CAVE CREEK DRAINAGE MASTER PLAN
Potential Alternatives Report

FINAL

Prepared for:

2/13/08
DATE

Flood Control District of Maricopa County

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1.0 INTRODUCTION

This portion of the Cave Creek Drainage Master Plan (DMP) – Phase I effort, has been prepared according to the Scope of Work, Section 2.9, and represents the initial results examining the potential for workable alternatives to the flooding problems in the Town of Cave Creek (Town) based on residents input from the public meetings, field reconnaissance, and other information as discovered during Phase 1 of the project.

As a part of the planning process, a first public meeting was held on July 26, 2006. The meeting was conducted as an open house, and solicited information from the public as to their perceptions of the locations and nature of flooding within the Town. This meeting was followed up with individual meetings with various Town officials, citizenry, and other stakeholder groups, to gather as much input as possible as to the history of flooding problems in the Town.

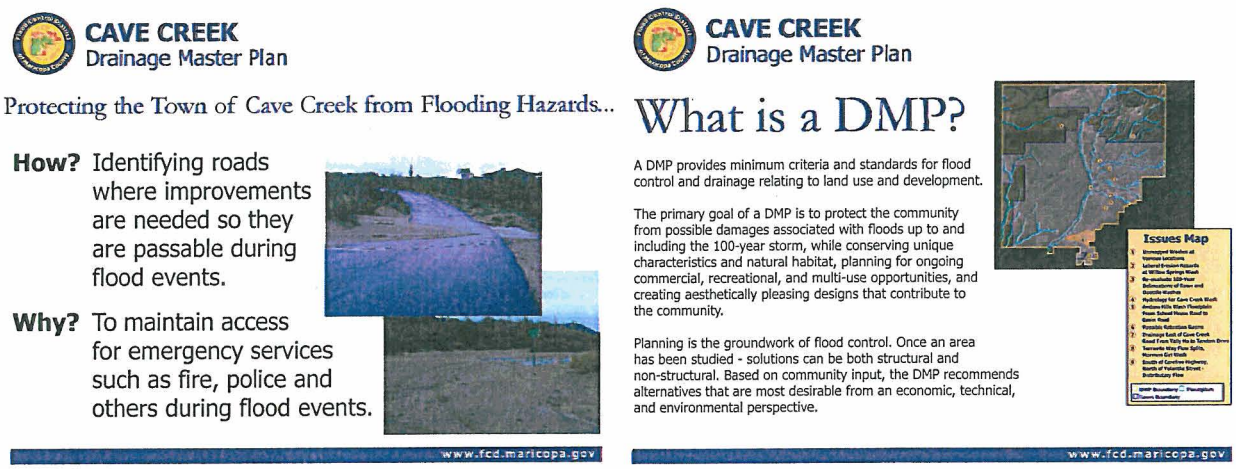


Figure 1: Meeting Boards from the July 26, 2006 Meeting

Investigative research was conducted by the consultant to identify additional technical documents in support of the flooding problems. Rain gage data collection was performed along with a historic flooding photo collection. Newspaper and internal articles discussing the problems from flooding were collected, along with news reports of previous flood events and problems from automotive crossings.

A second public meeting, also known as the Alternatives Formulation and Preliminary Analysis meeting, was held on October 12, 2006. This meeting was conducted as a public workshop, and resulted in the recommendation of preliminary alternatives or combinations of alternatives to be studied later. At the conclusion of the brainstorming portion of the workshop, five presentations were made which represented the working efforts of the five community/agency/consultant teams. A number of the same concepts were expressed by all the teams, including which techniques were appropriate or not appropriate for the Town. Some teams arrived at unique concepts. Additionally, some of the flood management tools presented by the consultant team were not adopted by any of the community teams. Figure 2, on the next page, provides an example of the meeting boards utilized.

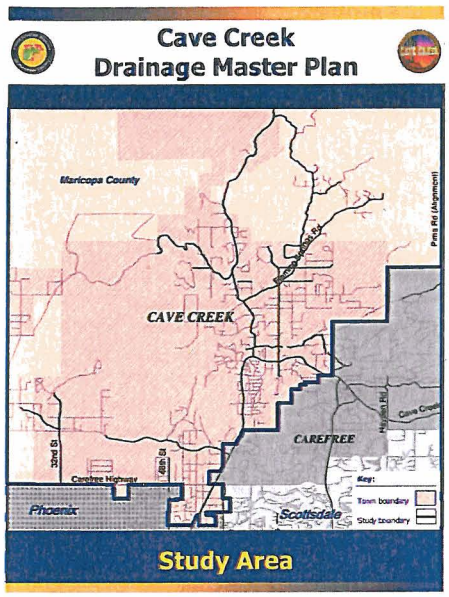


Figure 2: Meeting Boards from the October 12, 2006 Meeting

A general, but overriding theme in the presentations was that the citizenry has great pride in the community, and they want to maintain the western "cowboy" character of the Town. Even as the Town continues to grow toward build-out, it is important the charm, character, and remoteness from urban appearance that originally attracted residents to the Town, not be diminished. Residents in the Town of Cave Creek have chosen to live there specifically for its upscale western environment and resist having constructed flood control features that may detract from the natural appearance.

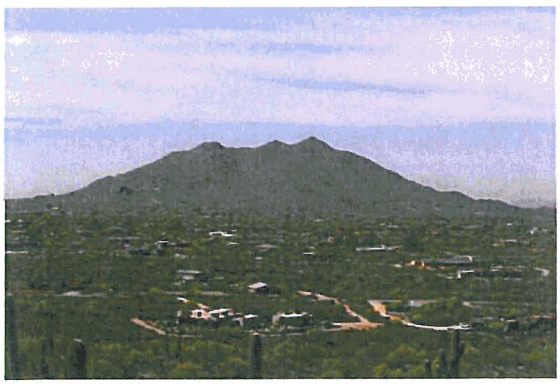


Figure 3: Cave Creek's Western Character

The purpose of this report is to represent to the Flood Control District of Maricopa County (District) and the Town that workable alternatives do exist that, and when developed, will help to solve flooding within the study limits in an effective and efficient manner.

2.0 FLOODING PROBLEMS

Those flooding problems and issues discussed with District and consultant staff during the initial public meeting held on July 26, 2006, that are within the scope of the DMP, have all centered on what happens when washes throughout the Town, that are normally dry, flow to capacity. Some flooding situations were discussed that are outside the scope of the DMP, and generally involve local flooding caused by the indiscriminant actions of adjacent property owners. When washes become flooded due to severe runoff events the following situations have been observed to occur;

- When normally dry washes flood, vehicles are often unable to cross resulting in one of the following situations;
  - People attempt to cross the flooded wash and get stuck (or worse swept away).
  - People are not able to get home and have to wait for the wash to recede.
  - People have to go out of their way and take a different route home.
  - People can't get out of their homes and are essentially stranded.

- The flooded washes erode laterally, causing movement and degradation of the banks of the wash, which endanger structures placed adjacent to the bank.

- Homes or outbuildings that have been built in wash or low-lying areas perceived to be always dry become flooded, generally because the risk of building in or near a dry wash was not recognized by the builder.

- Flood water exceeds the capacity of the wash. Overtopping of the banks occurs and excess floodwaters sheet flow across the adjacent areas, causing possible water damage to homes and personal property.

A complete range of potential solutions to these described typical flooding situations were evaluated with the public. It is important to note that many solutions were discussed at the second public meeting that were dismissed from future consideration because they did not meet the default consideration of not distracting from the character of the Town. These solutions generally fell into the category of hard-structural flood protection methods that have an imposing visual appearance. Also dismissed were several non-structural solutions that the public felt, while effective, were not appropriate for the Town. As a result of the public meetings, data collection, and site reconnaissance work, a Data Collection Report was prepared to document the findings. The complete list of evaluated solutions is discussed in the following sections.

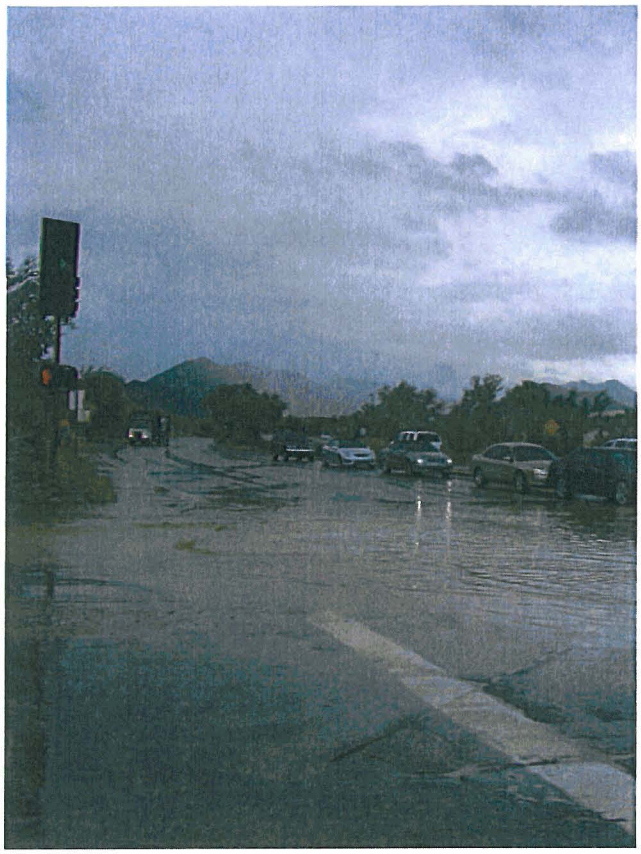


Figure 4.1: Identified Access Problems

Figure 4.2 : Identified Erosion Problems

3.0 POTENTIAL SOLUTIONS

Possible solutions to the various flooding problems identified have been discussed and evaluated with the stakeholders, which include (but are not limited to) the Town, Arizona State Land Development, Maricopa County Parks and Recreation, Maricopa County Planning and Development, Desert Foothills Land Trust, and Town of Carefree. While certain preferences have been expressed by various individuals as to the appropriateness of the solutions to specific locations, it has been agreed that the identified possible solutions can be categorized as follows:

Constructed Solutions
- Bridges
- Culverts
- Low Water Crossings (w/ Grade Control)
- Bank Protection
- Cut Banks
- Channelization
- Basins

Non-Constructed Solutions
- Early Flood Warning
- Education
- Conservation Easements
- Erosion Hazard Setbacks
- Floodplain Delineations

Any number of combinations of these various solutions may be assembled to produce a comprehensive alternative that addresses the flooding concerns of the Town, yet is acceptable from an aesthetic point of view. The keys to producing the optimum alternative will be in; first identifying those **specific locations** where the potential problems exist; second, selecting the **solution** that most appropriately addresses the problem; and third, designing the **aesthetic characteristics** of the solution that are sensitive to the natural surrounding environment.

While it is beyond the scope of this report to select the specific aesthetic treatments to be applied to each solution at each location, these three key decision points are discussed in the following sections in sufficient detail to warrant alternative development and identification of a recommended alternative.

3.1 SPECIFIC LOCATIONS

Those locations within the Town that have been identified as the site of either historic or potential flooding, were investigated and documented in the *Data Collection and Existing Conditions Report*. All flooding locations identified in the public meeting were included. Some of the locations, however, are not appropriate to address in the DMP, such as locations where flooding may be caused by the activity of an adjacent landowner. Extensive field work

techniques, including photography and surveyed measurements were used, along with discussions with Town staff and the public, to identify these locations.

The problem areas were categorized to aid in identifying appropriate solutions. The categories are:

- Access Problems
- Erosion Problems
- Wash Obstructions
- Floodway Encroachments
- Sediment Problems
- Damaged Storm Drains

3.2 IDENTIFIED SOLUTIONS

The District routinely investigates and implements a wide variety of methods to provide flood protection. One way of classifying these methods, especially at this early stage, is either as structural or non-structural. That is, either as a constructed solution that most significantly changes the behavior of the water, or as a regulatory solution that most significantly changes the behavior of the human environment. For purposes of this report, the identified possible solutions have been categorized as applying either to the constructed environment, or the non-constructed environment.

3.2.1 CONSTRUCTED SOLUTIONS

These types of facilities, when built, would require little or no additional human intervention, other than maintenance, to provide the level of flood protection anticipated in their design.

3.2.1.1 Crossings

Bridges

With increased development of the Town and an increased need for all weather access, bridges are a necessary alternative. These structures are reserved for larger washes and must meet aesthetic requirements while providing wildlife corridors and adequate storm capacity. Five new bridges are considered which would prevent the Town's residents from being stranded or cut off during major flow events. Several possible locations were presented for discussion at the public meeting.

In order to narrow down potential locations for consideration, the following criteria were applied to wash/roadway crossings:

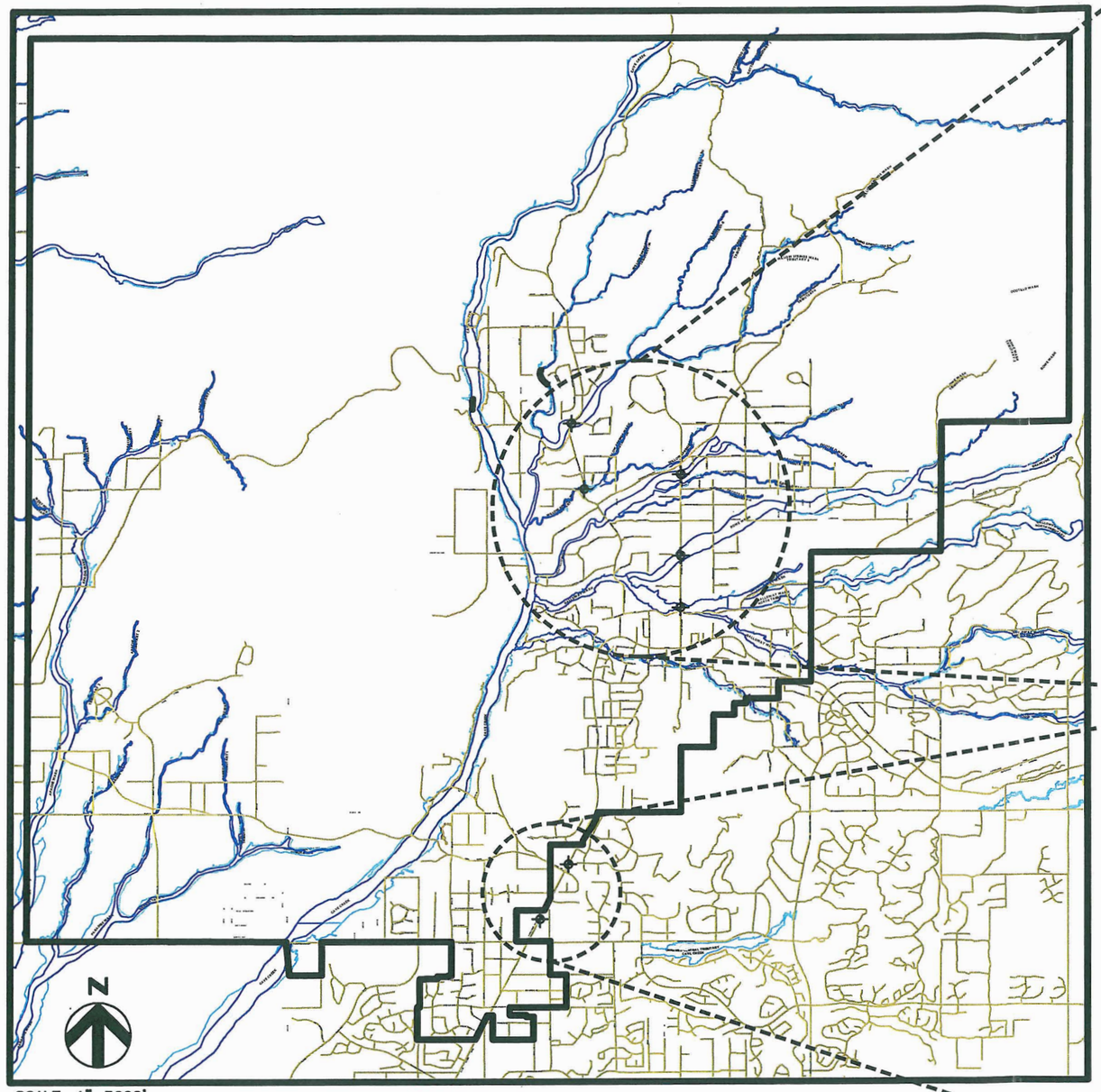
- Size of wash and duration of flooding
- Number of people stranded during storm events (from Flood Response Plan)
- Right-of-way ownership
- Average daily traffic demand

During examination of access routes, it was determined that approximately the same access to the north could be gained by either improving major wash crossings on School House Road or Spur Cross Road, or a combination of the two. School House Road to the south of Ocotillo Wash was identified as the main access road to properties to the north, as Spur Cross Road traverses through residential neighborhoods, with a narrower right-of-way and many jogs and curves. Construction of a bridge on Spur Cross Road at Galloway Wash would be difficult due to the curved geometry of the road and presence of the Mesquite Road intersection at the north bank. Additionally, access to School House Road from Cave Creek Road is from a four-way stop intersection, unlike Spur Cross Road which is uncontrolled.

Therefore, a combination of improvements on both roads is recommended as the first priority, with improvements to both roads recommended over time. This results in all-weather access improvements as a first priority on School House Road to the south of Ocotillo Wash and on Spur Cross Road to the north of Ocotillo Wash, with connection between the two roads via Fleming Springs Road.

The first priority improvements consist of three crossings on School House Road at Galloway Wash, Rowe Wash, and Ocotillo Wash, and two crossings on Spur Cross Road at Willow Springs Wash and Willow Springs Wash Tributary 5. After these improvements are made, additional crossing improvements can be made on Spur Cross Road at Galloway Wash and Ocotillo Wash to provide a secondary access to the north. Refer to Figure 5 located on the next page for an illustration of the locations with respect to the roadway alignments.

Another bridge location discussed is located across the Cave Creek Wash, located along the alignment of the New River Road. This alignment is currently closed to through traffic. The bridge is not necessary as a primary route to prevent residents from being stranded, but could provide secondary access if built.



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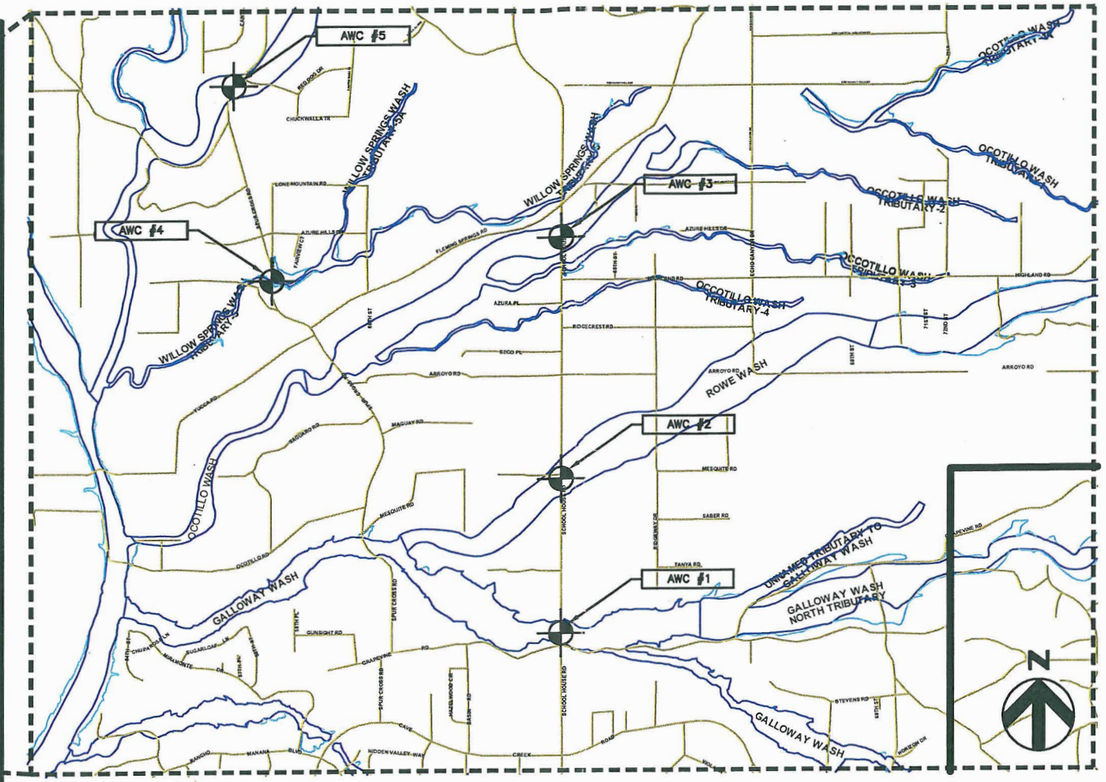

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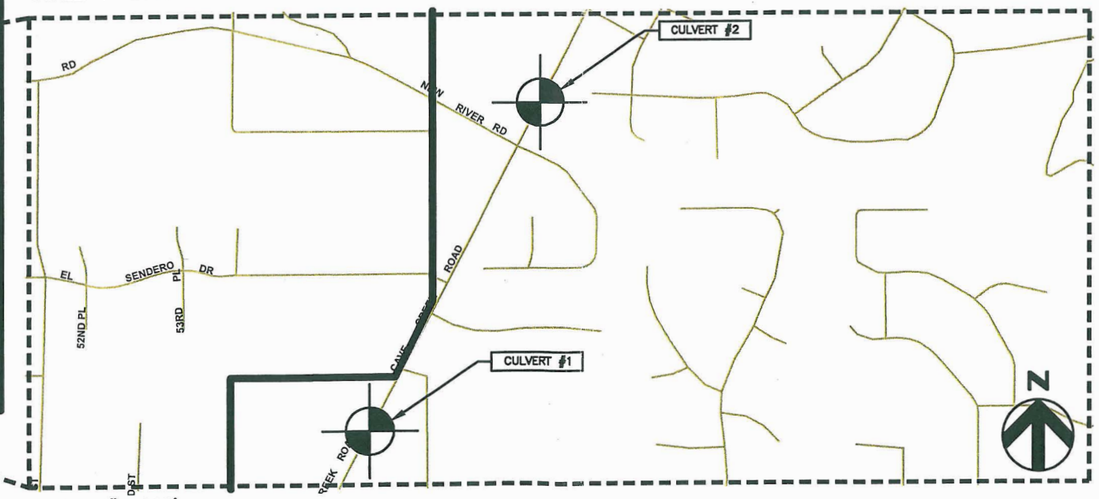

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LEGEND

AWC #1 — ALL WEATHER ACCESS CROSSING IMPROVEMENT LOCATION

- *GALLOWAY WASH
- *ROWE WASH
- *OCOTILLO WASH
- *WILLOW SPRINGS WASH
- *WILLOW SPRINGS WASH TRIBUTARY–5

CULVERT #1 — ALL WEATHER ACCESS (CULVERT) LOCATION

HDR

CAVE CREEK DRAINAGE MASTER PLAN PROPOSED ACCESS IMPROVEMENTS

DATE: DECEMBER 2007

FIGURE: FIGURE 5

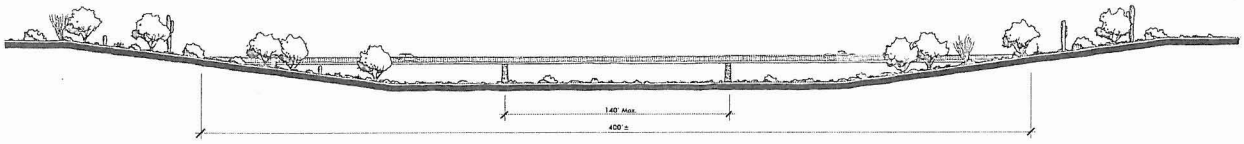

Figure 6: Bridge Crossing

Culverts

Large culverts are viewed as acceptable alternatives to bridges at most locations. Large culverts should allow for continuity of equestrian trails by realigning the trails around and over culverts, not through them.

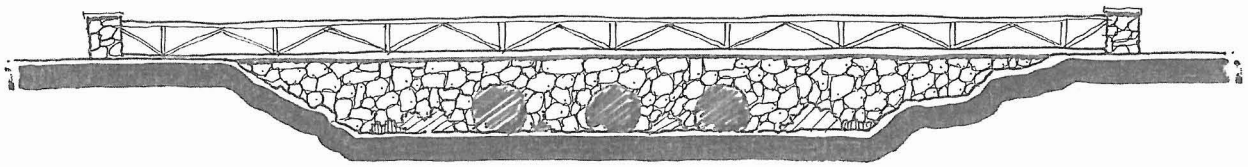

Figure 7: Improved Culvert Crossing

Low Water Crossings

Low water crossings typically have small pipes or culverts under the road which carry the low flows that occur during a 10-year event or less. They are not intended to be accessible during a 100-year event. Some type of structured protection is needed on the downstream side to prevent undercutting of the roadway. A disadvantage to low water crossings is that people attempt to cross them during flood events and may get swept away. In order to reduce this problem, warning signage and education are also needed.

Low water crossings are often accompanied by grade control structures. Grade control structures drop water safely from one level to another without causing further channel degradation. Multiple drops can occur if the channel is particularly steep. They can also help to control flooding and trap sediment moving within the runoff.

Dip crossings are similar to low water crossings, except that all flow is conveyed across the roadway, even minor runoff events. They can be both improved and unimproved roadway crossings at a wash. An improved dip crossing consists of an asphalt roadway with a concrete cutoff wall located adjacent to the roadway which aids in preventing head cutting and roadway failure due to erosion.

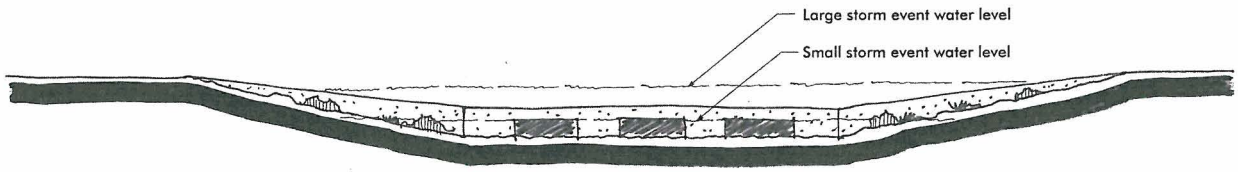

Figure 8: Low Water Crossing

3.2.1.2 Erosion

Bank Protection

Bank protection is needed where there is significant bank erosion occurring that could eventually erode the bank back to existing buildings and other structures. One source of bank erosion is the result of the force of the water overcoming the natural cohesion of the soil. Another source is geotechnical failure. This occurs when gravitational forces are greater than the strength of the soil.

To protect the bank from further or anticipated erosion, there are several types of bank protection including concrete lined, rip rap, gabion baskets or matting, or buried bank.

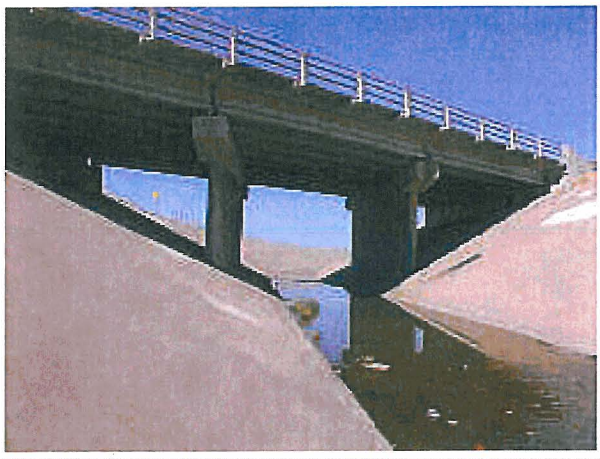

Figure 9: Concrete Lined Channel

Figure 10: Gabion Baskets lined Channel

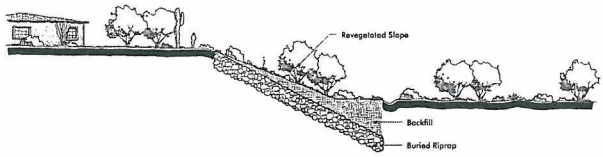

Figure 11: Buried Bank Protection–Cross Section View *Figure 12: Buried Bank Protection–After Construction*

Cut Banks

Cut banks are subject to erosion. Several different means exist to protect structures threatened by cut banks. To protect the buildings behind them, structural methods are available to provide bank protection, such as grouted riprap, gabions, or concrete walls. Additionally, bank protection can be buried between the bank edge and the buildings. When backfilled and revegetated, they are not visible and can provide a more aesthetically pleasing alternative to other forms of bank protection.

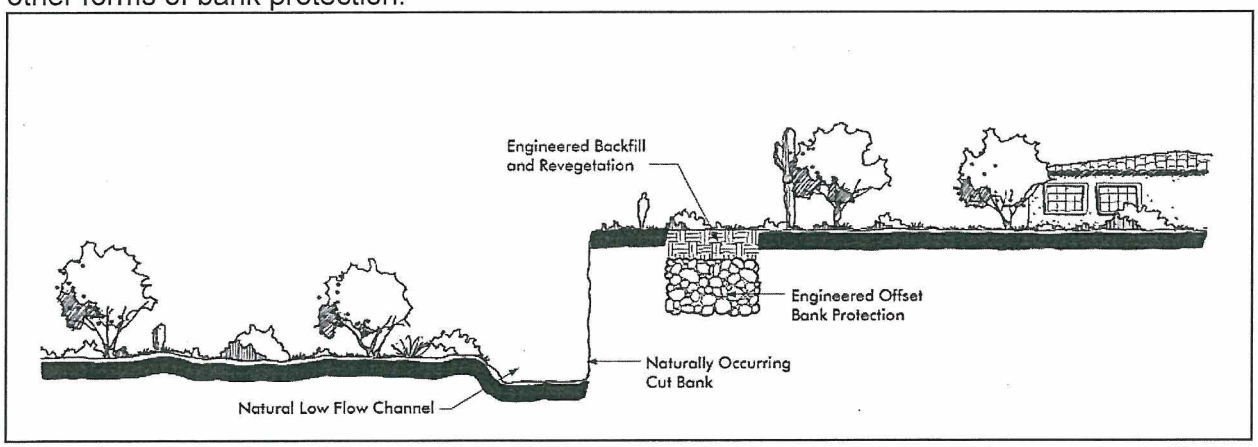

Figure 13: Cut Banks

Channelization

Channelizing water flows helps control and direct floodwaters during storm events, decreases erosion, and in some cases, improves the appearance of highly eroded channels. Modifications can include straightening, deepening or widening the channel; clearing vegetation from the banks; or lining the channel with concrete or other structured material. Channels are most often used in developed areas where streams can no longer be allowed to flow naturally because

they will cause damage to surrounding buildings. However, there are numerous ways to improve the appearance of a channel and blend it into the landscape setting.

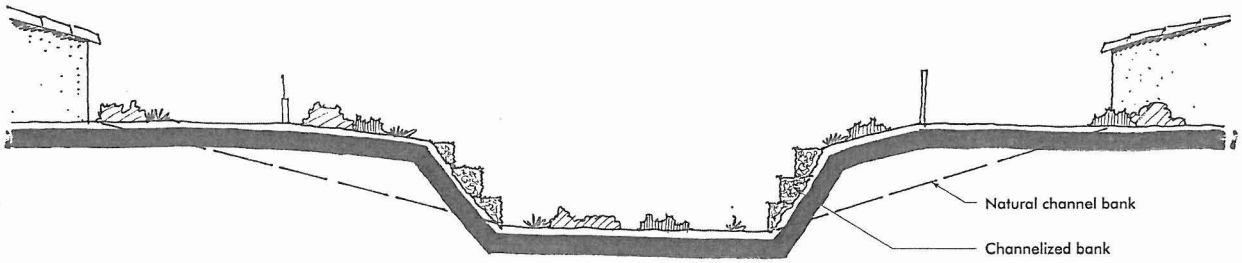

Figure 14: Channelization

3.2.1.3 Other

Basins

Sediment basins are designed to trap sediment so that it is not deposited in undesirable areas such as culverts or road crossings. Secondary benefits include runoff control and preserving the capacity of the downstream channels and culverts. The size of the structures depend on the location, size of drainage area, soil type, rainfall amount, and other site conditions that could cause high runoff and sediment.

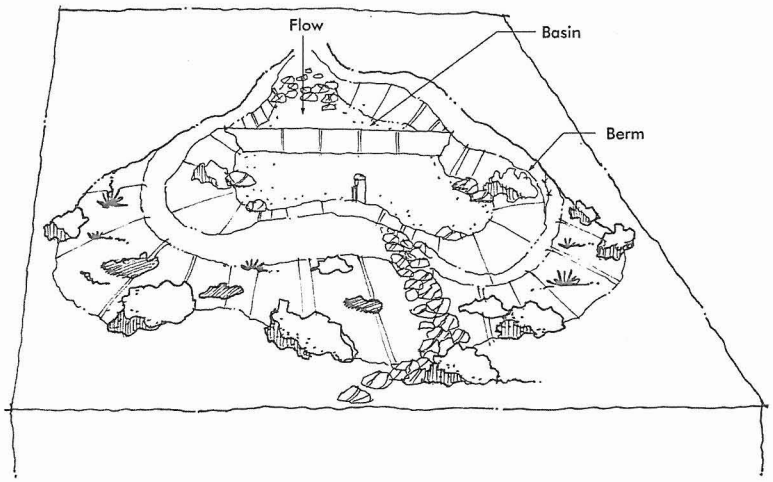

Figure 15: Sediment Basin

Detention basins are designed to hold stormwater collected temporarily from a source channel and then slowly drain when water levels in the receiving channel recede. This helps minimize

downstream erosion and reduce flooding. Detention basins are located where stormwater naturally flows or collects. Detention basins can also serve as sediment basins.

Retention basins are designed to collect stormwater runoff and percolate the water volume into the ground within 36 hours. These basins can additionally be utilized as sediment basins, but additional design criteria are required to prevent a reduction of the necessary storage volumes for water runoff.

3.2.2 NON-STRUCTURAL SOLUTIONS

Typically, non-structural solutions require a significant, coordinated involvement of a combination of Town and County staff, and other public and private concerns, along with the general public, to be effective. Non-structural solutions may be less costly than structural solutions. Some of these non-structural solutions have been identified as having the potential to work in the Town.

3.2.2.1 Flood Warning

Active flood warning methods that were specifically rejected during the meeting were:

Automated telephone notification system. This was viewed as unnecessary and ineffective. If residents are at home and receive the phone call, they will stay at home to avoid flooded areas. If they are not at home, then the call will be unanswered.

Flashing amber lights with automated crossing arms to warn of flooded low water crossings. While these would be effective, they would also be visually distractive when not in use and would detrimentally affect the character of area (see *Figure 16*). Also, they are not desirable because they would require electrical power, radio or telephone telemetry, calibration, and maintenance. It is noted that flashing lights may be acceptable at major crossings such as Spur Cross Road or School House Road. However, the automated barriers were rejected by residents and Town staff.

Manual Gates. Manual closure gates were not supported due to the intrusion on the landscape when not in use. Further, they do not reduce emergency response activities of the Town staff since they must be manually closed and opened.

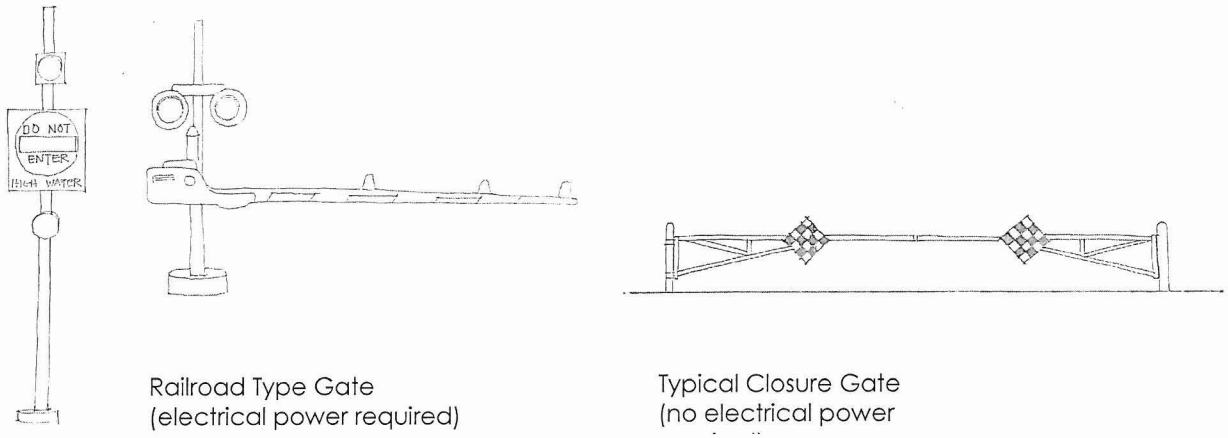

Figure 16: Flood Warning Devices Rejected

3.2.2.2 Active Flood Warning

Active flood warning methods that are acceptable are as follows:

ALERT Gage Network. To improve the warning systems for the drainage basins, it is recommended that additional precipitation/stage gages be installed.

Crest Gages. The Town and residents have expressed interest in the installation of crest gages at selected roadway crossings. It is recommended that the Town install crest gages at the following roads where they cross the identified watercourses:

Spur Cross Road
- Willow Springs Wash Tributary 5
- Willow Springs Wash (main stem)
- Ocotillo Wash
- Rowe Wash/Galloway Wash confluence

School House Road
- Ocotillo Wash
- Rowe Wash
- Galloway Wash
- Andora Hills Wash

Grapevine Road
- Galloway Wash North Tributary

Creek Canyon Road
- Cave Creek

Based on feedback from the Town and participating residents, the following attributes should be considered for the crest gages:

Markings should be easily seen and interpreted from the approaching road.

Flashing lights automatically activated by precipitation and/or stage data, with manual activation and deactivation capabilities.

Consider two levels of warning lights, "warning", and "do not cross"

Consider marketing the crest gages to indicate unsafe crossing based on flood hazard charts developed by the U.S. Bureau of Reclamation.

3.2.2.3 Coordination with Participants

Ultimately, the success of the Town's FRP depends on close coordination among the participants because they are tasked with notification and barricading of streets at risk of flooding. Therefore, it is critical that all plan participants be given copies of the Town's FRP, as well as electronic and/or full size prints of the flood vulnerability map and emergency access map. It also critical that each copy of the FRP be tracked so that replacements may be issued to all as it is updated. The Town has been tasked with distribution and coordination of the FRP with its participants.

3.2.2.4 Notification Updates

Continued development within the watershed will dictate changes to the Town's notification lists. Currently, the Town notifies selected residents who have expressed a need for early notification because of animal care or access concerns. As the Town continues to grow, this list may need to be expanded or replaced by procedures that can better accommodate a larger notification list.

3.2.2.5 Education

An education program can be developed to inform residents of the flooding and erosion potential along the washes, the danger of crossing flooded washes, how to mitigate the risk of getting stranded, and how to protect their structures from potential flood damage.
Public Education options include:

Newspaper articles after rain events

Brochures at Town Hall

Posters

Hand-outs

Mailers

Flyers

Billboards (rejected)

Video/CD-ROM on crossing flooded washes

Public meetings before rainy season

Variable Message Boards (likely rejected)

Radio broadcasts

TV commercials
Website
Emails

3.2.2.6 Conservation Easements

The Town may partner with the private landowners to acquire conservation easements that set aside areas which cannot be built upon, allowing natural flood processes to continue (see *Figure 17*). Public access through and across the easements will be determined on an individual basis.

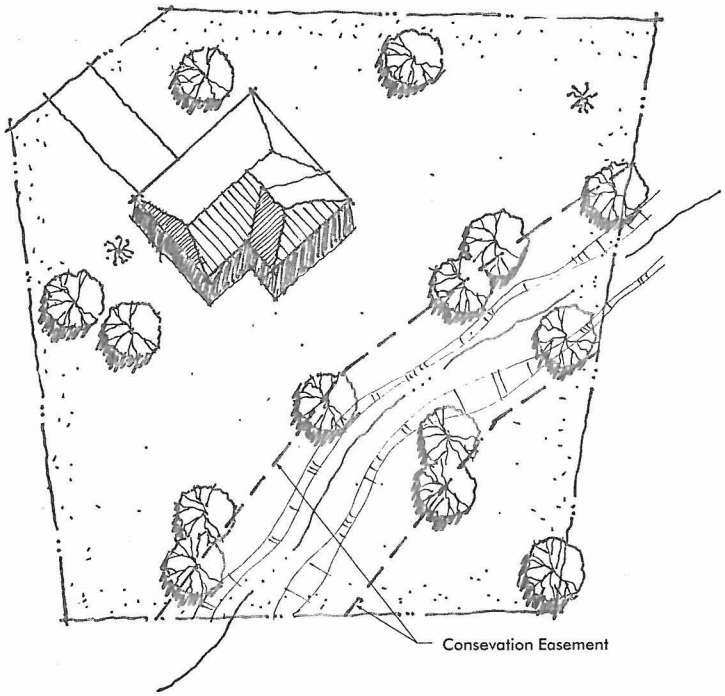

Figure 17: Conservation Easement

3.2.2.7 Erosion Hazard Setbacks

Erosion hazard setbacks are areas adjacent to or within major washes where the placement of structures is prohibited. These limits are established to protect structures from erosion related damages. Erosion hazard setback zones will be mapped and enforced throughout the Town to prevent damage to future structures as a result of lateral stream bank erosion (see *Figure 18*).

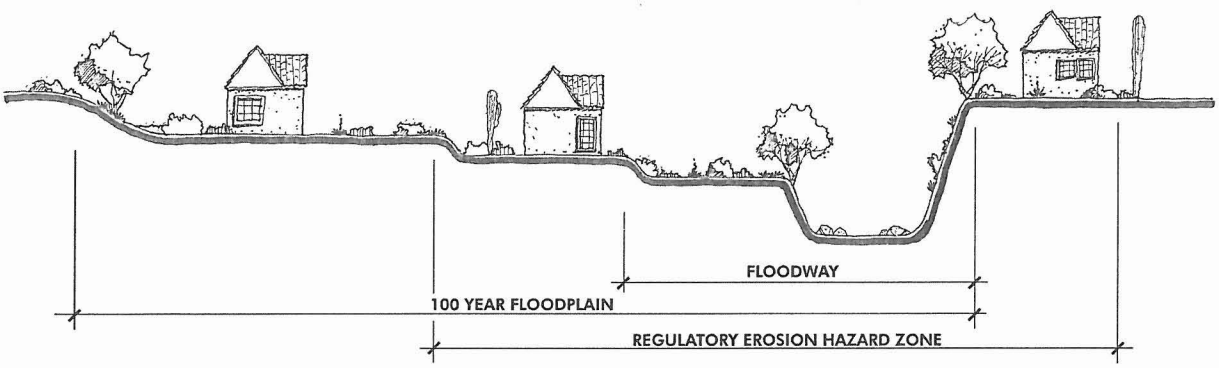

Figure 18: Erosion Hazard Setback

3.2.2.8 Floodplain Delineations

The flow of water through desert washes can be very swift, strong, and dangerous. Numerous washes in the Town have been identified with this potential, yet have not been delineated for floodplains. Additional mapping of the remaining 100-year floodplains within the study limits can prevent or reduce the flood risk activities in areas subject to inundation.

3.3 AESTHETIC CHARACTERSTICS

An important component of the DMP is to consider the landscape character, cultural setting, and natural environment that represent the uniqueness of the Town. More exact aesthetic and visual qualities of the various solutions will be developed during Phase II of the DMP. Initial estimations of the qualities that would be appropriate for the Town have been determined through several sources, including the draft *Scenery Resource Report* prepared by the District for the Cave Creek DMP.

The preference is first for **non-structural** followed by **soft** and **semi-soft structural** solutions, as described below. These solutions are the most natural and best fit the Town's environment. Any of the constructed solutions, also described, can be mitigated in a manner that will help blend them into the environment. As locations and solutions are specifically identified, the mitigations can be further refined to meet the specific surrounding environment. Hard structural solutions are additionally described herein; however they are intended for reference and are not part of the preferred alternative.

3.3.1 SOLUTION TYPES[1]

3.3.1.1 Non-structural

Non-structural solutions use the existing natural drainage features in the landscape. They do not

Figure 19: Non-structural (Sonoqui Wash, Queen Creek)

modify the existing landscape character, but instead retain the character of the landscape setting they are in. They are implemented through regulations and guidelines by the FCDMC and the Town.

[1] Flood Control District of Maricopa County, "Flood Protection Methods and the Landscape Settings of Maricopa County" PowerPoint.

3.3.1.2 Soft Structural

Soft structures can be channels, basins, and flood retarding structures, but they are constructed primarily with earthen materials. Any hard structural components are buried or disguised.

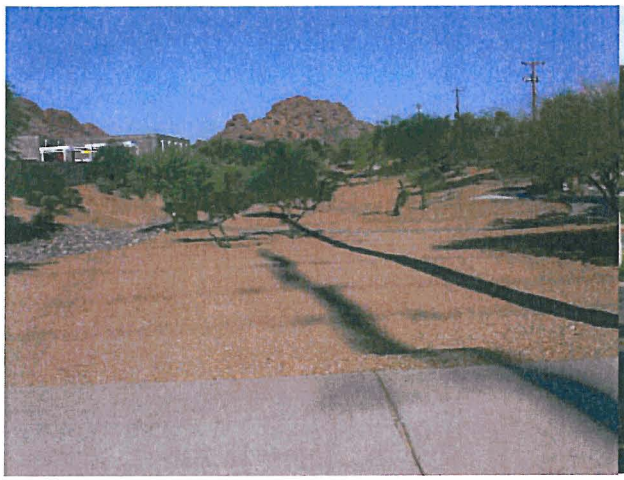

Figure 20: Soft Structural (Oak Street Storage Basin, Scottsdale)

Figure 21: Soft Structural (Indian Bend Golf Course, Scottsdale)

3.3.1.3 Semi-soft Structural

Like soft structural, the structure is constructed predominantly of earthen materials but any hard structural components may be visible such as grade control structures, energy dissipaters, and inlet and outlet structures. While visible, hard structural components are designed to be subordinate in the setting.

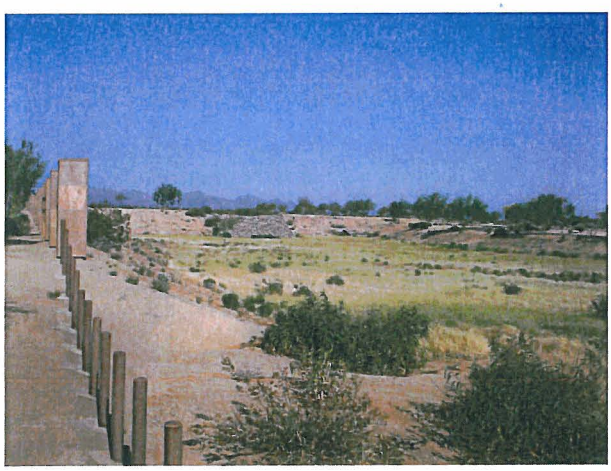

Figure 22: Semi-soft Structural (Storage Basin, National Memorial Cemetery, Phoenix)

3.3.1.4 Semi-hard Structural

Large scale structures are constructed predominantly of earthen materials, typically with geometric forms, straight lines, and uniform slopes. Components of the structures are often standard engineering designs rather than customized to the site and they generally lack aesthetic features or treatment.

Figure 23: Semi-hard Structural (Storage Basin on Tatum Wash, Phoenix)

Figure 24: Semi-hard Structural (Cave Buttes Dam, Phoenix)

3.3.1.5 Hard Structural

Hard structural solutions are composed of large-scale, hard-lined, and often concrete engineered hydraulic structures. These solutions can include aesthetic treatments such as meandering, warping the side slopes, meandering bottoms, landscaped areas, and colors and materials that fit the setting. However, they are usually engineered concrete structures.

Figure 25: Hard Structural (Arizona Canal Diversion Channel, Phoenix)

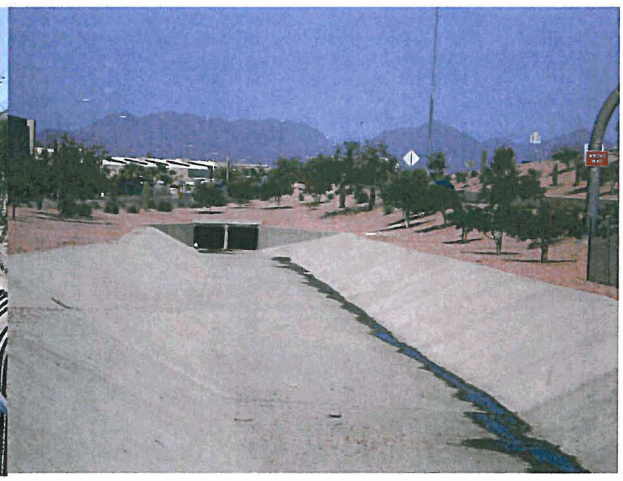

Figure 26: Hard Structural (Conveyance Channel at Cave Creek Road and Loop 101, Phoenix)

3.3.2 AESTHETIC TREATMENTS

3.3.2.1 Culverts

Culverts should not display plain, gray concrete or Concrete Masonry Unit (CMU) headwalls, wing-walls, or aprons, but should instead have stained concrete, native rock veneer, gabion mattresses, or other types of aesthetic treatments. Culverts should allow for continuity of trails by realigning the trails around and over culverts, not through them.

Figure 27: Stone Headwall

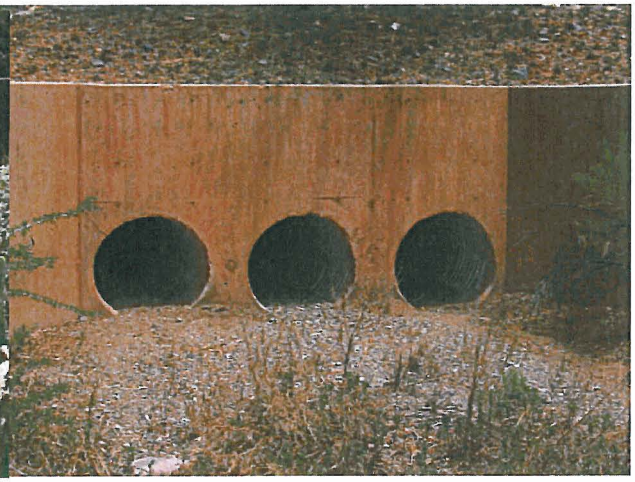

Figure 28: Stained Concrete Headwall

3.3.2.2 Low Water Crossings

Low water crossings generally do not visually impact the landscape setting. Sometimes the paving over the culverts differs from the roadway paving, but they are generally flush with the existing roadway pavement. The paving color can be matched to the surrounding landscape. The structural component on the downstream side can be constructed of colored concrete or stone.

3.3.2.3 Bank Protection

The least intrusive bank protection is buried bank. Once installed and the landscape revegetated, it is no longer visible (refer to page 9, *Figure 12*). The revegetation should be designed to match the surrounding natural landscape in species and density.

3.3.2.4 Cut Banks

Bank protection for cut banks can be buried between the bank edge and the buildings (see *Figure 12*). When backfilled and revegetated, they are not visible. Revegetation should be designed to match the surrounding natural landscape in species and density.

3.3.2.5 Grade Control Structures

Grade control structures can blend with the landscape setting if they are built of materials native to the site rather than grey concrete.

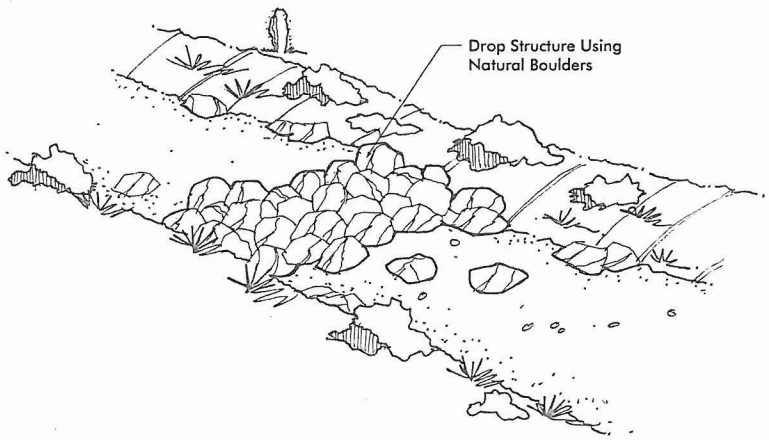

Figure 29: Grade Control Structure

3.3.2.6 Channels and Basins

The District has prepared detailed guidelines in the *Draft Scenery Resource Report* for development of basins and channel conveyance facilities specifically in the area of the Cave Creek Drainage Master Plan. In general, the guidelines result in basins and channels that are freeform in shape; have few, if any, straight lines or geometric shapes; are setback from adjacent properties to provide a visual transition; and are vegetated with landscape materials that are consistent with the setting.

Full channelization of the entire wash cross-section, including stream banks and channel bottom, would not be allowed, regardless of the material used. Even gabion baskets would destroy the character of the washes and have significant detrimental effect on access, visual quality, and wildlife habitat.

3.3.3 Examples for Identified Problems in the Town of Cave Creek

Following are examples applications of the features discussed to solve the various problems identified by the Town's residents and the project team.

Erosion Problems

Figure 30: Erosion Before

Figure 31: Erosion After

Access Problems

Figure 32: Crossing Before

Figure 33: Crossing After With Low Flow

Figure 34: Crossing Before

Figure 35: Crossing After With Culverts

Figure 36: Crossing Before

Figure 37: Crossing After With Bridge

Wash Obstructions

Figure 38: Wash Obstruction Before

Figure 39: Wash Obstruction After

Floodway Encroachments

Figure 40: Floodway Encroachment Before

Figure 41: Floodway Encroachment After

Sediment Problems

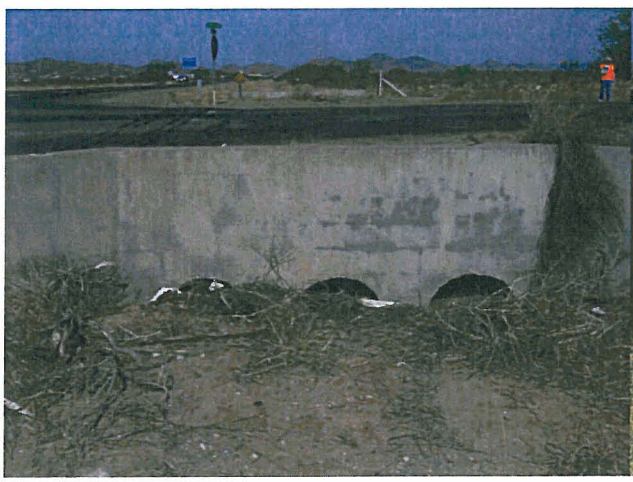

Figure 42: Sediment Before

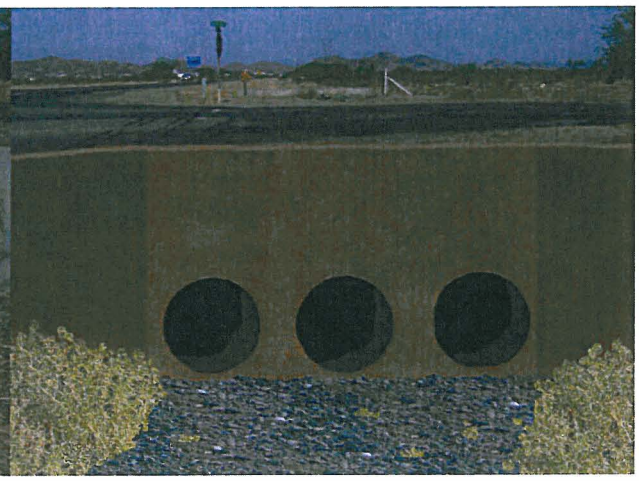

Figure 43: Sediment After

In this example, the sediment has been cleaned out to fully expose the culvert pipes. The concrete headwall has been stained a more natural color. In order to prevent further sediment buildup, ongoing maintenance will need to be carried out. A routine maintenance plan is suggested.

Damaged Storm Drains

Figure 44: Damaged Culvert Before

Figure 45: Damaged Culvert After

In this example, the headwall for the culvert has been reconstructed and wingwalls added with materials that complement the setting.

4.0 SUMMARY

This report has been prepared to document that potential alternatives exist that, when developed, will address the flooding problems in the Town. The development of these potential alternatives, and the formulation of a recommended alternative, will be performed during Phase II of the drainage master plan. The incorporation of associated studies, such as a visual analysis, cultural resources study, and an environmental overview, are included as Phase II tasks to help determine the acceptability of the recommended alternative.