMMON NAME*	NOTES
	CHILOPSIS LINEARIS *DESERT WILLOW*	TALL POT
	PROSOPIS VELUTINA *VELVET MESQUITE*	TALL POT
	OLNEYA TESOTA *IRONWOOD*	TALL POT
	PARKINSONIA FLORIDA *BLUE PALO VERDE*	TALL POT

HYDROSEED

HYDROSEED GENERAL

INERT MATERIALS

RIPRAP

PROJECT LIMITS

MOVABLE BED CHANNEL

DESIGN GUIDELINES, THEMES, AND LANDSCAPE GUIDANCE FOR THE MERIDIAN ROAD MOVEABLE BED CHANNEL.

Design Concept

The reach of movable bed channel within the Rittenhouse Recommended Alternative shall be designed in order to accomplish the following objectives:

Objective 1: Accomplish the storm water mitigation requirements of the East Mesa Area Drainage Master Plan Update (See civil plans and models).

Objective 2: Replicate a natural wash with a dynamic low-flow that may erode and deposit sediment within channel limits, but continues to protect adjacent properties through the use of a barrier structure such as the launchable rip-rap cut-off walls depicted in the conceptual design. Vegetation should be selected that best replicates that found in existing washes in the area.

Objective 3: Facilitate the use of the channel bottom as an equestrian trail and the use of the O&M road as a multi-use path.

The plan and section illustrate a typical reach of this channel, making use of off-site flows to provide natural irrigation to the vegetation at the top of bank, reducing maintenance by controlling where off-site flows enter the channel system, and illustrating the use of side-slope warping to create a varied and meandered low-flow channel that serves a dual use as an equestrian path.

Channel Design Criteria

LANDSCAPE DESIGN THEME:
NATURAL RIPARIAN SONORAN DESERT WASH

FLOOD PROTECTION STRUCTURAL METHOD:
SEMI-SOFT

MULTI-USE FUNCTION:
EQUESTRIAN TRAIL, PASSIVE OPEN SPACE, MULTI-USE PATH

BUFFER:
10 FEET BOTH SIDES OF THE CHANNEL

SIDE SLOPES:
8:1 AVERAGE (6:1 TO 10:1)

LANDSCAPE REQUIREMENT:
MAINTAIN A CLEAR LOW-FLOW FOR EQUESTRIAN USE.
TREES: AVERAGE 1 TREE PER 20 FEET OF WASH, SCATTERED INTO GROUPINGS ALONG LOW-FLOW AND TOP OF BANK. BASED ON DENSITY OF REPRESENTATIVE REACH OF SIPHON DRAW WASH.

epg
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50055 JOHN J. GRIFFIN
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EAST MESA
AREA DRAINAGE MASTER PLAN UPDATE

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

TYPICAL MERIDIAN CHANNEL
LANDSCAPE PLAN

SHEET 1 OF 1

S:\EPG\Projects\FCD\East Mesa ADMP-UD-CAD\Entellus_0002 LS2.1.dwg
Jun 29, 2014 - 8

APPENDIX D. COST ESTIMATES

Rittenhouse Zone - Alternative 5

Merrill Channel

Riprap Channel

Construction	UM	Quantity	Unit Cost	Budgetary Cost
Excavation	CY	4,600	$ 5.00	$ 23,000
Cut-off-Walls (6" Riprap)	CF	NA	$ 2.41	NA
Liner				
Riprap d_{50} = 1"	SY	1,247	$ 7.00	$ 9,000
Riprap d_{50} = 3"	SY	NA	$ 7.00	NA
Bank Materials Subtotal				***$ 9,000***
Structures and Roadway				
10' x 4' Culvert (Quadruple)	FT	70	$ 2,375	$ 166,000
10'x 4' Headwall & Transition (Quadruple)	EA	2	$ 135,000	$ 270,000
10' x 5' Culvert (Quintuple)	FT	NA	$ 3,200	NA
10'x 5' Headwall & Transition (Quintuple)	EA	NA	$ 139,000	NA
Construct Concrete Retaining Wall (6'-8' Tall)	LF	424	$ 200	$ 85,000
O&M Road	SY	NA	$ 3.52	NA
Miscellaneous Removals and Replacements	LS	1	$ 50,000.00	$ 50,000
Structures and Roadway Subtotal				$ 436,000
Design and Inspection 15%				$ 70,000
Construction Subtotal				***$ 538,000***

Landscaping	UM	Quantity	Unit Cost	Budgetary Cost
Hydroseed Channel Bottom	AC	0.4	$ 2,500	$ 1,000
Landscaped Setback				
15 Gallon Trees	AC	0.1	$ 3,080	$ -
24 inch Box Trees	AC	0.1	$ 7,040	$ 1,000
5 Gallon Shrubs	AC	0.1	$ 11,325	$ 1,000
Decomposed Granite	AC	0.1	$ 14,500	$ 1,000
Drip Irrigation	AC	0.1	$ 15,000	$ 1,000
Landscape Grading	AC	0.1	$ 6,600	$ 1,000
Landscaped Setback Subtotal				$ 5,000
View Fence	FT	424.0	$ 40	$ 17,000
Retaining Wall Form Liner	FT	424.0	$ 100	$ 42,000
Design and Inspection 15%				$ 10,000
Landscaping Subtotal				***$ 75,000***

Utility Relocation	UM	Quantity	Unit Cost	Budgetary Cost
Distribution OHE Relocation	FT	NA	$ 15	NA
69kV OHE Relocation	FT	NA	$ 185	NA
8" Water Line Relocation	FT	NA	$ 125	NA
12" Water Line Relocation	FT	NA	$ 175	NA
16" Water Line Relocation	FT	NA	$ 300	NA
Water Service Line	EA	NA	$ 10,500	NA
Irrigation Relocation	FT	140	$ 100	$ 14,000
2" Gas Line Relocation	FT	NA	$ 100	NA
4" Gas Line Relocation	FT	NA	$ 120	NA
Fiber Optics Relocation	FT	NA	$ 10	NA
Fiber Optics Splice	EA	NA	$ 2,500	NA
Existing Fence Relocation	FT	NA	$ 20	NA
Sewer Service Line	EA	NA	$ 24,000	NA
Sewer Line Relocation	FT	NA	$ -	NA
Siphon Irrigation Crossing	EA	NA	$ 40,000	NA
Utility Relocation Subtotal				***$ 14,000***

Land Acquisition	UM	Quantity	Unit Cost	Budgetary Cost
Vacant Hold for Investment	AC	NA	$ 26,000	NA
Residential Lots 1-5 acres	AC	3	$ 49,500	$ 149,000
Vacant Undeveloped Commercial	AC	NA	$ 158,000	NA
Residential Home	AC	NA	$ 130,000	NA
Land Acquisition Subtotal				***$ 149,000***

Maintenance	UM	Quantity	Unit Cost	Budgetary Cost[2]
Movable Bed Channel	AC/YEAR	NA	$ 150	NA
Hardened Channel	MI/YEAR	0.1	$ 9,500	$ 36,000
Maintenance Subtotal				***$ 36,000***

Merrill Channel Subtotal	***$***	***812,000***
Contingency 20%	$	162,000
Merrill Channel Total	***$***	***974,000***

Queen Creek Channel

Riprap Channel

Construction	UM	Quantity	Unit Cost	Budgetary Cost
Excavation	CY	24,278	$ 5.00	$ 121,000
Cut-off-Walls (6" Riprap)	CF	NA	$ 2.41	NA
Liner				
Riprap d_{50} = 1"	SY	-	$ 7.00	$ -
Riprap d_{50} = 3"	SY	4,600	$ 7.00	$ 32,000
Bank Materials Subtotal				***$ -***
Structures and Roadway				
10' x 4' Culvert (Quadruple)	FT	558	$ 2,375	$ 1,325,000
10'x 4' Headwall & Transition (Quadruple)	EA	3	$ 135,000	$ 405,000
10' x 5' Culvert (Quintuple)	FT	NA	$ 3,200	NA
10'x 5' Headwall & Transition (Quintuple)	EA	NA	$ 139,000	NA
Construct Concrete Retaining Wall (6'-8' Tall)	LF	2,300	$ 200	$ 460,000
O&M Road	SY	NA	$ 3.52	NA
Miscellaneous Removals and Replacements	LS	1	$ 40,000.00	$ 40,000
Structures and Roadway Subtotal				$ 1,730,000
Design and Inspection 15%				$ 278,000
Construction Subtotal				***$ 2,129,000***

Landscaping	UM	Quantity	Unit Cost	Budgetary Cost
Hydroseed Channel Bottom	AC	2.1	$ 2,500	$ 5,000
Landscaped Setback				
15 Gallon Trees	AC	0.5	$ 3,080	$ 2,000
24 inch Box Trees	AC	0.5	$ 7,040	$ 4,000
5 Gallon Shrubs	AC	0.5	$ 11,325	$ 6,000
Decomposed Granite	AC	0.5	$ 14,500	$ 8,000
Drip Irrigation	AC	0.5	$ 15,000	$ 8,000
Landscape Grading	AC	0.5	$ 6,600	$ 3,000
Landscaped Setback Subtotal				$ 31,000
View Fence	FT	2,300.0	$ 40	$ 92,000
Retaining Wall Form Liner	FT	-	$ 100	$ -
Design and Inspection 15%				$ 19,000
Landscaping Subtotal				***$ 147,000***

Utility Relocation	UM	Quantity	Unit Cost	Budgetary Cost
Distribution OHE Relocation	FT	200	$ 15	$ 3,000
69kV OHE Relocation	FT	NA	$ 185	NA
8" Water Line Relocation	FT	200	$ 125	$ 25,000
12" Water Line Relocation	FT	200	$ 175	$ 35,000
16" Water Line Relocation	FT	NA	$ 300	NA
Water Service Line	EA	NA	$ 10,500	NA
Irrigation Relocation	FT	2,500	$ 100	$ 250,000
2" Gas Line Relocation	FT	NA	$ 100	NA
4" Gas Line Relocation	FT	200	$ 120	$ 24,000
Fiber Optics Relocation	FT	400	$ 150	$ 60,000
Fiber Optics Splice	EA	NA	$ 2,500	NA
Existing Fence Relocation	FT	NA	$ 20	NA
Sewer Service Line	EA	NA	$ 24,000	NA
Sewer Line Relocation	FT	NA	$ -	NA
Siphon Irrigation Crossing	EA	NA	$ 40,000	NA
Utility Relocation Subtotal				***$ 397,000***

Land Acquisition	UM	Quantity	Unit Cost	Budgetary Cost
Vacant Hold for Investment	AC	NA	$ 26,000	NA
Residential Lots 1-5 acres	AC	4	$ 49,500	$ 199,000
Vacant Undeveloped Commercial	AC	NA	$ 158,000	NA
Residential Home	AC	NA	$ 130,000	NA
Land Acquisition Subtotal				***$ 199,000***

Maintenance	UM	Quantity	Unit Cost	Budgetary Cost[1]
Movable Bed Channel	AC/YEAR	NA	$ 150	NA
Hardened Channel	MI/YEAR	0.4	$ 9,500	$ 207,000
Maintenance Subtotal				***$ 207,000***

Queen Creek Channel Subtotal	***$***	***3,079,000***
Contingency 20%	$	616,000
Queen Creek Channel Total	***$***	***3,695,000***

Sports Complex Retention Basin

Construction	UM	Quantity	Unit Cost	Budgetary Cost
Excavation for Basins A,B,C,D	CY	224,000	$ 4.00	$ 896,000
Excavation for Channel in Sports Cplex.	CY	85,764	$ 4.00	$ 343,000
Excavation Subtotal				***$ 1,239,000***
Structures				
Weir Control Structue A	EA	1	$ 50,000	$ 50,000
Weir Control Structure B	EA	1	$ 50,000	$ 50,000
Side Weir B	EA	1	$ 40,000	$ 40,000
Side Weir C	EA	1	$ 20,000	$ 20,000
Channel Control Structure D	EA	1	$ 60,000	$ 60,000
Side Weir D	EA	1	$ 80,000	$ 80,000
10' x 4' Culvert (Quadruple)	FT	70	$ 2,375	$ 166,000
10'x 4' Headwall & Transition (Quadruple)	EA	2	$ 135,000	$ 270,000
10' x 5' Culvert (Quintuple)	FT	120	$ 3,200	$ 384,000
10'x 5' Headwall & Transition (Quintuple)	EA	2	$ 139,000	$ 278,000
30 inch Outlet Works for Basin B	LS	2	$ 60,000	$ 120,000
18 inch Outlet Works for Basin C	LS	2	$ 10,000	$ 20,000
36 inch Outlet Works for basin D	LS	2	$ 70,000	$ 140,000
Miscellaneous Removals and Replacements	LS	1	$ 20,000.00	$ 20,000
Structures Subtotal				**$ 1,698,000**
Design and Inspection 15%				$ 441,000
Construction Subtotal				**$ 3,378,000**

Landscaping	UM	Quantity	Unit Cost	Budgetary Cost
Landscaping	AC	15	$27,890	$418,000
Design and Inspection 15%				$63,000
Landscaping Subtotal				$481,000

Land Acquisition	UM	Quantity	Unit Cost	Budgetary Cost
Land Acq. (Residential Lots 1-5 acres)	AC	30	$49,500	$1,485,000

Maintainence	UM	Quantity	Unit Cost	Budgetary Cost
Maintenance	AC/YEAR	30	$ 16,400	$ 492,000

Sports Complex Retention Basin	$ 5,836,000
Contingency 20%	$ 1,167,000
Sports Complex Retention Basin Total	***$ 7,003,000***

Rittenhouse Alternative 5 Channel - Summary

	Construction	Landscaping	Utility Relocation	Land Acquisition	Maintenance	Contingency	Totals
Merrill Channel	$ 538,000	$ 75,000	$ 14,000	$ 149,000	$ 36,000	$ 162,000	$ 974,000
Queen Creek Channel	$ 2,129,000	$ 147,000	$ 397,000	$ 199,000	$ 207,000	$ 616,000	$ 3,695,000
Totals	$ 2,667,000	$ 222,000	$ 411,000	$ 348,000	$ 243,000	$ 778,000	**$ 4,669,000**

Rittenhouse Alternative 5 Basin - Summary

	Construction	Landscaping	Utility Relocation	Land Acquisition	Maintenance	Contingency	Total
Sports Complex Retention Basin	$ 3,378,000	$ 481,000	$ -	$ 1,485,000	$ 492,000	$ 1,167,000	**$ 7,003,000**

Rittenhouse Alternative 5 Grand Total - Summary

Grand Total	**$ 11,672,000**

APPENDIX E. MASTER LIST OF REFERENCES

Project: **East Mesa ADMP Update**
FCD Contract **FCD2011C017**

Data Collection Tracking Sheet

Item Number	Type	Number of Copies	Title	Description	Prepared			Received From		Date Received	Stored/Location	Entered by
					By	Agency	Date	Contact	Agency			
Flood Control Distric of Maricopa County												
5	PDF	1	East Mesa ADMP Project Phasing Map	ADMP Map	Dibble & Associates Consulting Engineers	FCDMC	7/23/1998	-	FCDMC		Entellus	MAN
80	JPG	1	East Mesa ADMP Field Photos	Field Photos	Unkown	FCDMC	8/17/2009	-	FCDMC	3/8/2012	Entellus	RLJ
81	PDF	1	East Mesa ADMPU Hydrology	Field Photos	Unkown	FCDMC	9/9/2006	-	FCDMC	3/8/2012	Entellus	RLJ
82	JPG	1	Stock tank West of BMX	Field Photos	Unkown	FCDMC	4/22/2009	-	FCDMC	3/8/2012	Entellus	RLJ
91	DAT	1	EMF HEC-1 Models	Modified Hydrology Models	FCDMC	FCDMC	5/9/2002	-	FCDMC	3/8/2012	Entellus	RLJ
92	PDF	1	EMF HEC-1 Schematics	Modified Hydrology Schematics	J2 Engineering and Environmental Design	FCDMC	6/8/2009	-	FCDMC	3/8/2012	Entellus	RLJ
93	XLS	1	Williams Gateway Freeway HEC-1 Results Summary	Hydrology Flows	J2 Engineering and Environmental Design	FCDMC	10/20/2009	-	FCDMC	3/8/2012	Entellus	RLJ
94	PDF	1	Southeast Mesa Area Drainage Master Plan	Hydrology Schematic	FCDMC	FCDMC	6/8/2008	-	FCDMC	3/8/2012	Entellus	RLJ
96	PRJ	1	Ellsworth Channel HEC-RAS Model	HEC-RAS Model	Unkown	FCDMC	8/3/2006	-	FCDMC	3/8/2012	Entellus	RLJ
99	PDF	1	East Mesa Area Drainage Master Plan Update	ADMPU	FCDMC	FCDMC	8/11/2011	-	Unkown	2/16/2012	Entellus	RLJ
100	PDF	1	East Mesa ADMPU Project Landscape Inventory & Analysis (LIA)	Landscape Report	FCDMC	FCDMC	2/12/2012	-	Unkown	2/16/2012	Entellus	RLJ
101	PDF	1	MCDOT Corridor Studies Book of Summaries 1997-2010	Corridor Study	Maricopa County	MCDOT	10/1/2012	-	Unkown	2/16/2012	Entellus	RLJ
102	PDF	1	Powerline Floodway Final Survey Report	Survey Report	FCDMC	FCDMC	1/19/2012	-	Unkown	2/16/2012	Entellus	RLJ
103	PDF	1	Powerline and Vineyard Road FRS 2010-2011 Instrumentation Monitoring Report	Subsidence Report	AMEC Infrastructure, Inc	FCDMC	4/29/2011	-	Unkown	2/16/2012	Entellus	RLJ
107	PDF	1	East Mesa ADMP Recommended Design Report	Master Drainage Plan	Dibble & Associates Consulting Engineers	FCDMC	7/23/1998	-	Unkown	2/16/2012	Entellus	RLJ
108	PDF	1	A class I Cultural Resources Literature Review for the East Mesa ADMP, Maricopa and Pinal Counties, Arizona	Literature Review	Archaeological Consulting Services	FCDMC	6/10/2011	-	Unkown	2/16/2012	Entellus	RLJ
109	PDF	1	East Mesa Area Drainage Master Plan Preliminary Biological Survey	Biological Survey	EcoPlan Associates, Inc.	FCDMC	6/24/2011	-	Unkown	2/16/2012	Entellus	RLJ
111	PDF	1	Annual Monitoring Inspection Report Earth Fissure Site Investigation Siphon Draw Wash Drainage Improvements Project	Earth Fissure Report	AMEC Earth & Environmental, Inc.	FCDMC	8/23/2011	-	FCDMC	3/22/2012	Ninyo & Moore	HAH
112	PDF	1	Initial Subsidence and Earth Fissure Report Powerline Vineyard Road and Rittenhouse Flood Retarding Structures Rehabilitation or Replacement Project	Subsidence and Earth Fissure Report	AMEC Earth & Environmental, Inc.	FCDMC	8/10/2010	-	FCDMC	3/22/2012	Ninyo & Moore	HAH
113	PDF	1	Preliminary Design Report Site Evaluation of Interim Dam Safety Measure Powerline Flood Retarding Structure	Preliminary Dam Design Report	AMEC Earth & Environmental, Inc.	FCDMC	7/15/2009	-	FCDMC	3/22/2012	Ninyo & Moore	HAH
114	PDF	1	Geologic/Geotechnical Investigation Report Site Evaluation of Interim Dam Safety Measure Powerline Flood Retarding Structure	Geotechnical Report	AMEC Earth & Environmental, Inc.	FCDMC	7/15/2009	-	FCDMC	3/22/2012	Ninyo & Moore	HAH
115	PDF	1	Powerline and Vineyard Road FRS 2008-2009 Instrumentation Monitoring Report	Subsidence Report	AMEC Earth & Environmental, Inc.	FCDMC	5/5/2009	-	FCDMC	3/22/2012	Ninyo & Moore	HAH
116	PDF	1	Siphon Draw Drainage Improvement Project Geologic Hazard Assessment and Geotechnical Characterization Report	Geotechnical Report	AMEC Earth & Environmental, Inc.	FCDMC	9/3/2008	-	FCDMC	3/22/2012	Ninyo & Moore	HAH
117	PDF	1	Powerline Flood Retarding Structure Earth Fissure Failure Modes and Effects Analysis - Planning Phase	Earth Fissure Report	AMEC Earth & Environmental, Inc.	FCDMC	6/5/2008	-	FCDMC	3/22/2012	Ninyo & Moore	HAH
118	PDF	1	Supplemental Earth Fissure/Ground Subsidence Investigation Report Powerline Flood Retarding Structure	Subsidence and Earth Fissure Report	AMEC Earth & Environmental, Inc.	FCDMC	6/4/2008	-	FCDMC	3/22/2012	Ninyo & Moore	HAH
119	PDF	1	Earth Fissure/Ground Subsidence Instrumentation Installation Report and Monitoring Plan Powerline & Vineyard Road Flood Retarding Structures	Subsidence and Earth Fissure Report	AMEC Earth & Environmental, Inc.	FCDMC	6/29/2007	-	FCDMC	3/22/2012	Ninyo & Moore	HAH
120	PDF	1	Preliminary Earth Fissure Risk Zone Investigation Report Hawk Rock Study Area	Earth Fissure Report	AMEC Earth & Environmental, Inc.	FCDMC	9/25/2006	-	FCDMC	3/22/2012	Ninyo & Moore	HAH
121	PDF	1	Earth Fissure Risk Zone Investigation Report Powerline and Vineyard Flood Retarding Structures	Earth Fissure Report	AMEC Earth & Environmental, Inc.	FCDMC	5/25/2006	-	FCDMC	3/22/2012	Ninyo & Moore	HAH
198	PDF	1	Floodplain Regulations for Maricopa County	Regulatons		FCDMC	11/1/2011	-	MC		JE Fuller	
224	PDF	1	Supplemental Earth Fissure Risk Report, Powerline FRS Interim Dam Safety Design Measure Project	Earth Fissure Report	AMEC Earth & Environmental, Inc.	FCDMC	12/6/2010	-	FCDMC	3/28/2012	Ninyo & Moore	HAH
225	PDF	1	Powerline and Vineyard Road FRS, 2009-2010 Instrumentation Monitoring Report	Subsidence Report	AMEC Earth & Environmental, Inc.	FCDMC	6/25/2010	-	FCDMC	3/28/2012	Ninyo & Moore	HAH
226	PDF	1	Survey Report Manual for Powerline and Vineyard FRS Subsidence Surveys 2008	Survey Report	A Team Professional Associates, Inc.	FCDMC	10/1/2008	-	FCDMC	3/22/2012	Ninyo & Moore	HAH
227	PDF	1	Structures Assessment Phase II Investigation of Ground Subsidence and Earth Fissures Assignment 2 - Vineyard FRS (Volumes I, II, and III)	Subsidence and Earth Fissure Report	AMEC Earth & Environmental, Inc.	FCDMC	4/29/2002	-	FCDMC	3/22/2012	Ninyo & Moore	HAH
228	PDF	1	Procedural Documents for Land Subsidence and Earth Fissure Appraisals	Subsidence and Earth Fissure Report	AMEC Earth & Environmental, Inc.	FCDMC	5/27/2011	-	FCDMC	3/22/2012	Ninyo & Moore	HAH
231	PDF	1	East Mesa Area Drainage Master Plan Hydrologic Analysis Vol 1 of 2	Hydrology Report	FCDMC	FCDMC	10/1/1998	-	FCDMC	4/6/2012	Entellus	RLJ
232	PDF	1	East Mesa Area Drainage Master Plan Hydrologic Analysis Vol 2 of 2	Hydrology Report	FCDMC	FCDMC	10/1/1998	-	FCDMC	4/6/2012	Entellus	RLJ
233	PDF	1	Southeast Mesa Area Drainage Master Plan Data Collection Report	Data Collection Report	Dibble & Associates Consulting Engineers	FCDMC	5/3/1997	-	FCDMC	4/6/2012	Entellus	RLJ
234	PDF	1	East Mesa Area Drainage Master Plan Recommended Design Report	Drainage Report	Dibble & Associates Consulting Engineers	FCDMC	6/23/1998	-	FCDMC	4/6/2012	Entellus	RLJ
235	PDF	1	Geotechnical Engineering Report Southeast Mesa Area Drainage Master Plan	Geotechnical Report	Ricker, Atkinson, McBee & Associates, Inc.	FCDMC	5/7/1998	-	FCDMC	4/6/2012	Entellus	RLJ
236	PDF	1	DRAFT Phase 1 Environmental Site Assessment Southeast Mesa Area Drainage Master Plan	Environmental Assessment	Western Technologies Inc.	FCDMC	4/15/1998	-	FCDMC	4/6/2012	Entellus	RLJ
237	PDF	1	East Mesa Area Drainage Master Plan - Preliminary Plan	Preliminary Drainage Plan Map	Dibble & Associates Consulting Engineers	FCDMC		-	FCDMC	4/6/2012	Entellus	RLJ
247	PDF	1	Rittenhouse Channel LOMR	LOMR	FCDMC	FCDMC	10/28/1999	Jennifer Pokorski	FCDMC	5/2/2012	Entellus	RAS
248	PDF	1	Letter of Map revision for Rittenhouse Road Channel - Technical Data Notebook	Technical Data Notebook	FCDMC	FCDMC	1/1/1999	Jennifer Pokorski	FCDMC	5/2/2012	Entellus	RAS
249	PDF	1	Final Conceptual Design Report For Rittenhouse Channel From Signal Butte Road to the East Maricopa Floodway	Design Concept report	Gannett Fleming, Inc.	FCDMC	8/19/1993	Jennifer Pokorski	FCDMC	5/2/2012	Entellus	RAS
258		1	Appendix HEC - 1 Schematic - North and South of the Superstition Freeway	FCDMC East Mesa Area Drainage Master Plan	Dibble & Associates Consulting Engineering	FCDMC	-	-	FCDMC	6/16/12	Entellus	ATC
259	PDF	1	Siphon Draw Drainage Improvements Phase 1	Plans for the Siphon Draw Drainage Improvements	Stanley Consultants, Inc.	FCDMC	1/19/2009	-	FCDMC	6/18/12	Entellus	ATC
261	PDF	1	East Mesa Area Drainage Master Plan	Preliminary Design Plans	Dibble & Associates Consulting Engineering	FCDMC	6/18/1998	-	FCDMC	6/18/12	Entellus	ATC
Development												
1	PDF	1	Master Drainage Report for Mesa Proving Grounds (Redline Version)	Redline Version	Wood-Patel		9/30/2008	Shahir Safi	City of Mesa	12/15/2008	Entellus	MAN
2	PDF	1	Final Drainage Report for Ironwood Crossing	Drainage Report	CMX		1/16/2006	Elise Moore	Pinal County	12/13/2009	Entellus	MAN
3	PDF	1	Preliminary Drainage Report for Ironwood/Pima Subdivision	Drainage Report	CAN-AM		10/27/2004	Elise Moore	Pinal County	12/13/2009	Entellus	MAN
12	PDF	1	Final Drainage Report for Gila River Ranches Sub Division	Final Drainage Report	CMX		1/25/2005	Shahir Safi	City of Mesa	3/2/2009	Entellus	MAN

Project: **East Mesa ADMP Update**
FCD Contract **FCD2011C017**

Data Collection Tracking Sheet

Item Number	Type	Number of Copies	Title	Description	Prepared			Received From		Date Received	Stored/Location	Entered by
					By	Agency	Date	Contact	Agency			
13	PDF	1	Final Drainage Report for Mountain Heights Sub division	Final Drainage Report	Infinity Engineering Services		9/12/2001	Shahir Safi	City of Mesa	3/2/2009	Entellus	MAN
14	PDF	1	Final Drainage Report for Mountain Horizons Sub Division 1 of 2	Final Drainage Report - 1st Submittal	CMX		9/20/2005	Shahir Safi	City of Mesa	3/2/2009	Entellus	MAN
15	PDF	1	Final Drainage Report for Mountain Horizons Sub Division 2 of 2	Final Drainage Report - 2nd Submittal	CMX		1/18/2006	Shahir Safi	City of Mesa	3/2/2009	Entellus	MAN
18	PDF	1	Master Drainage Plan for Mountain Ranch Sub Division	Drainage Report	DEI Professional Services		12/8/1999	Shahir Safi	City of Mesa	3/2/2009	Entellus	MAN
21	PDF	1	Offsite Flow Management for Gila River Ranches Sub Division 1 of 2	Offsite Drainage Report - 2nd Submittal	CMX		6/15/2005	Shahir Safi	City of Mesa	3/2/2009	Entellus	MAN
22	PDF	1	Offsite Flow Management for Gila River Ranches Sub Division 2 of 2	Offsite Drainage Report - 1st Submittal	CMX		12/2/2004	Shahir Safi	City of Mesa	3/2/2009	Entellus	MAN
25	PDF	1	Drainage Master Plan for Leslie Estates	Master Drainage Report	Community Science Corporation		6/29/2000	-	Town of Queen Creek	3/16/2009	Entellus	MAN
26	PDF	1	Final Drainage Report for Charleston Estates	Final Drainage Report	Sunrise Engineering		6/5/2007	-	Town of Queen Creek	3/16/2009	Entellus	MAN
27	PDF	1	Final Drainage Report for ALC Builders	Final Drainage Report	D & M Engineering		5/10/2005	-	Town of Queen Creek	3/16/2009	Entellus	MAN
28	PDF	1	Final Drainage Report for Langley Gateway Estates	Final Drainage Report	AMEC Infrastructure, Inc		1/18/2005	-	Town of Queen Creek	3/16/2009	Entellus	MAN
29	PDF	1	Final Drainage Report for Nauvoo Station	Final Drainage Report	Fleet-Fisher Engineering, Inc		6/7/2006	-	Town of Queen Creek	3/16/2009	Entellus	MAN
30	PDF	1	Final Drainage Report for Grismon Heights	Final Drainage Report	Fleet-Fisher Engineering, Inc		9/24/2004	-	Town of Queen Creek	3/16/2009	Entellus	MAN
54	PDF	1	Gila River Ranches - Offsite Improvement Plans for South Meridian Drive	As-Built	CMX		10/30/2006	-	FCDMC	3/9/2012	Entellus	RLJ
55	PDF	1	Gila River Ranches Unit 2 - Grading Plans	As-Built	CMX		6/30/2005	-	FCDMC	3/8/2012	Entellus	RLJ
56	PDF	1	Gila River Ranches Unit 3 - Final Plat	As-Built	CMX		1/21/2005	-	FCDMC	3/8/2012	Entellus	RLJ
57	PDF	1	Gila River Ranches: Offsite Water Plans - S. Mountain Road	As-Built	CMX		7/9/2004	-	FCDMC	3/8/2012	Entellus	RLJ
60	PDF	1	Mountain Horizons Improvement Plans - Unit 5	Plans	CMX		1/26/2006	-	FCDMC	3/8/2012	Entellus	RLJ
61	PDF	1	Mountain Horizons Improvement Plans - Unit 6	Plans	CMX		1/25/2006	-	FCDMC	3/8/2012	Entellus	RLJ
62	PDF	1	Mountain Horizons Improvement Plans - Unit 8	As-Built	CMX		1/25/2006	-	FCDMC	3/8/2012	Entellus	RLJ
63	PDF	1	Final Plat of Mountain Horizons Unit 5	Plat	CMX		2/15/2006	-	FCDMC	3/8/2012	Entellus	RLJ
64	PDF	1	Final Plat of Mountain Horizons Unit 2	Plat	CMX		2/15/2006	-	FCDMC	3/8/2012	Entellus	RLJ
65	PDF	1	Mountain Horizons Offsite Improvement Plans - Phase 2	Plans	CMX		3/3/2008	-	FCDMC	3/8/2012	Entellus	RLJ
66	PDF	1	Mountain Horizons Improvement Plans - Unit 1	Plans	CMX		9/14/2006	-	FCDMC	3/8/2012	Entellus	RLJ
67	PDF	1	Mountain Horizons Improvement Plans - Unit 9	Plans	CMX		3/28/2007	-	FCDMC	3/8/2012	Entellus	RLJ
68	PDF	1	Mountain Horizons Improvement Plans - Unit 4	Plans	CMX		9/7/2007	-	FCDMC	3/8/2012	Entellus	RLJ
69	PDF	1	Mountain Horizons Water Meter Plans - Unit 7	Plans	CMX		8/23/2007	-	FCDMC	3/8/2012	Entellus	RLJ
70	PDF	1	Mountain Horizons Improvement Plans - Unit 10	Plans	CMX		2/7/2008	-	FCDMC	3/8/2012	Entellus	RLJ
71	PDF	1	Mountain Horizons South Offsite Water & Sewer Plans - Phase 2	Plans	CMX		11/19/2007	-	FCDMC	3/8/2012	Entellus	RLJ
72	PDF	1	Mountain Ranch Unit 2 Improvement Plans	As-Built	DEI Professional Services		12/30/1999	-	FCDMC	3/8/2012	Entellus	RLJ
73	PDF	1	Nova Vista Arterial Improvement Plans	As-Built	CMX		6/30/2006	-	FCDMC	3/8/2012	Entellus	RLJ
74	PDF	1	Nova Vista Collector Improvement Plans	As-Built	CMX		8/25/2006	-	FCDMC	3/8/2012	Entellus	RLJ
75	PDF	1	Nova Vista Improvement Plans - Unit C	As-Built	CMX		7/12/2006	-	FCDMC	3/8/2012	Entellus	RLJ
76	PDF	1	Nova Vista Improvement Plans - Unit A	As-Built	CMX		8/25/2006	-	FCDMC	3/8/2012	Entellus	RLJ
77	PDF	1	Nova Vista Improvement Plans - Unit B	As-Built	CMX		8/26/2006	-	FCDMC	3/8/2012	Entellus	RLJ
78	PDF	1	Nova Vista Improvement Plans - Unit D	Plans	CMX		5/25/2007	-	FCDMC	3/8/2012	Entellus	RLJ
79	PDF	1	Offsite Improvements for Stratford Estates	As-Built	Infinity Engineering Services		9/29/2000	-	FCDMC	3/8/2012	Entellus	RLJ
106	PDF	1	Master Drainage Report for Development Unit 7 at Mesa Proving Grounds	Drainage Report	Wood-Patel		9/29/2011	-	Unkown	2/16/2012	Entellus	RLJ
205	PDF	1	Community Plan for Mesa Proving Grounds-Section 4- Regulatory Framework	Guide			10/1/2008	-	Mesa		JE Fuller	
206	PDF	1	Community Plan for Mesa Proving Grounds-Section 9- Applicability of Mesa Engineering & Design Standards	Guide			10/1/2008	-	Mesa		JE Fuller	
207	PDF	1	Community Plan for Mesa Proving Grounds-Section 12- Landscape Standards	Guide			10/1/2008	-	Mesa		JE Fuller	
208	PDF	1	Community Plan for Mesa Proving Grounds-Section 13- Stormwater Drainage & Ret Stds	Guide			10/1/2008	-	Mesa		JE Fuller	
213	Hard Copy	1	Eastmark Thematic Design Guidelines	Eastmark Thematic Design Guidelines	DMB		10/1/2011	Trevor Barger	DMB	3/22/2012	EPG	JJG
229	PDF	1	Pacific Proving Grounds Master Drainage Report	Drainage Report	EPS Group, Inc.		1/1/2012	-	FCDMC	4/6/2012	Entellus	RLJ
241	PDF	1	Master Drainage Report for Mesa Proving Grounds	Drainage Report	Wood-Patel		9/15/2011	-			Entellus	RLJ
262	PDF	1	MGC Pure Chemicals America Warehouse & Isotainer Parking Additions	Plans	Wood-Patel	MGC Pure Chemicals	01/112	Ashok Patel	Wood-Patel	41088	Entellus	RLJ
Williams Gateway Airport												
11	PDF	1	Drainage Master Plan for Phoenix Mesa Gateway Airport	Drainage Master Plan	Dibble Engineering		2/11/2008	Shahir Safi	City of Mesa	3/2/2009	Entellus	MAN
16	PDF	1	Hydrology & Drainage Plan for Williams Gateway Airport Apr 1999	Supplement to Master Drainage Report	Gilbertson Associates, Inc		4/30/1999	Shahir Safi	City of Mesa	3/2/2009	Entellus	MAN
17	PDF	1	Hydrology Study-Drainage Master Plan for Williams Gateway Airport Oct 2001	Hydrology Study	Gilbertson Associates, Inc		10/10/2001	Shahir Safi	City of Mesa	3/2/2009	Entellus	MAN
19	PDF	1	North Area Drainage Evaluation for Williams Gateway Airport	Drainage Report	Dibble & Associates Consulting Engineers		10/31/2006	Shahir Safi	City of Mesa	3/2/2009	Entellus	MAN
20	PDF	1	North General Aviation Area Drainage Improvements & Cul-de-sac Design for Williams Gateway Airport	Final Drainage Report	Dibble & Associates Consulting Engineers		6/14/2007	Shahir Safi	City of Mesa	3/2/2009	Entellus	MAN
85	PDF	1	Drainage Report for Gateway Airport Commerce Center	Drainage Report	Allen Consulting Engineers, Inc.		4/26/2007	-	FCDMC	3/8/2012	Entellus	RLJ
87	PDF	1	Master Drainage Plan for Williams Gateway Airport	Master Drainage Report	Dibble & Associates Consulting Engineers		4/19/1996	-	FCDMC	3/8/2012	Entellus	RLJ
88	PDF	1	Supplement to Williams Gateway Airport Hydrology Study and Master Drainage Plan	Master Drainage Report Supplement	Gilbertson Associates, Inc		6/12/2002	-	FCDMC	3/8/2012	Entellus	RLJ
Arizona State Land Department												
4	PDF	1	Desert Drive Study	Hydrology & Sediment Yield Study	JE Fuller	ASLD	12/10/2007	-	ASLD		Entellus	MAN
33	PDF	1	Desert Drive Area Study Volume I - Existing Conditions Hydrology	Area Study	JE Fuller	ASLD	12/10/2007	-	ASLD	3/8/2012	Entellus	RLJ
34	PDF	1	Desert Drive Area Study Volume II - Book 1	Area Study	JE Fuller	ASLD	4/28/2008	-	ASLD	3/8/2012	Entellus	RLJ
35	PDF	1	Desert Drive Area Study Volume II - Book 2	Area Study	JE Fuller	ASLD	4/29/2008	-	ASLD	3/8/2012	Entellus	RLJ
City of Mesa												
32	PDF	1	City of Mesa Storm Drain Master Plan	Storm Drain Master Plan	Entellus, Inc	City of Mesa	1/14/2010	-	FCDMC	3/8/2012	Entellus	RLJ
58	PDF	1	City of Mesa Improvement Plans for Keighley Place	As-Built	Landaide, Inc.	City of Mesa	3/19/2007	-	FCDMC	3/8/2012	Entellus	RLJ

Project: **East Mesa ADMP Update**
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Data Collection Tracking Sheet

Item Number	Type	Number of Copies	Title	Description	Prepared			Received From		Date Received	Stored/Location	Entered by
					By	Agency	Date	Contact	Agency			
59	PDF	1	City of Mesa Improvement Plans for Mountain Heights	As-Built	Infinity Engineering Services	City of Mesa	3/5/2001	-	FCDMC	3/8/2012	Entellus	RLJ
110	PDF	1	City of Mesa Engineering and Design Standards 2009	Design Standards	City of Mesa	City of Mesa	2/1/2009	-	Unkown	3/8/2012	Entellus	RLJ
203	PDF	1	Mesa Storm Water Management Plan	Guide		City of Mesa	9/1/2011	-	Mesa		JE Fuller	
204	PDF	1	Mesa Stormwater Annual Report to ADEQ 2010-2011	Guide		City of Mesa	9/1/2011	-	Mesa		JE Fuller	
209	PDF	1	Mesa Subdivision Regulations	Reg		City of Mesa	11/1/2006	-	Mesa		JE Fuller	
215	GIS	1	City of Mesa Utilities	GIS utility files	City of Mesa	City of Mesa	3/24/2012		City of Mesa	3/24/2012	Entellus	HAA
Town of Queen Creek												
7	PDF	1	Town of Queen Creek General Plan	General Plan Update 2008	Town of Queen Creek	Town of Queen Creek	5/21/2008	Chris Dovel	Town of Queen Creek	1/14/2009	Entellus	MAN
8	PDF	1	Town of Queen Creek Landuse Plan	Landuse Plan Amendment	Town of Queen Creek	Town of Queen Creek	5/21/2008	Chris Dovel	Town of Queen Creek	1/14/2009	Entellus	MAN
9	PDF	1	Town of Queen Creek Parks, Trails & Open Space Master Plan	Parks, Trails & Open Space Master Plan	Town of Queen Creek	Town of Queen Creek	11/30/2005	Chris Dovel	Town of Queen Creek	1/14/2009	Entellus	MAN
10	PDF	1	Town of Queen Creek Five Parks Master Plan	Five Parks Master Plan	Town of Queen Creek	Town of Queen Creek	9/30/2007	Chris Dovel	Town of Queen Creek	1/14/2009	Entellus	MAN
210	PDF	1	Queen Creek Subdivision Ordinance - Chapter 6 Subdivision Design Standards and Principles	Ord		Town of Queen Creek	10/1/2007	-	Town of Queen Creek		JE Fuller	
211	PDF	1	Queen Creek Design Standards and Procedures Manual Final Drainage Report Review Checklist	Guide		Town of Queen Creek	10/1/2007	-	Town of Queen Creek		JE Fuller	
212	PDF	1	Queen Creek Flood Control Ordinance	Ord		Town of Queen Creek	8/1/2007	-	Town of Queen Creek		JE Fuller	
214	GIS	1	Queen Creek Utilities	GIS utility files	Town of Queen Creek	Town of Queen Creek	4/23/2012	-	Town of Queen Creek	4/23/2012	Entellus	HAA
257	PDF	1	Germann Road Corridor Improvement Study	Slideshow Slides from Technical Advisory Group Meeting #3	Town of Queen Creek	Town of Queen Creek	3/28/2012	-	Town of Queen Creek	3/28/12	Entellus	ATC
Pinal County												
6	PDF	1	Draft Pinal County ADMP - Phase C - Queen Creek Watershed	Draft ADMP	Entellus, Inc	Pinal County	10/31/2008	Elise Moore	Pinal County	Unkown	Entellus	MAN
23	PDF	1	Final Drainage Report for Germann Road Between Ironwood Drive and Kenworthy Road	Improvement Drainage Report	Jacobs	Pinal County	3/10/2009	Elise Moore	Pinal County	3/12/2009	Entellus	MAN
24	PDF	1	Final Pavement Drainage Memorandum East West Arterial Widening Between Ironwood and Meridian, Combs Rd, Ocotillo Rd, Pecos Rd (Phase I) Pima Rd, Germann Rd (Phase II)	Drainage Report	Carter Burgess	Pinal County	6/7/2007	Elise Moore	Pinal County	3/12/2009	Entellus	MAN
31	PDF	1	Apache Junction Watershed (Pinal County)	Final Drainage Report	Entellus, Inc	Pinal County	10/25/2006	Andrea Betts	Pinal County	4/1/2009	Entellus	MAN
43	PDF	1	Ironwood Drive Paving Plans Phase B1	Paving Plans	Kimley-Horn and Associates, Inc.	Pinal County	12/7/2006	-	FCDMC	3/8/2012	Entellus	RLJ
44	PDF	1	Ironwood Drive Paving Plans Phase B2	Paving Plans	Kimley-Horn and Associates, Inc.	Pinal County	12/2/2006	-	FCDMC	3/8/2012	Entellus	RLJ
45	PDF	1	Ironwood Drive Paving Plans Phase B3 and B4	Paving Plans	Kimley-Horn and Associates, Inc.	Pinal County	1/22/2007	-	FCDMC	3/8/2012	Entellus	RLJ
83	PDF	1	Pinal County Comprehensive Plan	Comprehensive Plan	Pinal County	Pinal County	11/18/2009	-	FCDMC	3/8/2012	Entellus	RLJ
97	TIF	1	Ironwood Drive - Ocotillo Road	Plans/As-Built	Kimley-Horn and Associates, Inc.	Pinal County	1/29/2007	-	FCDMC	3/8/2012	Entellus	RLJ
255	Hard Copy	1	Pinal County Area Drainage Master Plan Phase A - Apache Junction (Final)	Area Drainage Master Plan	Entellus, Inc	Pinal County	10/25/2006	-	Entellus Library		Entellus	RLJ
256	Hard Copy	1	Pinal County Area Drainage Master Plan Phase C - Queen Creek (Final)	Area Drainage Master Plan	Entellus, Inc	Pinal County	5/15/2009	-	Entellus Library		Entellus	RLJ
MCDOT												
36	PDF	1	Final Drainage Report for Ellsworth Road - Phase I - Germann Road to Ray Road	Final Drainage Report	AMEC Infrastructure, Inc	MCDOT	5/23/2005	-	FCDMC	3/8/2012	Entellus	RLJ
37	PDF	1	Plans for the Construction of Ellsworth Road - Phase I - Germann Road to Ray Road	As-Built	AMEC Infrastructure, Inc	MCDOT	4/19/2005	-	FCDMC	3/8/2012	Entellus	RLJ
46	PDF	1	Signal Butte Corridor Improvement Study: US 60 to Rittenhouse Road	Draft Roadway Improvements Study	EPS Group, Inc.	MCDOT	12/1/2009	-	FCDMC	3/8/2012	Entellus	RLJ
47	PDF	1	Signal Butte Corridor Improvement Study: US 60 to Rittenhouse Road - Technical Memorandum No. 1: Purpose and Need	Draft Roadway Improvements Study	EPS Group, Inc.	MCDOT	1/2/2009	-	FCDMC	3/8/2012	Entellus	RLJ
48	PDF	1	Signal Butte Corridor Improvement Study: US 60 to Rittenhouse Road - Technical Memorandum No. 5: Conceptual Drainage report	Draft Roadway Improvements Study	JE Fuller	MCDOT	4/6/2009	-	FCDMC	3/8/2012	Entellus	RLJ
49	PDF	1	Signal Butte Corridor Improvement Study: US 60 to Rittenhouse Road - Technical Memorandum No. 8: Design Features & Access Management Guidelines	Draft Roadway Improvements Study	EPS Group, Inc.	MCDOT	11/1/2009	-	FCDMC	3/8/2012	Entellus	RLJ
50	PDF	1	MCDOT RightToads Program Summary of Public Involvement - Signal Butte Corridor Improvement Study: US 60 to Rittenhouse Road	Final Roadway Improvements Study	MCDOT	MCDOT	12/1/2009	-	FCDMC	3/8/2012	Entellus	RLJ
51	PDF	1	Signal Butte Corridor Improvement Study: US 60 to Rittenhouse Road - Draft Technical Memorandum No. 2: Corridor Characteristics	Draft Roadway Improvements Study	EPS Group, Inc.	MCDOT	2/1/2009	-	FCDMC	3/8/2012	Entellus	RLJ
52	PDF	1	Signal Butte Corridor Improvement Study: US 60 to Rittenhouse Road - Draft Technical Memorandum No. 5: Conceptual Drainage report	Draft Roadway Improvements Study	JE Fuller	MCDOT	2/1/2009	-	FCDMC	3/8/2012	Entellus	RLJ
53	PDF	1	Signal Butte Corridor Improvement Study: US 60 to Rittenhouse Road - Draft Technical Memorandum No.4: Environmental Overview	Draft Roadway Improvements Study	Logan Simpson Design Inc.	MCDOT	1/1/2009	-	FCDMC	3/8/2012	Entellus	RLJ
98	DAT	1	Signal Butte Corridor HEC-1	Hydrology Models	Unkown	MCDOT	1/14/2009	-	FCDMC	3/8/2012	Entellus	RLJ
191	PDF	1	Pavement Design Summary, Ironwood-Gantzel, Roadway Improvement Project, Pinal County, Arizona N&M Project No. 600948002	Pavement Design Report	Ninyo & Moore	Pinal County	9/13/2005	-	Ninyo & Moore		Ninyo & Moore	HAH
192	PDF	1	Geotechnical Evaluation, Ironwood Drive Improvements, Ocotillo Road to US 60, Pinal County, Arizona N&M Project No. 600948001	Geotechnical Evaluation Report	Ninyo & Moore	Pinal County	3/11/2005	-	Ninyo & Moore		Ninyo & Moore	HAH
238	PDF	1	Ellsworth Rd Phase I - Germann Rd to Ray Road	As-Built	MCDOT	MCDOT	6/6/2007	-	FCDMC	4/6/2012	Entellus	RLJ
239	PDF	1	Erie Street Drainage Improvements	Drainage Report	Prestige Engineering Consultants	MCDOT	6/1/2008	-	FCDMC	4/6/2012	Entellus	RLJ
250	PDF	1	Meridian Road Access Control and Corridor Improvement Study - Final Report	Corridor Study	URS	MCDOT	1/1/2006	-	Baker	5/17/2012	Entellus	RLJ
251	PDF	1	Meridian Road Access Control and Corridor Improvement Study - Appendices 1 - 7	Corridor Study	URS	MCDOT	1/1/2006	-	Baker	5/17/2012	Entellus	RLJ
252	PDF	1	Meridian Road Access Control and Corridor Improvement Study - Appendices 8 - 9	Corridor Study	URS	MCDOT	1/1/2006	-	Baker	5/17/2012	Entellus	RLJ
253	PDF	1	Meridian Road Access Control and Corridor Improvement Study - Technical Memo No. 9	Corridor Study	URS	MCDOT	1/1/2006	-	Baker	5/17/2012	Entellus	RLJ
254	PDF	1	Meridian Road Access Control and Corridor Improvement Study - Appendix 10	Corridor Study	URS	MCDOT	1/1/2006	-	Baker	5/17/2012	Entellus	RLJ

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					By	Agency	Date	Contact	Agency			
FEMA												
38	JPG	1	FIRM Maricopa County, Arizona - Panel 2685 of 4350	Flood Insurance Rate Map	FEMA	FEMA	9/30/2005	-	FCDMC	3/8/2012	Entellus	RLJ
39	JPG	1	FIRM Maricopa County, Arizona - Panel 2690 of 4350	Flood Insurance Rate Map	FEMA	FEMA	9/30/2005	-	FCDMC	3/8/2012	Entellus	RLJ
40	JPG	1	FIRM Maricopa County, Arizona - Panel 2695 of 4350	Flood Insurance Rate Map	FEMA	FEMA	9/30/2005	-	FCDMC	3/8/2012	Entellus	RLJ
41	PDF	1	FIRM Pinal County, Arizona - Panel 200 of 2575 (Rittenhouse Air Force Auxiliary Field)	Flood Insurance Rate Map	FEMA	FEMA	10/4/2007	-	FCDMC	3/8/2012	Entellus	RLJ
42	PDF	1	FIRM Pinal County, Arizona - Panel 200 of 2575	Flood Insurance Rate Map	FEMA	FEMA	10/4/2007	-	FCDMC	3/8/2012	Entellus	RLJ
ADOT												
89	PDF	1	SR 802 Williams Gateway Freeway - Powerline Floodway Overpass	Preliminary Plans	AECOM	ADOT	10/9/2012	-	FCDMC	3/8/2012	Entellus	RLJ
90	PDF	1	SR 802 Williams Gateway Freeway - Ironwood Drive	Draft Roll Plot	Unkown	ADOT	9/29/2009	-	FCDMC	3/8/2012	Entellus	RLJ
95	PDF	1	SR 802 Williams Gateway Freeway Corridor Study: SR 202L to Florence Junction Location/Design Concept Study & Environmental Assessment	Draft SR802 Alignments	ADOT	ADOT	5/9/2012	-	FCDMC	3/8/2012	Entellus	RLJ
230	PDF	1	Germann Road Corridor Improvement Study Technical Advisory Group Meeting #3	Roadway Study	ADOT/Town of Queen Creek	ADOT	11/3/2011		FCDMC	4/6/2012	Entellus	RLJ
240	PDF	1	Germann Road Corridor Improvement Study Power Road to Ironwood Road	Drainage Report	Wilson & Company	ADOT	3/1/2012	Jennifer Pokorski	FCDMC	4/11/2012	Entellus	RLJ
242	Hard copy	1	Project Plans State Highway Getaway Freeway (SR -24)	Construction Plans	Stantec Consultants Inc.	ADOT	11/3/2011	Jennifer Pokorski	FCDMC	3/24/2012	Entellus	HAA
242	PDF	1	Final Materials Design Memorandum - State Route 24 - Gateway Freeway - State Route 202L to Ellsworth Road	Final Materials Design Memorandum	AMEC Earth & Environmental, Inc.	ADOT	10/7/2011	-	ADOT	4/13/2012	Ninyo & Moore	HAH
243	PDF	1	Final Foundation Investigation Report - State Route 24 - Gateway Freeway - State Route 202L to Ellsworth Road	Final Foundation Investigation Report	AMEC Earth & Environmental, Inc.	ADOT	8/12/2011	-	ADOT	4/13/2012	Ninyo & Moore	HAH
244	PDF	1	Final Design Concept Report (Volume 1 of 2) SR 24, Gateway Freeway (SR 202L - Ironwood Road)	Final Design Concept Report	AECOM	ADOT	4/1/2011	-	ADOT	4/13/2012	Ninyo & Moore	HAH
245	PDF	1	Final Geotechnical Investigation Report - State Route 24 - Gateway Freeway - State Route 202L to Ellsworth Road	Final Geotechnical Investigation Report	AMEC Earth & Environmental, Inc.	ADOT	8/12/2011	-	ADOT	4/13/2012	Ninyo & Moore	HAH
260	PDF	1	State Highway Gateway Freeway (SR 24)	SR 24: SR 202L to Ellsworth Road	Stanley Consultants, Inc.	ADOT	11/1/2011	-	ADOT	6/18/12	Entellus	ATC
ADWR												
105	PDF	1	Land Subsidence Maps	Subsidence Maps	ADWR	ADWR	Varies	-	Unkown	2/16/2012	Entellus	RLJ
167	PDF	1	Land Subsidence in the Hawk Rock Area of East Mesa and Apache Junction 2/22/2006 to 4/2/2008	Land Subsidence Map	Arizona Dept of Water Resources	ADWR	6/30/1905	-	ADWR		Ninyo & Moore	HAH
168	PDF	1	Land Subsidence in the Hawk Rock Area of East Mesa and Apache Junction 2/7/2007 to 4/2/2008	Land Subsidence Map	Arizona Dept of Water Resources	ADWR	7/1/1905	-	ADWR		Ninyo & Moore	HAH
169	PDF	1	Land Subsidence in the Hawk Rock Area of East Mesa and Apache Junction 2/7/2007 to 3/18/2009	Land Subsidence Map	Arizona Dept of Water Resources	ADWR	7/2/1905	-	ADWR		Ninyo & Moore	HAH
170	PDF	1	Land Subsidence in the Hawk Rock Area of East Mesa and Apache Junction 2/11/2009 to 3/3/2010	Land Subsidence Map	Arizona Dept of Water Resources	ADWR	7/1/1905	-	ADWR		Ninyo & Moore	HAH
171	PDF	1	Land Subsidence in the Hawk Rock Area of East Mesa and Apache Junction 1/23/2008 to 2/11/2009	Land Subsidence Map	Arizona Dept of Water Resources	ADWR	7/2/1905	-	ADWR		Ninyo & Moore	HAH
172	PDF	1	Land Subsidence in the Hawk Rock Area of East Mesa and Apache Junction 1/23/2008 to 3/3/2010	Land Subsidence Map	Arizona Dept of Water Resources	ADWR	7/2/1905	-	ADWR		Ninyo & Moore	HAH
173	PDF	1	Land Subsidence in the Hawk Rock Area of East Mesa and Apache Junction 5/15/2010 to 5/10/2011	Land Subsidence Map	Arizona Dept of Water Resources	ADWR	7/3/1905	-	ADWR		Ninyo & Moore	HAH
174	PDF	1	Land Subsidence in the Hawk Rock Area of East Mesa and Apache Junction 10/20/2004 to 9/29/2010	Land Subsidence Map	Arizona Dept of Water Resources	ADWR	7/2/1905	-	ADWR		Ninyo & Moore	HAH
175	PDF	1	Land Subsidence in the Hawk Rock Area of East Mesa and Apache Junction 5/17/1992 to 4/19/2000	Land Subsidence Map	Arizona Dept of Water Resources	ADWR	6/22/1905	-	ADWR		Ninyo & Moore	HAH
176	PDF	1	East Mesa Change in Water Level from 1900 to 2002	Water Level Map	Arizona Dept of Water Resources	ADWR	6/24/1905	-	ADWR		Ninyo & Moore	HAH
177	PDF	1	ADWR Hydrologic Map Series Report No. 35 Depth to Water and Water-Level Altitude	Water Level Map	Arizona Dept of Water Resources	ADWR	2/1/2003	-	ADWR		Ninyo & Moore	HAH
AZGS												
104	PDF	1	Suggested Guidelines for Investigating Land-Subsidence and Earth Fissure Hazards in Arizona	Subsidence Report	Arizona Geological Survey	AZGS	8/1/2011	-	Unkown	2/16/2012	Entellus	RLJ
155	PDF	1	AZGS DGM-52 Estimated Depth to Bedrock in Arizona	Geologic Map	rd, S.M., Shipman, T.C., Greene, L., & Harris	AZGS	4/1/2007	-	AZGS		Ninyo & Moore	HAH
156	PDF	1	AZGS DM-EF-17 Earth Fissure Map of Maricopa County, Arizona	Earth Fissure Map	Arizona Geological Survey	AZGS	12/1/2009	-	AZGS		Ninyo & Moore	HAH
157	PDF	1	AZGS DM-EF-21 Earth Fissure Map of Pinal County, Arizona	Earth Fissure Map	Arizona Geological Survey	AZGS	3/1/2011	-	AZGS		Ninyo & Moore	HAH
158	PDF	1	AZGS DM-EF-2 Earth Fissure Map of the Apache Junction Study Area: Pinal and Maricopa Counties, Arizona	Earth Fissure Map	Arizona Geological Survey	AZGS	4/1/2008	-	AZGS		Ninyo & Moore	HAH
159	PDF	1	AZGS DM-EF-1 Earth Fissure Map of the Chandler Heights Study Area: Pinal and Maricopa Counties, Arizona	Earth Fissure Map	Arizona Geological Survey	AZGS	8/1/2008	-	AZGS		Ninyo & Moore	HAH
160	PDF	1	AZGS OFR 96-23 Geologic Map of the Mesa 30' x 60' Quadrangle, East-Central Arizona	Geologic Map	pencer, J.E., Richard, S.M., & Pearthree, P.A	AZGS	9/1/1996	-	AZGS		Ninyo & Moore	HAH
161	PDF	1	AZGS OFR 94-24 Surficial Geologic Map of the Mesa 30' x 60' Quadrangle, Arizona	Geologic Map	Pearthree, P.A. and Huckleberry, G.	AZGS	11/1/1994	-	AZGS		Ninyo & Moore	HAH
162	PDF	1	AZGS OFR 94-10 Surficial Geology of the Apache Junction Area, Northern Pinal and Eastern Maricopa Counties, Arizona	Geologic Map and Report	Huckleberry, Gary	AZGS	6/1/1994	-	AZGS		Ninyo & Moore	HAH
163	PDF	1	AZGS OFR 07-01 Earth Fissure Mapping Program 2006 Progress Report	Earth Fissure Report	Allison, M.L., and Shipman, T.C.	AZGS	6/1/2007	-	AZGS		Ninyo & Moore	HAH
164	PDF	1	AZGS OFR 08-02 Earth Fissure Mapping Program 2007 Progress Report	Earth Fissure Report	Allison, M.L., and Shipman, T.C.	AZGS	3/20/2008	-	AZGS		Ninyo & Moore	HAH

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165	PDF	1	AZGS OFR 08-03 Arizona's Earth Fissure Mapping Program: Protocols, Procedures and Products	Earth Fissure Report	Shipman, T.C., and Diaz, M.	AZGS	5/1/2008	-	AZGS		Ninyo & Moore	HAH
166	PDF	1	AZGS OFR 94-11 A Reconnaissance of Earth Fissures Near Apache Junction, Chandler Heights, and Southwestern Picacho Basin	Earth Fissure Report	Harris, R.C.	AZGS	6/1/1994	-	AZGS		Ninyo & Moore	HAH
CAP												
122	PDF & TIF	1	Salt-Gila Aqueduct - Various Plan Sheets	Plans/As-Built	Central Arizona Project	CAP	Varies	-	CAP	3/21/2012	Ninyo & Moore	HAH
123	PDF	1	Earth Fissure Investigations for Reaches 2A Salt-Gila Aqueduct	Earth Fissure Report	Central Arizona Project	CAP	1/1/1985	-	CAP	3/21/2012	Ninyo & Moore	HAH
124	PDF	1	Execution of Earth Fissure Repair Contract, Reach 2, Salt-Gila Aqueduct	Earth Fissure Report	Central Arizona Project	CAP	8/16/1985	-	CAP	3/21/2012	Ninyo & Moore	HAH
126	PDF	1	Salt-Gila Aqueduct Reaches 1, 2 and 3 Subsidence Study	Subsidence Report	Geodetic Surveying Services, LLC	CAP	1/4/2002	-	CAP	3/21/2012	Ninyo & Moore	HAH
127	PDF	1	PXAO Library Database Keyword "Subsidence"	Library List	Central Arizona Project	CAP	11/8/2007	-	CAP	3/21/2012	Ninyo & Moore	HAH
128	PDF	1	PXAO Library Database Keyword "Earth Fissure"	Library List	Central Arizona Project	CAP	11/8/2007	-	CAP	3/21/2012	Ninyo & Moore	HAH
129	PDF	1	PXAO Library Database Keyword "Compaction"	Library List	Central Arizona Project	CAP	11/8/2007	-	CAP	3/21/2012	Ninyo & Moore	HAH
130	PDF	1	PXAO Library Database Keyword "Tension"	Library List	Central Arizona Project	CAP	11/8/2007	-	CAP	3/21/2012	Ninyo & Moore	HAH
135	PDF	1	Superstition Mountains Recharge Project	Article	Central Arizona Project	CAP	Unknown	-	CAP Website	3/21/2012	Ninyo & Moore	HAH
USBR												
125	PDF	1	Final Environmental Statement Salt-Gila Aqueduct Central Arizona Project	Environmental Statement	U.S. Bureau of Reclamation	USBR	11/13/1979	-	CAP	3/21/2012	Ninyo & Moore	HAH
131	PDF	1	Subsidence Test Well No. 1 Joint USGS-USBR Earth Fissure and Subsidence Study Bid Documents	Specifications/Bid Docs	U.S. Bureau of Reclamation	USBR	5/19/1978	-	CAP	3/21/2012	Ninyo & Moore	HAH
132	PDF	1	Geohyrdrologic Data Along the Salt-Gila Aqueduct of the Central Arizona Project in Maricopa and Pinal Counties, Arizona, USGS OFR 86-236	Technical Paper	U.S. Geological Survey	USGS	5/1/1986	-	CAP	3/21/2012	Ninyo & Moore	HAH
133	PDF	1	Ground-Water Depletion and Land Subsidence in Western Pinal County, Arizona	Technical Paper	U.S. Geological Survey	USGS	10/1/1986	-	CAP	3/21/2012	Ninyo & Moore	HAH
134	PDF	1	Salt-Gila Aqueduct Earth Fissure Repair Modifications-Reach 2	Specifications/Bid Docs	U.S. Bureau of Reclamation	USBR	6/7/1905	-	CAP	3/21/2012	Ninyo & Moore	HAH
USGS												
178	PDF	1	Desert Well, AZ USGS Topographic Quadrangle 7.5-Minute Series 2011	Topographic Map	United States Geological Survey	USGS	7/3/1905	-	USGS		Ninyo & Moore	HAH
179	PDF	1	Desert Well, AZ USGS Topographic Quadrangle 7.5-Minute Series 2009	Topographic Map	United States Geological Survey	USGS	7/1/1905	-	USGS		Ninyo & Moore	HAH
180	PDF	1	Desert Well, AZ USGS Topographic Quadrangle 7.5-Minute Series 1971	Topographic Map	United States Geological Survey	USGS	5/24/1905	-	USGS		Ninyo & Moore	HAH
181	PDF	1	Desert Well, AZ USGS Topographic Quadrangle 7.5-Minute Series 1956	Topographic Map	United States Geological Survey	USGS	5/9/1905	-	USGS		Ninyo & Moore	HAH
182	PDF	1	Desert Well, AZ USGS Topographic Quadrangle 7.5-Minute Series 1906 (Reprinted 1946)	Topographic Map	United States Geological Survey	USGS	3/20/1905	-	USGS		Ninyo & Moore	HAH
183	PDF	1	Higley, AZ USGS Topographic Quadrangle 7.5-Minute Series 2011	Topographic Map	United States Geological Survey	USGS	7/3/1905	-	USGS		Ninyo & Moore	HAH
184	PDF	1	Higley, AZ USGS Topographic Quadrangle 7.5-Minute Series 2009	Topographic Map	United States Geological Survey	USGS	7/1/1905	-	USGS		Ninyo & Moore	HAH
185	PDF	1	Higley, AZ USGS Topographic Quadrangle 7.5-Minute Series 1971	Topographic Map	United States Geological Survey	USGS	5/24/1905	-	USGS		Ninyo & Moore	HAH
186	PDF	1	Higley, AZ USGS Topographic Quadrangle 7.5-Minute Series 1956	Topographic Map	United States Geological Survey	USGS	5/9/1905	-	USGS		Ninyo & Moore	HAH
187	PDF	1	Mesa, AZ USGS Topographic Map 30 x 60 Minute Series	Topographic Map	United States Geological Survey	USGS	6/16/1905	-	USGS		Ninyo & Moore	HAH
Others												
84	PDF	1	Town of Gilbert General Plan Land Use Map	Land Use Map	Town of Gilbert	Town of Gilbert	2/10/2010	-	FCDMC	3/8/2012	Entellus	RLJ
86	PRJ	1	Ocotillo Channel HEC-RAS Model	HEC-RAS Model	Unkown		4/17/2006	-	FCDMC	3/8/2012	Entellus	RLJ
136	PDF	1	Land Subsidence, Earth Fissures, and Water-Level Change in Southern Arizona, AZGS OFR 86-14	Technical Paper/Map	Schumann, H.H. and Genualdi, R.B.		6/8/1905	-	N&M Library		Ninyo & Moore	HAH
137	PDF	1	Land Subsidence and Earth Fissures in Arizona	Technical Paper	Slaff, Steven		6/15/1905	-	AZGS	3/19/2012	Ninyo & Moore	HAH
138	PDF	1	Ground-Water Pumping Causes Arizona to Sink, Arizona Geology, Vol. 29, No. 3	Technical Paper	Fellows, Larry		6/21/1905	-	N&M Library		Ninyo & Moore	HAH
139	PDF	1	Use of Low-Sun Angle Photography for Identification of Subsidence-Induced Earth Fissures, IAHS Publication No. 200	Technical Paper	eckwith, G.H., Slemmons, D.B., &Weeks, R. E.		6/13/1905	-	N&M Library		Ninyo & Moore	HAH
140	PDF	1	South Central Arizona, Earth Fissures and Subsidence Complicate Development of Desert Water Resources, USGS	Technical Paper	Carpenter, M.C.		Unknown	-	N&M Library		Ninyo & Moore	HAH
141	PDF	1	Land Subsidence, Earth Fissures Change Arizona's Landscape, Arroyo, Summer 1992, Vol. 6, No. 2	Technical Paper	Gelt, Joe		6/14/1905	-	N&M Library		Ninyo & Moore	HAH
142	PDF	1	Impacts of Land Subsidence Caused by Withdrawal of Underground Fluids in the United States, GSA, Reviews in Engineering Geology, Volume XVI	Technical Paper	Holzer, T.L. and Galloway, D.L.		6/27/1905	-	N&M Library		Ninyo & Moore	HAH
143	PDF	1	Methods for Prediction of Earth Fissures and Surface Faults Caused by Groundwater Withdrawal, International Conference	Technical Paper	Holzer, T.L.		6/22/1905	-	N&M Library		Ninyo & Moore	HAH
144	PDF	1	Earth Fissures and Localized Differential Subsidence, Water Resources Research, Vol. 17, No. 1, Pgs. 223-227	Technical Paper	Holzer, T.L. and Pampeyan, E.H.		2/1/1981	-	N&M Library		Ninyo & Moore	HAH
145	PDF	1	Faulting Caused by Groundwater Extraction in South-central Arizona, Journal of Geophysical Research, Vol. 84, No. 82	Technical Paper	Holzer, T.I., Davis, S.N., and Lofgren, B.E.		2/10/1979	-	N&M Library		Ninyo & Moore	HAH
146	PDF	1	Geophysical Investigations of Ground Failure Related to Ground-Water Withdrawal - Picacho Basin, Arizona, Ground Water, Vol. 17, No. 6	Technical Paper	Jachens, R.C. and Holzer, T.L.		12/1/1979	-	N&M Library		Ninyo & Moore	HAH
147	PDF	1	Land Subsidence and Earth Fissuring on the Central Arizona Project, Arizona, IAHS Publication No. 200	Technical Paper	Sandoval, J.P. and Bartlett, S.R.		6/13/1905	-	N&M Library		Ninyo & Moore	HAH
148	PDF	1	Notes on Earth Fissures in Southern Arizona, Geological Survey Circular 466	Technical Paper	Robinson, G.M. and Peterson, D.E.		5/15/1905	-	N&M Library		Ninyo & Moore	HAH
149	PDF	1	Land Subsidence, Earth Fissures and Groundwater Withdrawal in South-Central Arizona, U.S.A.	Technical Paper	Schumann, H.H. and Poland, J.F.		5/22/1905	-	N&M Library		Ninyo & Moore	HAH

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150	PDF	1	Land Subsidence in Central Arizona, Second International Symposium on Land Subsidence	Technical Paper	Winikka, C.C. and Wold, P.D.		12/1/1976	-	FCDMC	3/22/2012	Ninyo & Moore	HAH
151	PDF	1	Field Trip Guidebook for the 2011 AEG Shlemon Specialty Conference, Opportunities for Alternative Energy Development in Arizona and the Southwest	Technical Paper	AEG and ALSG		10/1/2011	-	N&M Library		Ninyo & Moore	HAH
152	PDF	1	Ground Subsidence and Earth Fissuring: Investigations, Solutions and Monitoring, 2011 AEG Shlemon Specialty Conference Presentation	Technical Presentation	Rucker, M.R.		10/1/2011	-	N&M Library		Ninyo & Moore	HAH
153	PDF	1	Land Subsidence and Cracking Due to Ground-Water Depletion, Ground Water, Vol. 15, No. 5	Technical Paper	Bouwer, Herman		10/1/1977	-	N&M Library		Ninyo & Moore	HAH
154	PDF	1	Subsidence Areas and Earth-Fissure Zones, Field notes Publication	Technical Paper	Unknown		6/9/1905	-	N&M Library		Ninyo & Moore	HAH
188	PDF	1	Investigation of Earth Fissure Across San Tan Boulevard, Queen Creek, Arizona	Earth Fissure Report	Shi, John and Perera, Yugantha		7/26/2007	-	MCDOT		Ninyo & Moore	HAH
189	PDF	1	Arizona State Hazard Mitigation Plan 2010, Chapter 5, Section 5.4.5 Fissures	Hazard Mitigation Planning Report	AZ Division of Emergency Management	AZDEM	7/2/1905	-	AZDEM		Ninyo & Moore	HAH
190	PDF	1	Arizona State Hazard Mitigation Plan 2010, Chapter 5, Section 5.4.10 Subsidence	Hazard Mitigation Planning Report	AZ Division of Emergency Management	AZDEM	7/2/1905	-	AZDEM		Ninyo & Moore	HAH
193	PDF	1	Limited Fissure Evaluation, Lost Dutchman Heights UPP, Pinal County, Arizona N&M Project No. 601700001	Earth Fissure Report	Ninyo & Moore		1/14/2009	-	Ninyo & Moore		Ninyo & Moore	HAH
194	PDF	1	Limited Subsidence Evaluation, Lost Dutchman Heights UPP, Pinal County, Arizona N&M Project No. 601700001	Subsidence Report	Ninyo & Moore		1/14/2009	-	Ninyo & Moore		Ninyo & Moore	HAH
195	PDF	1	Initial Geotechnical Evaluation, Desert Drive Planning Area, Pinal County, Arizona N&M Project No. 601702001	Geotechnical Evaluation Report	Ninyo & Moore		6/19/2007	-	Ninyo & Moore		Ninyo & Moore	HAH
196	PDF	1	Earth Fissure Mitigation Plan, Affordable Storage, Apache Junction, Arizona	Earth Fissure Report	Ray Harris Consulting, LLC		3/22/2010	-	Pinal County		Ninyo & Moore	HAH
197	PDF	1	Draft Memorandum Geotechnical Assessment North-South Corridor Study US 60 to I-10, Pinal County, Arizona	Geotechnical Evaluation Report	NCS Consultants, LLC		6/1/2011	-	Pinal County		Ninyo & Moore	HAH
199	PDF	1	Maricopa County Subdivision Regulations	Regulations			3/1/2011	-	MC		JE Fuller	
200	PDF	1	Drainage Regulations for Maricopa County	Regulations		FCDMC	11/1/2010	-	MC		JE Fuller	
201	PDF	1	Clarification of Drainage Regulations	Regulations		FCDMC	9/1/2001	-	MC		JE Fuller	
202	PDF	1	Maricopa County Land Use Plan - Queen Creek Planning Area	Study		MAG	4/1/1992	-	MC		JE Fuller	
218	PDF	1	2nd Gateway-are home plan - 3,500 dwellings would occupy part of former GM test site	Article	Arizona Republic		3/9/2012	Jennifer Pokorski	FCDMC	3//13/2012	Entellus	RLJ
219	PDF	1	On the Ground-Arizona is Cracking Up, Southwest Hydrology, pp. 8 and 9	Technical Paper	Harris, Ray		2/1/2006	-	N&M Library		Ninyo & Moore	HAH
220	PDF	1	Water-Level Declines, Land Subsidence, and Specific Compaction Near Apache Junction, South-Central Arizona	Technical Paper	Carpenter, M.C.		1/1/1987	-	N&M Library		Ninyo & Moore	HAH
221	PDF	1	Geotechnical Evaluation, East Maricopa Floodway, Rittenhouse Detention Basin, Maricopa County, Arizona N&M Project No. 600198002	Geotechnical Evaluation Report	Ninyo & Moore		10/10/2002	-	Ninyo & Moore		Ninyo & Moore	HAH
222	Hard Copy	1	Land Subsidence and Earth Fissures in Alluvial Deposits in the Phoenix Area, Arizona USGS Map I-845-H	Land Subsidence Map	Schumann, H.H.		5/27/1905	-	N&M Library		Ninyo & Moore	HAH
223	PDF	1	Mechanisms of Earth Fissuring Caused by Groundwater Withdrawal, Environmental & Engineering Geoscience, Vol. IX, No. 4, pp. 351-362	Technical Paper	Sheng, Z., Helm, D.C., & Li, J.		11/1/2003	-	N&M Library		Ninyo & Moore	HAH