Siphon Draw Drainage Improvements

2010 Engineering Excellence Awards Competition
American Council of Engineering Companies of Arizona

Stanley Consultants
A Stanley Group Company
Engineering, Environmental and Construction Services - Worldwide

RETURN THIS OFFICIAL
30th ANNUAL AWARDS ENTRY FORM

Deadline 5 p.m. September 1st
Complete both pages and submit with entry.

Please furnish all information requested below for each entry *(both signatures are required)*. Firm, project, and client/owner's name should be typed or printed as they are to appear on the award. Please limit project name to 45 characters.

A fee of $200 per entry for ACEC of Arizona members *($1,500 for non-ACEC of Arizona members)* must accompany this form.

Make all checks payable to "ACEC of Arizona."

ABOUT THE PROJECT

Project Name Siphon Draw Drainage Improvements

Project Location/Address: Northeast Corner of Meridian Road and Elliot Road

City Incorporated Apache Junction State Arizona Zip 85217
Pinal County, Arizona

Type of Project *(check one)*:

- ☐ *Studies, Research, and Consulting*
- ☐ *Building/Technology Systems*
- ☐ *Structural Systems*
- ☐ *Surveying and Mapping Technology*
- ☐ *Environmental*
- ☐ *Water and Storm Water*
- ☒ *Water Resources*
- ☐ *Transportation*
- ☐ *Special Projects*
- ☐ *Small Projects*
- ☐ *Energy*
- ☐ *Industrial and Manufacturing Processes and Facilities*

Completion/Use Dates: Scheduled December 5, 2010 Actual July 30, 2010

Costs: Budgeted $ 11 Million Actual $ 6.1 Million
(Budgeted and/or actual costs may not apply to some studies)

Construction Costs: Total Project Budget $ 9 Million

Total Project Actual $ 4.5 Million

Entrants portion of Total Project Budget $ 1.4 Million

Entrants portion of Total Project Actual $ 1.4 Million

ABOUT THE FIRM(S) SUBMITTING THE PROJECT

Entering Firm(s) Stanley Consultants

Firm CEO Gregs Thomopulos

Firm Representative Mike Lopez

Address 1661 E. Camelback Road, Suite 400

City: Phoenix State: Arizona Zip: 85016

Phone: (602) 333-2417 Cell: (602) 291-2537 Fax: (602) 333-2333

E-Mail Address: lopezmike@stanleygroup.com

"I hereby authorize submission of this project into the American Council of Engineering Companies of Arizona's 30th Annual Engineering Excellence Awards competition."

Senior Executive/Principal Gregs Thomopulos

Title CEO **Date** August 26, 2010

Signature  **Email** thomopulosgregs@stanleygroup.com

ABOUT THE CLIENT/OWNER(S) OF THE PROJECT

Client/Owner(s) Flood Control District of Maricopa County

"I currently believe the work of the engineer meets the intended uses and expectations for the project and hereby grant permission to enter this project in the American Council of Engineering Companies of Arizona's 30th Annual Engineering Excellence Awards competition, and authorize publication of its outstanding features, unique aspects, or innovations. I confirm the project was substantially completed and ready for use between January 1, 2009 and September 1, 2010."

Client/Owner Representative Timothy S. Phillips, P.E.

Title Chief Engineer & General Manager **Signature** 

Date 8\30\10 **Email** tsp@mail.maricopa.gov

Address 2801 West Durango

City: Phoenix State: Arizona Zip: 85009

Phone: (602) 506-4701 Cell: ( ) Fax: ( )

Flood Control District
of Maricopa County

Board of Directors
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August 25, 2010

ACEC of Arizona Engineering Excellence Competition
1309 East Echo Lane
Phoenix, Arizona 85020

Subject: Siphon Draw Wash Drainage Improvements Project

Dear Judging Committee:

The Flood Control District of Maricopa County is pleased to grant Stanley Consultants permission to submit the Siphon Draw Wash Drainage Improvements Project to the ACEC of Arizona 2010 Engineering Excellence Awards Competition for potential award recognition. We have also requested that Stanley Consultants provide us with the opportunity to review for accuracy any and all information prior to it being submitted during this process.

The design services provided by Stanley Consultants, AMEC, and EPG were excellent, resulting in a finished product that achieved all of its goals: provide protection from the 100-year storm event to the homes west of Meridian Road, provide context sensitive design that is aesthetically pleasing, provide potential for future multi-use recreational purposes, and provide mitigation for fissures that have and could occur in the area.

This project involved many agencies and private stakeholders. We are pleased to report that the design effort was completed on schedule and that the construction was completed ahead of schedule and under budget.

Sincerely,

Timothy S. Phillips, P.E.
Chief Engineer & General Manager
Flood Control District of Maricopa County

Executive Summary

Problem #1: Homes in the Meridian Pointe Subdivision and future planned developments in the City of Mesa and unincorporated Maricopa County were at risk of being flooded from the 100-year storm event.

The Solution: Provided flood protection in the form of an 80-acre detention basin that can attenuate the runoff from over 3100 cfs coming into the basin to less than 500 cfs exiting the basin, it blends with the surrounding natural environment; and it provides for future multi-use opportunities. The basin includes a stepped drop spillway inlet structure that can double as double as an amphitheatre, a concrete lined trapezoidal channel that can accept overland flows, and an interior berm that allows the basin to function as an off-line basin keeping most of the basin floor dry low volume high frequency events.

Problem #2: The basin site contains multiple active earth fissures and has the potential for more fissures to occur. The basin had to be designed such that if a fissure develops while the basin is full it will not exacerbate the situation by sending floodwaters toward the developed homes.

The Solution: The fissure mitigation defense includes a geomembrane buried three feet below the downstream (southern and western) slopes and concrete cut-off wall downstream of the geomembrane constructed to a depth of 20 to 25 feet below grade to force any water that might get past the geomembrane down into the ground.

The project was completed ahead of schedule and well under budget. ***"Our goal was to implement a flood control project that would mitigate the regional 100-year flood, be an amenity to the area, be context-sensitive with its surroundings, provide multi-use potential, and be fairly easy to maintain. All of these goals were met,"*** said Bobbie Ohler, Project Manager with the Flood Control District of Maricopa County.

Project Description:

The purpose of the project is to intercept and detain the 100-year storm to protect properties to the west of Meridian Road within the City of Mesa and in unincorporated Maricopa County. Storm flows from the north and storm flows from Siphon Draw Wash enter the basin, are detained, and released such that the capacity of the existing wash within the Meridian Pointe Subdivision (Project's outfall) is not exceeded.

The project is a partnership between the Flood Control District of Maricopa County (District) and the City of Mesa (City). The project includes an 80 acre detention basin with maintenance access roads to and around the basin; a stepped spillway inlet structure and grade control structure, box culvert inlet structure, low-flow channel, emergency spillway, and a one-half mile long curvilinear concrete channel with maintenance roads and associated structures. The basin and channel have native desert landscaping, O&M roads that can also function as trails, and aesthetic wall treatments. The basin has been graded for potential use as a park. The project included an analysis and implementation of mitigation measures to address potential land settlement and earth fissure issues.

The basin was designed with mitigation measures to reduce the risk associated with failure from an encroaching earth fissure. This included two low strength concrete cut-off walls and buried geomembrane material. Alternative detention basin locations and configurations and inlet channel configuration were developed during the design effort. Alternatives development included a thorough geotechnical investigation to identify additional fissures and a Failure Modes and Effects Assessment (FMEA) to identify appropriate risk-reducing mitigation measures.

Role of Stanley Consultants:

Stanley Consultants provided pre-design efforts including alternatives development, evaluation and assessment; value engineering; final design, preparation of the construction documents, and post-design services.

Role of Other Consultants:

- AMEC performed a geotechnical and geologic hazard investigation to locate and identify existing earth fissures, conducted a FMEA Workshop, and developed fissure mitigation measures and a monitoring plan for the basin.
- EPG helped to develop the form and shape of the channel and basin, provided aesthetics design on the concrete structures, and provided the landscape design.
- Cooper Aerial Mapping provided aerial mapping services.

Original or Innovative Application of New or Existing Techniques:

- **Does the entry demonstrate the use of a new science or a breakthrough in the general knowledge of engineering?**
- **Does the entry represent a unique application of different technology, techniques, materials or equipment?**

Land subsidence induced earth fissures are highly undesirable within a flood control basin. Earth fissures can appear unexpectedly and can rapidly increase in size. A fissure in a flood

control basin could undermine the basin's ability to retain water. The team studied multiple basin configurations and components before finally concluding that avoiding potential fissures within the existing site constraints was impossible. Once this conclusion was reached, the challenge became how to design a flood control basin in an area with an encroaching fissure and that was also likely to develop more fissures. The solution was to apply fissure mitigation techniques designed to maintain basin impoundment integrity with proper long-term monitoring and maintenance. To our knowledge the mitigation utilized has never before been applied to a flood control basin project.

A two-day FMEA workshop was held with the consultant team, client, project owner and major stakeholders, in order to develop project fissure mitigation recommendations. The team identified various mitigation alternatives related to the acceptable level of flooding risk tolerance associated with the basin breaching or losing water as a result of an earth fissure.
AMEC, the geotechnical sub consultant, performed an extensive geotechnical investigation using Synthetic Aperture Radar Interferometry (InSAR), high resolution aerial imagery, ground reconnaissance, geophysical seismic refraction profiling, and site excavation to look for fissures as well as making some estimates of the probability of fissures occurring in the future. This information assisted in the development of the mitigation measures used in the project.

The final design included a series of cut-off walls between the basin and downstream of the encroaching fissure, and used excavation spoils to redirect surface runoff away from the fissure. On the down-stream side of the project, a vertical low strength concrete cut-off wall was constructed. Along the slope of the flood control basin a geomembrane material was buried three feet deep to act as a barrier between the water and potential earth fissures.

"Using geomembrane for fissure mitigation is a unique application," according to Brett Howey, AMEC project manager. "To the best of my knowledge it is a mitigation that has never been applied to a flood control basin."

Future Value to the Engineering Profession:

- **Will the entry redefine current engineering thinking?**
- **Does the entry advance a positive public image of engineering excellence?**

A unique application of different materials was creatively combined with a thorough geotechnical investigation. The Consultant, District, and City are satisfied that the basin and channel will function well, and if future fissures do develop, they can be managed.

From the start, the basin was designed to be an amenity to the community. The landscape aesthetic character for the Siphon Draw Basin and Channel Improvements blend with the natural environment. The "freeform" shape with undulating perimeter berms and island landforms breaks-up the overall size of the basin and creates topographic variety and visual interest.

The exposed faces of the concrete structures received aesthetic treatment and color to match the environment. The Siphon Wash Draw stepped drop inlet structure wash shaped to add interest and create an ampitheater for people to gather. The basin's interior berm provides protection to the majority of the basins floor protecting future uses such as ball fields from being inundated in low frequency events.

Perimeter swales that are lined with rock of contrasting color to provide visual awareness capture sheet flow directed at the basin and delivers it to protected inlet structures. From design through construction, the public's image of the project and minimizing impacts to the environment were key. Local residents that attended the public meetings were very pleased to hear their views to the Superstition Mountains would not be compromised and that the basin can accommodate park amenities in the future. In the future, this will probably become known as Siphon Draw Park, hiding the fact that it was first a flood control project.

Social, Economic and Sustainable Design Considerations:

- **Do the solutions identified produce secondary benefits of value to the community environment?**
- **Does the entrant's approach provide society with social, economic, or sustainable development benefits?**
- **Is the public's health, safety, or welfare significantly improved as a result of the entrant's, and/or affected environments, contribution to the project?**

- Though the impetus for the project was flood protection, all structures were designed with a consideration for future regional multi-use. The innovative stepped drop inlet structure capturing flows from Siphon Draw Wash could also double as an amphitheatre that may be used by the community. The concrete apron at the bottom of the drop structure can serve as a stage and the drops (steps) were designed to be seat height. The invert or bottom of the basin can be used in the future for baseball diamonds, soccer fields, walking trails, or other recreational features.

- For items such as the operation and maintenance road crossing rip-rapped areas, and for the cut-off walls, Controlled Low Strength Material (CLSM) was used in the place of concrete. CLSM is a low-strength concrete that is low-cost and easy to install, and can be used for non-structural purposes.

- This project provides flood protection to the adjacent homeowners downstream of the basin and will likely enhance their property value.

- The construction cost portion of the budget came in substantially less than the owner's budget thanks to a favorable construction environment, and a value engineering assessment performed by the project team resulted in a $1 million savings by eliminating a storm drain.

- A Project Aesthetics Advisory Committee provided a forum for the public and major stakeholders to have input. A public meeting was held at the conclusion of predesign, and the project received favorable reviews from the public so the team proceeded with final design.

- During construction the team and contractor were sensitive to the close proximity of residential development and the potential impact that construction could have on adjacent property. During construction a public information hot line was established.

- Only two dust-related complaints and three requests for information on the project were fielded during the 18-month project duration.

- The 80-acre basin and the channel were constructed with little impact to the environment. All cacti were salvaged from the basin and relocated. Fill material was graded around existing trees where possible. As much of the natural environment as possible was saved.

Complexity:

- **Did the entry successfully address very complex criteria or unique problems?**
- **Were extraordinary problems of site, location, hazardous conditions, project requirements or similar elements present?**
- **Did the entry require the use of out-of-the-ordinary technology or ingenuity for achievement of the project's goals?**

The project was a study in complexity from beginning to end. From potential earth fissures to multiple stakeholders to reluctant utility companies, nothing came easy in this project. Multiple stakeholders were involved with the project. The homes at risk of being flooded by the 100-year rainfall event were located downstream in Maricopa County but the project is located upstream in Pinal County. The District was the lead agency. The District obtained a drainage easement from the State of Arizona which owns the land where the Project is located. The project required coordination with the City of Mesa, the City of Apache Junction, Maricopa County Department of Transportation (MCDOT), Salt River Project, Pinal County, the Arizona State Land Department, and local developers.

Earth fissures, which are difficult to mitigate, added a level of complexity not normally found in a flood control project. The earth fissure mitigation had to be sensitive to the other project goals such as aesthetics and future operations and maintenance. The technical aspects had to align with the softer side of the project, as well as the long-term operation, while still achieving the necessary risk reduction measures.

A 230 kV high voltage power line owned by SRP ran adjacent to the concrete drainage channel. Large cranes are occasionally brought in for line maintenance. The concrete channel lining within SRP's power corridor had to be structurally strengthened to be able to withstand the heavy crane loads that can result during maintenance of the high voltage lines. This also required a special geotechnical analysis of slope failure.

Water from the upstream watershed could be contained in the basin but collecting the flow presented a challenge. Hydraulics were used to identify how far we might have to place fill to direct flow into the collection channel, then minimize what the impact on the adjacent natural area would be.

A $1 million cost savings was realized by modifying the functional operation of the basin to eliminate the need for a storm drain. The basin design was modified so that it could drain back in to the Siphon Draw Wash at the basin outlet, to avoid the need for a costly storm drain.

Exceeding Owner/Client Needs:

NOTE: All quotes are from Bobbie Ohler, Project Manager with the District.

Did Stanley Consultants successfully engage you in the overall project development process?

"Yes. Stanley Consultants, Inc. worked closely with the District, City of Mesa, and numerous stakeholders throughout the predesign and design efforts of the project. Stanley Consultants participated in monthly stakeholder meetings, at which design issues and proposed solutions were discussed."

Is it an economical and cost-effective solution?

"Yes. The consultant participated with the District and City of Mesa in a Value Analysis Workshop that identified substantial cost savings. The consultant also worked diligently to keep costs down with innovative design features, such as the CLSM crossing of the rip rapped spillway structure and bermed areas within the basin to create an "off-line" basin within the larger basin. The stakeholders worked out a stockpile plan for the excavated dirt that also was a substantial cost savings to the project."

How did final cost relate to original budget estimate?

"The original budget for construction of Phase 1 was $6.5 million, and actual costs were $3.2 million. The original budget for construction of Phase 2 was $2.5 million and actual costs were $1.3 million."

How closely does the entrant's solution meet the total goals of the client/owner?

"Our goal was to implement a flood control feature that would mitigate the regional 100-year flood, be an amenity to the area, be context-sensitive with its surroundings, provide multi-use potential, and be fairly easy to maintain. All of these goals were met."

Did the entrant meet the client's time schedule?

"Yes. Stanley Consultants was on time with every design submittal and the construction contract was bid when planned. Stanley Consultants also provided all invoices and paperwork in a timely manner. The construction effort was under budget and ahead of schedule for both phases of the project, in good part due to the excellent construction documents prepared by Stanley Consultants and their timely efforts in responding to design questions during construction."

Why is this project worthy of special recognition?

A residential development was built in an area subject to flooding from a 100-year rainfall event prior to flood protection being in place. Now the Siphon Draw Drainage Improvements Project mitigates this hazard. Stanley Consultants designed an 80-acre detention basin and half-mile long channel upstream of the development that will intercept flood water and provide protection to the properties. An innovative design using fissure mitigation consisting of low strength concrete and geomembrane fabric turned a challenging site into a functional flood control basin and channel.

Key Participants

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Flood Control District of Maricopa County
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Project Photos

Note: Captions correspond with the photo below.

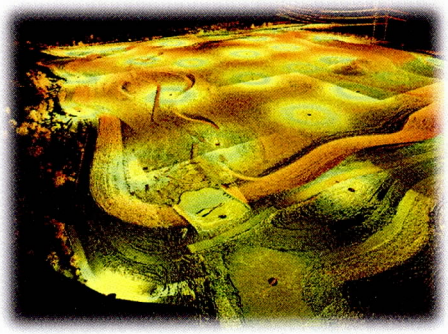
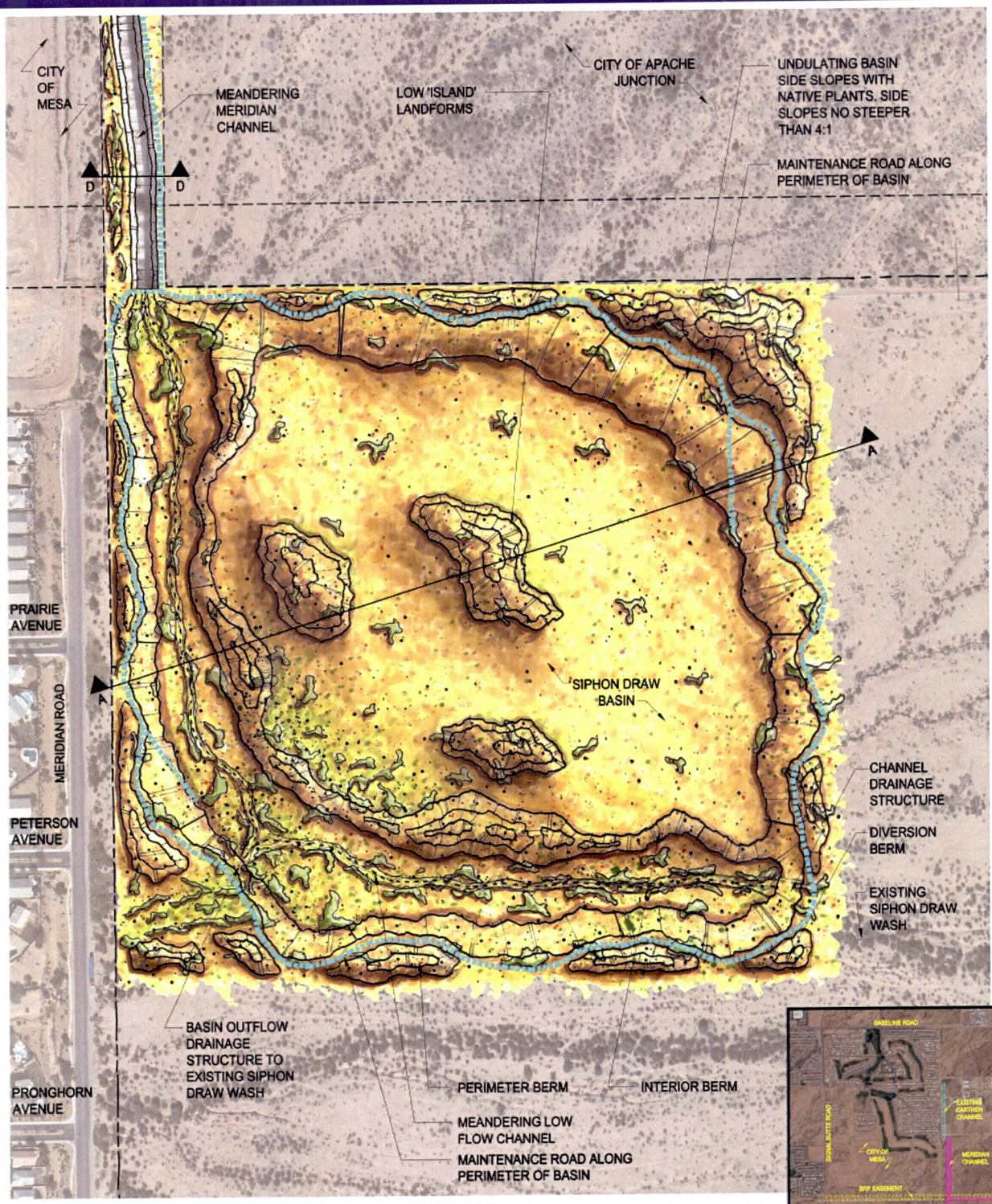


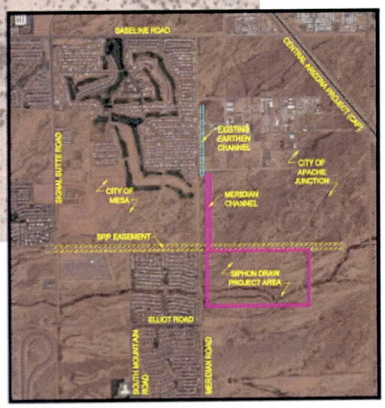
Photo 1:
"Hawk Rock" earth fissure. A fissure in a flood control detention basin could undermine the basin's ability to detain water. This fissure zippered (extended) 200 feet from one rainfall event during the design stage. The design team studied multiple basin configurations before concluding that avoiding fissures altogether within the existing site constraints was impossible.

Photo 2:
The team designed a 270 acre foot detention basin upstream (east) of the Meridian Point Subdivision to intercept, detain, and attenuate runoff to protect properties.

Siphon Draw Basin

Siphon Draw Drainage Improvement Project





LOCATION MAP

Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, AZ 85009

Photo 3:
The basin is equipped with a stepped inlet structure to capture flows from Siphon Draw (foreground) and another inlet structure (foreground) to capture flows from the Meridian Channel. The outlet is an un-gated box culvert that discharges flows back into the Siphon Draw Wash that travels through the Meridian Point Subdivision. (facing west)

Photo 4:
3 D Scanning image of Photo 3. Notice the high power aerial lines (upper right) that are captured with laser scanning. Clearance for these lines is critical to SRP.

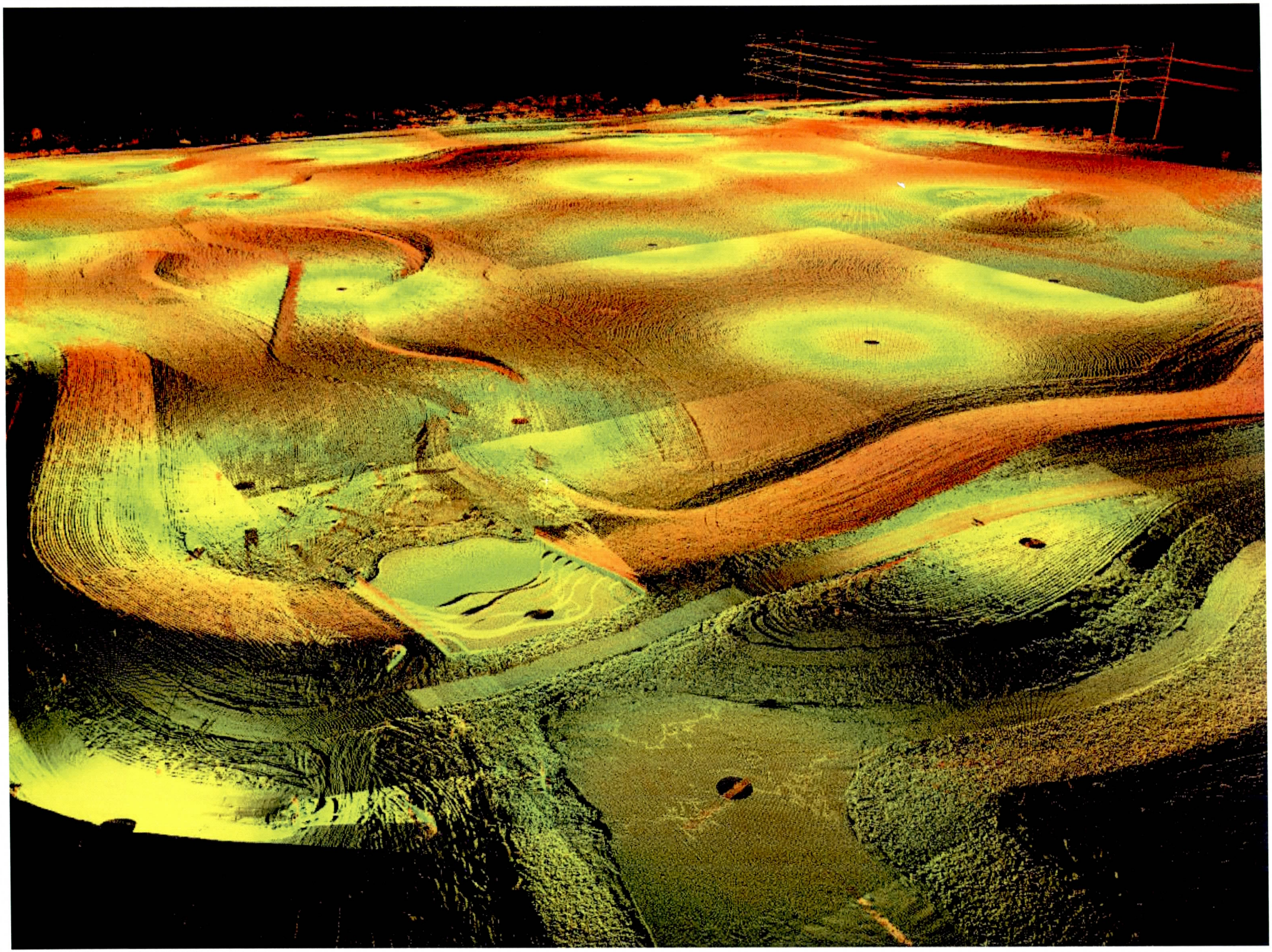
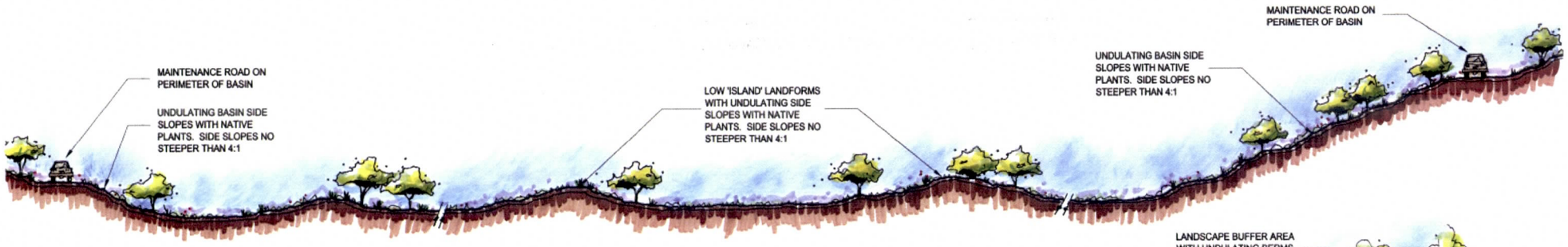


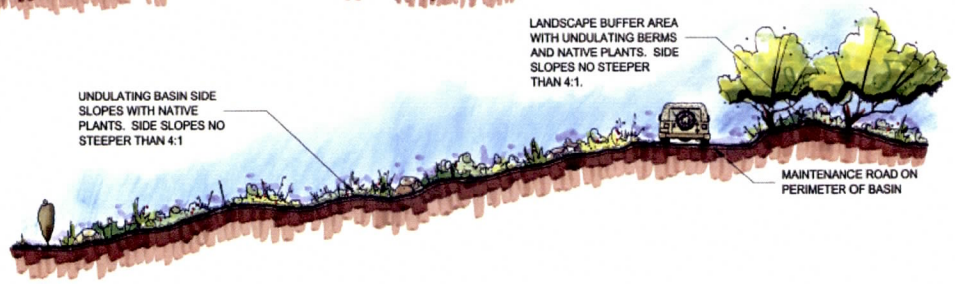
Photo 5:
Cross section showing proposed landscaping of the site. The basin and channel were constructed with little hardscape, thus limiting impact to the natural environment.

Cross Sections

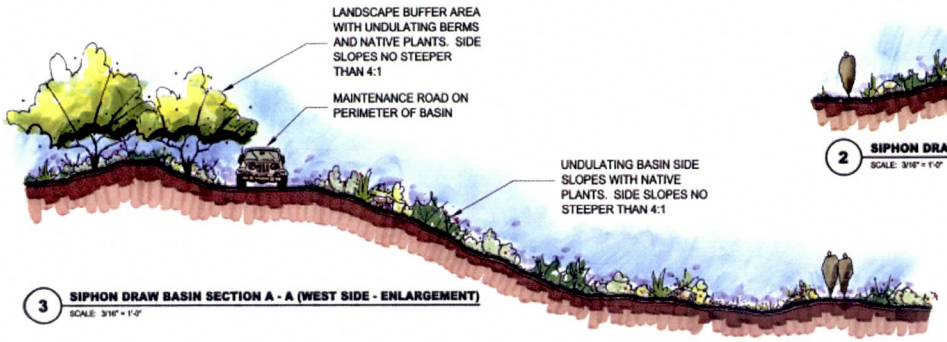
Siphon Draw Drainage Improvement Project



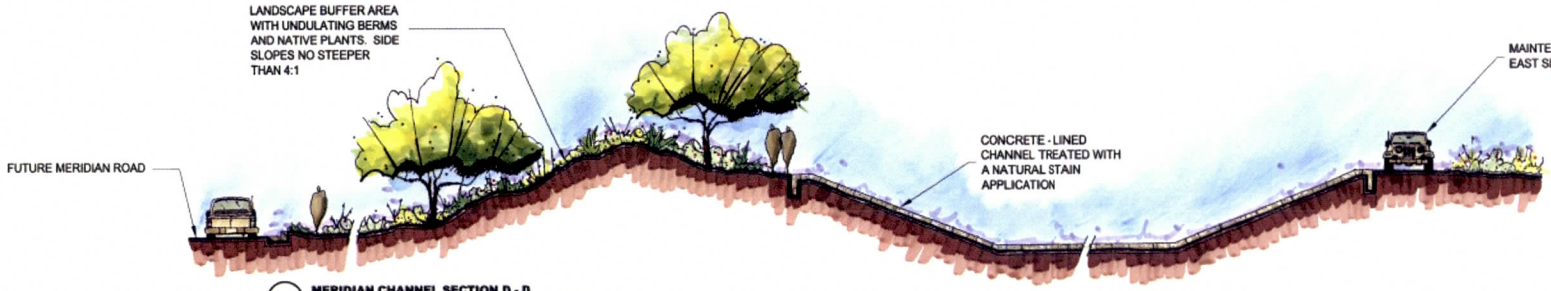
1 **SIPHON DRAW BASIN SECTION A - A**
SCALE: VERTICAL 1" = 10'-0" / HORIZONTAL 1" = 20'-0"



2 **SIPHON DRAW BASIN SECTION A - A (EAST SIDE - ENLARGEMENT)**
SCALE: 3/16" = 1'-0"



3 **SIPHON DRAW BASIN SECTION A - A (WEST SIDE - ENLARGEMENT)**
SCALE: 3/16" = 1'-0"



4 **MERIDIAN CHANNEL SECTION D - D**
SCALE: 3/16" = 1'-0"

Flood Control District of Maricopa County
2801 West Durango Street
Phoenix, AZ 85009

www.fcd.maricopa.gov

Photo 6:
Geomembrane was installed three feet below the finished surface along the south and west slopes of the basin with concrete cutoff walls along its toe. The team developed fissure mitigation consisting of low strength concrete and a geomembrane


CAT
D4G

Photo 7:
A cutoff wall was constructed downstream of the basin's south and west slope. The cutoff wall will force any flows that penetrate the geomembrane down 20 to 25 feet before it can travel toward any developments.

Photo 8:
Concrete drop structure and cutoff walls upstream of the stepped spillway. The drop structure directs sheet flows into a channel that connects to the stepped drop structure.

Photo 9:
This stepped drop structure will dissipate the energy from flows from the Siphon Draw Wash. When not functioning as a drop structure, the steps can become the seats of an amphitheater, with the bottom of the drop structure serving as a stage. Though the impetus for the project was flood protection, all structures were designed for regional multi-use.

Photo 10:
The Meridian Channel and inlet structure are in the bottom left foreground. Along the left side of the basin is an inlet channel that intercepts flows and delivers them to the channel to discharge into the basin. The box culvert crossing the Meridian channel serves the District maintenance staff and SRP for its powerline access.