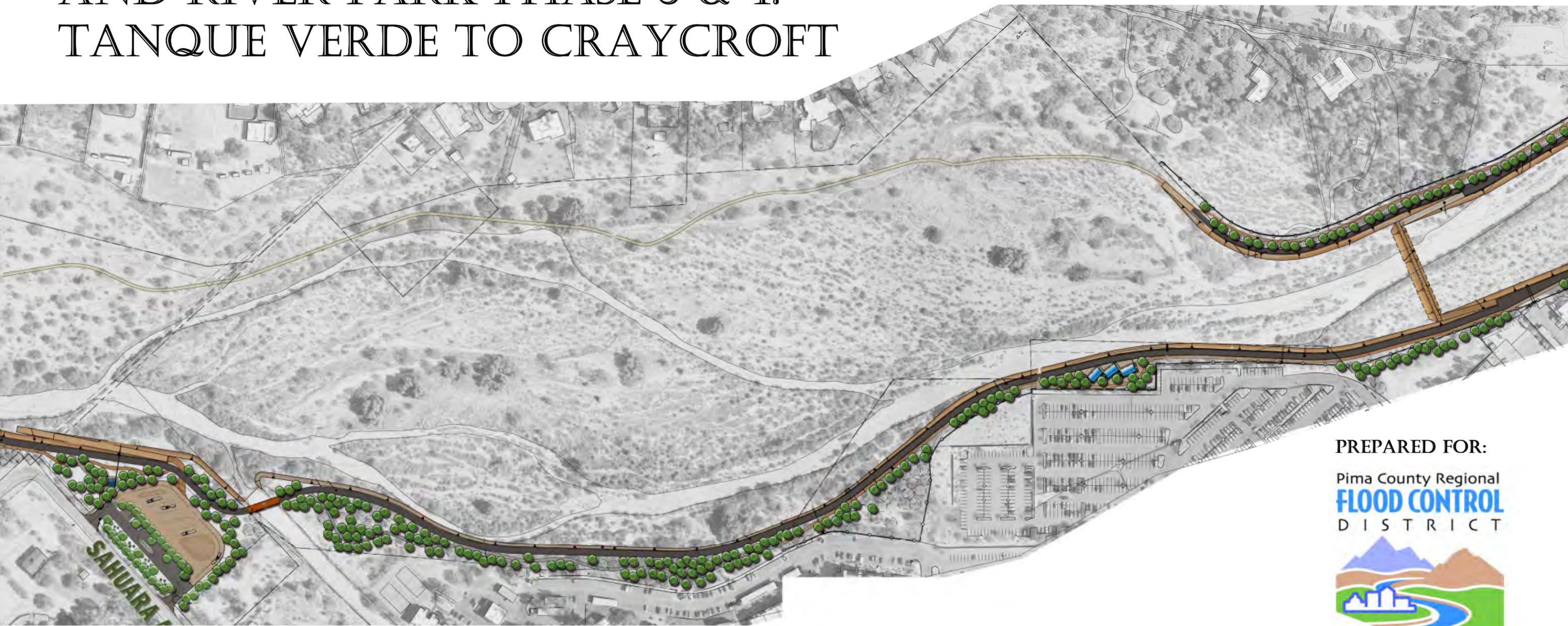


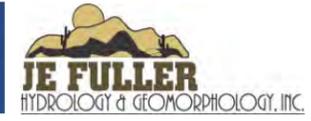
# BASIS OF DESIGN REPORT FOR PANTANO WASH BANK PROTECTION AND RIVER PARK PHASE 3 & 4: TANQUE VERDE TO CRAYCROFT



PREPARED FOR:  
Pima County Regional  
**FLOOD CONTROL**  
DISTRICT



PREPARED BY:



NOVEMBER 2013

PCRFCDD PROJECT NO. 5PWFLT

## EXECUTIVE SUMMARY

Pima County is in the process of creating an urban bicycle loop (the Loop) along the major washes of the community. This 1.7 mile project will close a gap along one of the more difficult segments of the Loop, connecting the Rillito River Park with the existing River Park along the Pantano Wash. Once completed, this project will connect two completed sections, to form nearly 20 miles of uninterrupted linear park, within a larger 110 miles of completed multi-use path throughout Pima County. While the closing of the Loop and adding recreational features to the River Park is a major goal, additional objectives of this project include flood and erosion control, and natural and cultural resources preservation and enhancement.

Project construction will be divided into two phases. Phase III will consist of 1.3 miles of paved and DG pathway along the west bank on top of new soil cement, beginning at Tanque Verde Road at the termination of Pantano Phase II, to the south end of Fort Lowell Park where the soil cement will terminate. The paved pathway will continue to the north end of Fort Lowell Park to allow for future pathway connections in the park. A new staging area will be provided at the end of Glenn Street near Rose Hill Wash as well as additional recreational nodes. Paved and DG pathways will also be extended on the east bank from the termination of Phase II improvement to a point where the channel widens significantly across from Costco on the Wilmot Road alignment. The pathways will be located on both existing soil cement and 1200' of new soil cement. A natural surface path will be extended from the termination of the east bank paved pathway through the wash and floodplain area to connect to the west bank pathway at Fort Lowell Park. A new grade control structure and access ramps will also be constructed near the termination of the Phase III east bank improvements to provide long term channel stability and to provide pedestrian access from the east bank to the west bank.

Phase IV extends paved and DG pathways along the west bank only from the north end of Fort Lowell Park to existing pathways and underpass at Craycroft Road. This phase requires the protection of riparian ecosystem elements and right-of-way acquisitions from several different private land owners, which will likely extend the project schedule beyond the Phase III improvements. The preferred alternative for this phase does not include bank protection as it is cost prohibitive and the banks have been generally stable in this reach based on the review of historic data. Development is also sparse in this reach and there are no inhabitable structures located directly adjacent to the banks within the anticipated lateral bank migration limits. In the event bank protection is included in this phase, it would likely extend on the west bank from approximately 850' north of Fort Lowell Park to tie into existing bank protection at Craycroft Road. The extents on the east bank would be similar but would be terminated with a "key-in" at Craycroft Road as there on no existing bank protection to tie into.

The development of the preferred design concept for the project included a detailed assessment of project specific conditions and constraints including topography, land ownership, utilities, channel hydraulics and scour, biological and cultural resources, and public input. An opinion of probable construction costs was developed for the recommended design as well as for select alternatives which were considered feasible given project constraints. The estimated costs for the recommended alternative are \$5.5 million for Phase III and \$850,000 for Phase IV. The estimated cost of the Phase IV alternative which includes soil cement bank protection is \$3.0 million.

Minimizing impact to existing high value biological and cultural resources is a major goal of the project. A detailed existing conditions biological assessment was completed for the project which included extensive field work and inventory of existing native and invasive vegetation, as well as the determination of existing wildlife habitat features. The project team worked closely with both Pima County and City of Tucson staff to develop a riparian habitat mitigation approach which is acceptable to both jurisdictions. The project area is tightly constrained in many locations and it might not be possible to meet the conditions of the riparian mitigation requirements due to lack of space for new plantings. Alternative mitigation options may be utilized such as invasive species removal beyond the project limits, offsite mitigation, or in-lieu fees. An extensive cultural resources survey was also completed to determine the location and extent of existing features, and to provide the basis for detailed data recovery effort and mitigation plans.

# TABLE OF CONTENTS

## EXECUTIVE SUMMARY

|   |          |
|---|----------|
| TABLE OF CONTENTS .....   | i        |
| TABLES.....   | ii       |
| FIGURES.....  | ii       |
| APPENDICES.....   | ii       |
| <b>1.0 Introduction .....</b>                                     | <b>1</b> |
| 1.1 Project Description and Summary .....                         | 1        |
| 1.2 Project Objectives and Priorities.....                        | 1        |
| 1.3 Relationship of Project to Pima Regional Trails Plan .....    | 3        |
| <b>2.0 Facilities Program .....</b>                               | <b>3</b> |
| 2.1 Improvements for Public Recreation .....                      | 3        |
| 2.1.1 Paved Multi-Use Path .....                                  | 3        |
| 2.1.2 Soft-Surfaced Paths and Trails.....                         | 3        |
| 2.1.3 Staging Area.....   | 3        |
| 2.1.4 Gathering and Rest Nodes .....                              | 4        |
| 2.1.5 Trailside Planting and Irrigation .....                     | 4        |
| 2.1.6 Public Art.....   | 4        |
| 2.1.7 Emergency and Maintenance Vehicle Access .....              | 5        |
| 2.2 Flood Control and Drainage Improvements .....                 | 5        |
| 2.2.1 Soil Cement Bank Protection.....                            | 5        |
| 2.2.2 Tributary Drainage Improvements.....                        | 5        |
| 2.2.3 Water Harvesting .....                                      | 5        |
| 2.3 Ecosystem Protection and Enhancement .....                    | 6        |
| <b>3.0 Site Conditions and Constraints .....</b>                  | <b>7</b> |
| 3.1 Land Ownership and Acquisitions.....                          | 7        |
| 3.1.1 Existing Land Use and Property Ownership.....               | 7        |
| 3.1.2 Easement and Right of Way Acquisition for Development.....  | 7        |
| 3.2 Site Development and Construction .....                       | 7        |
| 3.2.1 Construction Staging Area.....                              | 7        |
| 3.2.2 Site Clean-Up and Restoration.....                          | 7        |
| 3.2.3 Preliminary Earthwork Balance for Development.....          | 12       |
| 3.3 Utilities.....  | 12       |
| 3.3.1 Utility Identification and Base Mapping.....                | 12       |
| 3.3.2 Special Utility Issues.....                                 | 12       |
| 3.3.3 Utility Connections for Development.....                    | 12       |
| 3.4 Pantano Wash Hydraulics and Scour.....                        | 18       |
| 3.4.1 Current FEMA Status .....                                   | 18       |
| 3.4.2 Hydraulic Modeling.....                                     | 18       |
| 3.4.3 Scour and Geomorphic Assessment.....                        | 18       |
| 3.4.3.1 Historic Lateral Bank Migration .....                     | 18       |
| 3.4.3.2 Historic Channel Aggradation / Degradation .....          | 24       |
| 3.4.4 Sediment Transport and Scour Analysis.....                  | 24       |
| 3.4.4.1 Single Event Scour Analysis .....                         | 24       |
| 3.4.4.2 Equilibrium Slope and Long Term Degradation Analysis..... | 24       |

|   |           |
|---|-----------|
| 3.4.5 Scour Recommendations .....                                       | 25        |
| 3.4.6 Proposed Hydraulic Conditions .....                               | 25        |
| 3.5 Tributary Drainage.....   | 26        |
| 3.5.1 Major Tributary Drainage Features .....                           | 26        |
| 3.5.2 Localized Drainage Conditions.....                                | 26        |
| 3.5.2.1 West Bank Tributary Drainage.....                               | 26        |
| 3.5.2.2 East Bank Tributary Drainage.....                               | 27        |
| 3.5.3 Water Harvesting .....  | 30        |
| 3.6 Biological Resources .....  | 30        |
| 3.6.1 Important Riparian Habitat .....                                  | 30        |
| 3.6.2 Vegetation.....   | 30        |
| 3.6.2.1 Vegetation Communities.....                                     | 30        |
| 3.6.2.2 Vegetation Diversity.....                                       | 33        |
| 3.6.2.3 Non-native Invasive Plant Species.....                          | 33        |
| 3.6.3 Existing Wildlife Values.....                                     | 33        |
| 3.6.3.1 Special Status Wildlife Species.....                            | 33        |
| 3.6.4 Potential Project Impacts .....                                   | 37        |
| 3.6.4.1 Construction Impacts.....                                       | 37        |
| 3.6.4.2 Long Term Project Impacts.....                                  | 37        |
| 3.6.5 Opportunities and Strategies for Protection and Enhancement ..... | 37        |
| 3.6.5.1 Design Methods and Controls .....                               | 39        |
| 3.6.5.2 Construction Methods and Controls.....                          | 39        |
| 3.6.5.3 Invasive Species Management .....                               | 39        |
| 3.6.6 Riparian Mitigation Coordination Approach.....                    | 39        |
| 3.6.6.1 Anticipated Impacts.....  | 39        |
| 3.6.6.2 Regulatory Approach .....                                       | 40        |
| 3.6.6.3 Mitigation Approach .....                                       | 40        |
| 3.7 Corps of Engineers Section 404 Permitting.....                      | 40        |
| 3.8 Cultural Resources .....  | 42        |
| 3.9 Coordination with Outside Agencies .....                            | 42        |
| 3.9.1 City of Tucson.....   | 42        |
| 3.9.2 Pima Trails Association .....                                     | 42        |
| 3.10 Traffic Impacts.....   | 42        |
| 3.11 Public Input.....  | 43        |
| <b>4.0 Alternatives Assessment.....</b>                                 | <b>45</b> |
| 4.1 Phase III Alternatives Assessment.....                              | 45        |
| 4.1.1 West Bank Pathways and Bank Protection Alternatives .....         | 45        |
| 4.1.1.1 General Project Design Conditions .....                         | 45        |
| 4.1.1.2 Preferred Alternative .....                                     | 45        |
| 4.1.1.3 Alternative Option #1 .....                                     | 46        |
| 4.1.1.4 Alternative Option #2.....                                      | 46        |
| 4.1.2 East Bank Pathways and Bank Protection Alternatives.....          | 46        |
| 4.1.2.1 General Project Design Conditions .....                         | 46        |
| 4.1.2.2 Preferred Alternative .....                                     | 46        |
| 4.1.2.3 Alternative Option #1 .....                                     | 47        |
| 4.1.3 Phase III Recreational Amenities.....                             | 47        |

|            |   |           |
|------------|---|-----------|
| 4.1.4      | Rose Hill Wash Crossing .....                       | 47        |
| 4.2        | Phase IV Alternatives Assessment.....               | 47        |
| 4.2.1      | Pathways and Bank Protection Alternatives .....     | 47        |
| 4.2.1.1    | General Project Design Conditions .....             | 47        |
| 4.2.1.2    | Preferred Alternative .....                         | 50        |
| 4.2.1.3    | Alternative Option #1 .....                         | 50        |
| 4.2.1.4    | Alternative Option #2.....                          | 50        |
| 4.2.1.5    | Alternative Option #3 .....                         | 50        |
| 4.2.2      | Recreational Amenities .....                        | 50        |
| <b>5.0</b> | <b>Opinion of Probable Construction Costs .....</b> | <b>53</b> |
| 5.1        | Derivation of Unit Costs .....                      | 53        |
| 5.2        | Derivation of Probable Construction Costs .....     | 53        |
| 5.3        | Project Funding .....                               | 54        |

## TABLES

|             |   |    |
|-------------|---|----|
| Table 3.3.1 | Summary of Existing Utilities and Potential Conflicts.....                | 16 |
| Table 3.3.2 | Summary of Required Utility Connections.....                              | 17 |
| Table 3.4.1 | Summary of Historic Channel Changes.....                                  | 24 |
| Table 3.4.2 | Summary of Computed Single-Event Scour Depths (Z) by Reach .....          | 24 |
| Table 3.4.3 | Summary of Proposed Conditions Hydraulics.....                            | 25 |
| Table 3.5.1 | Summary of Peak Discharges and Drainage Structures .....                  | 27 |
| Table 3.6.1 | Vegetation Communities and Cover Types Present in the Study Area .....    | 30 |
| Table 3.6.2 | Biological and Habitat Resources with High Priority for Preservation..... | 37 |
| Table 5.1.1 | Summary of Unit Cost Reference Projects .....                             | 53 |
| Table 5.3.1 | Summary of Opinion of Probable Costs .....                                | 55 |

## FIGURES

|              |  |    |
|--------------|--|----|
| Figure 1.2.1 | Project Location Map.....                            | 2  |
| Figure 3.2.1 | Existing Land Ownership .....                        | 8  |
| Figure 3.2.2 | Property Acquisitions.....                           | 10 |
| Figure 3.3.1 | Preliminary Earthwork Balance .....                  | 13 |
| Figure 3.3.2 | Existing Utilities Map .....                         | 14 |
| Figure 3.4.1 | Effective FEMA FIS Mapping.....                      | 19 |
| Figure 3.4.2 | Existing 100-Year Floodplain Depths and Extents..... | 20 |

|               |   |    |
|---------------|---|----|
| Figure 3.4.3  | Existing 100-Year Floodplain Velocities.....  | 21 |
| Figure 3.4.4  | Existing 25-Year Floodplain Depths and Extents.....                                 | 22 |
| Figure 3.4.5  | Existing 25-Year Floodplain Velocities.....   | 23 |
| Figure 3.5.1  | Tributary Drainage Map .....  | 28 |
| Figure 3.6.1  | SDCP Important Riparian Areas and Shallow Groundwater.....                          | 31 |
| Figure 3.6.2  | Existing Vegetation Communities .....   | 32 |
| Figure 3.6.3  | Preliminary Non-native Invasive Tree Species.....                                   | 34 |
| Figure 3.6.4  | Preliminary Non-native Invasive Shrubs and Grasses with Limited Distribution.....   | 35 |
| Figure 3.6.5  | Preliminary Non-native Invasive Perennial Grasses with Extensive Distribution ..... | 36 |
| Figure 3.6.6  | General Biological Resources and Special Habitat Features .....                     | 38 |
| Figure 3.7.1  | Preliminary Jurisdictional Delineation .....  | 41 |
| Figure 3.11.1 | Preliminary Traffic Counts .....  | 44 |
| Figure 4.2.1  | Preferred Alternative – Phase III and IV .....                                      | 48 |
| Figure 4.2.2  | Phase IV – Alternative 1 .....  | 51 |
| Figure 4.2.3  | Phase IV – Alternative 2 .....  | 52 |

## APPENDICES

|            |  |
|------------|--|
| Appendix A | Public Facilities Master Plan  |
| Appendix B | 30% Concept Design Plans   |
| Appendix C | Record of Survey   |
| Appendix D | Pantano Wash Hydraulic Modeling Report                                   |
| Appendix E | Tributary Watershed Hydraulic Calculations                               |
| Appendix F | Existing Conditions Biological Assessment Report                         |
| Appendix G | Preliminary Bid Item Breakdown and Opinion of Probable Construction Cost |

## 1.0 Introduction

### 1.1 Project Description and Summary

Pima County is in the process of creating an urban bicycle loop (the Loop) along the major washes of the community. The project discussed herein represents one of the more difficult segments of the Loop. It will connect the Rillito River Park with the existing River Park along the Pantano Wash which currently terminates just north of Tanque Verde Road. While the completion of the Loop is a key goal of this project, additional goals include flood control, and natural resources and cultural resources preservation and enhancement.

Project construction will be divided into two phases. Phase III will extend from Tanque Verde Road, beginning at the terminus of Phase II, to the north end of Fort Lowell Park. The approximately 1.4 miles of paved pathway on the west bank will be located directly on top of new soil cement bank protection with the exception of the segment through Fort Lowell Park. In addition to providing a stable surface for the paved pathway, construction of new soil cement also limits the required right-of-way acquisitions and provides flood protection to existing residents, apartments and businesses between the south end of Fort Lowell Park and Tanque Verde Road. Where adequate right-of-way exists, a decomposed granite pathway will be provided on the west bank parallel to the paved path and allowed to meander to the extent possible. A significant portion of this reach will only accommodate the DG path as a shoulder to the paved path. There is the opportunity for additional “off-path” amenities at discrete nodes in this reach. A staging area with paved parking and equestrian facilities will be provided at the end of Glenn Street near Rose Hill Wash. A restroom will not be included at the staging area based on public input.

The new paved pathway through Fort Lowell Park will facilitate connectivity to the park and will include a River Park node with some amenities and interpretive features which are yet to be determined. The paved pathway will traverse the park on the far east side, and possibly on the floodplain bench above the low flow channel in an attempt to avoid potential conflicts with existing cultural resources and other existing and planned improvements to Fort Lowell Park. A Master Plan for Fort Lowell Park was developed by the City of Tucson with input from key stakeholder groups and local residences. The City is unlikely to consider any design elements that are not consistent with the Master Plan. No alternative considered will include the construction of bank protection adjacent to Fort Lowell Park with the exception of a short segment at the southern boundary needed to provide a suitable termination of the bank protection.

The existing east bank pathway and DG path will be extended north from the Phase II improvements north for approximately 2700’ and terminate where the channel abruptly widens adjacent to Costco. The first 1300’ of the new path will be located on existing soil cement bank protection adjacent to Tucson Country Club Estates. The remaining 1400 feet will be placed directly on new soil cement which will serve to arrest and mitigate ongoing lateral erosion and permit the installation of a grade control structure adjacent to Costco to limit future channel bed degradation. East bank path users will have the option to cross to the west bank pathway via new access ramps and the new grade control structure, or continue north in the channel via a natural surface marked path which begins at the termination of the new soil cement.

The Phase IV improvements will extend north of Fort Lowell Park along the wash bank and tie into existing bank protection and pathways at Craycroft Road. Phase IV requires protection of lush and fragile riparian ecosystem elements and securing right-of-way from several different private property owners. This will tend

to extend the Phase IV project schedule beyond the Phase III improvements. A goal of this study was to determine if soil cement is warranted on the reach north of Fort Lowell Park where the broad floodplain narrows into a more confined channel section. This reach is characterized by a low level of historic bank migration, high level of mature vegetation along much of the banks, and low level of existing development. These factors all indicate that the banks are generally stable and the cost and environmental impacts associated with bank protection outweigh the potential benefits. Paved and decomposed granite pathways are proposed on the west bank for the entire reach north of Fort Lowell Park to Craycroft Road. RFCD will pursue acquisition of a 100’ corridor from the north side of Fort Lowell Park to Craycroft Road in which to meander the pedestrian paths and facilitate reasonable avoidance of existing high-quality vegetation.

An alternative which includes bank protection in Phase IV would include both banks to address the issue of reflective scour in the narrow corridor. It would also include a grade control structure to protect the existing 8” sewer which crosses Pantano Wash, as well as accommodate a potential new interceptor sewer along the same alignment.

### 1.2 Project Objectives and Priorities

The overall goals for the project can be separated into three distinct categories: River Park and recreational features, flood control and erosion mitigation, and preservation and enhancement of the existing ecosystem and cultural resources.

#### **RIVER PARK AND RECREATIONAL FEATURES**

- Provide a safe and fully functional, continuous River Park pathway that connects and extends the Pantano and Rillito River Parks by constructing improvements from Tanque Verde Road to Craycroft Road.
- Develop the Pantano Wash River Park in accordance with the design guidelines included in the (2011) Pima Regional Trail System Master Plan.
- Accommodate a wide range of pathway and trail related activities and alternate modes of transportation including, but not limited to, walking, jogging, bicycling, and horseback riding.
- Accommodate other compatible activities such as birding, wildlife observation, non-commercial fitness / wellness programs, and educational programs.
- Accommodate users of various ages and users with various physical abilities.
- Create an accessible (ADA compliant) paved pathway along the project corridor and provide accessible connections to this path where feasible.
- Provide safe and legal access to the River Park.
- Develop staging areas with amenities such as parking lots where feasible to enhance the River Park experience.

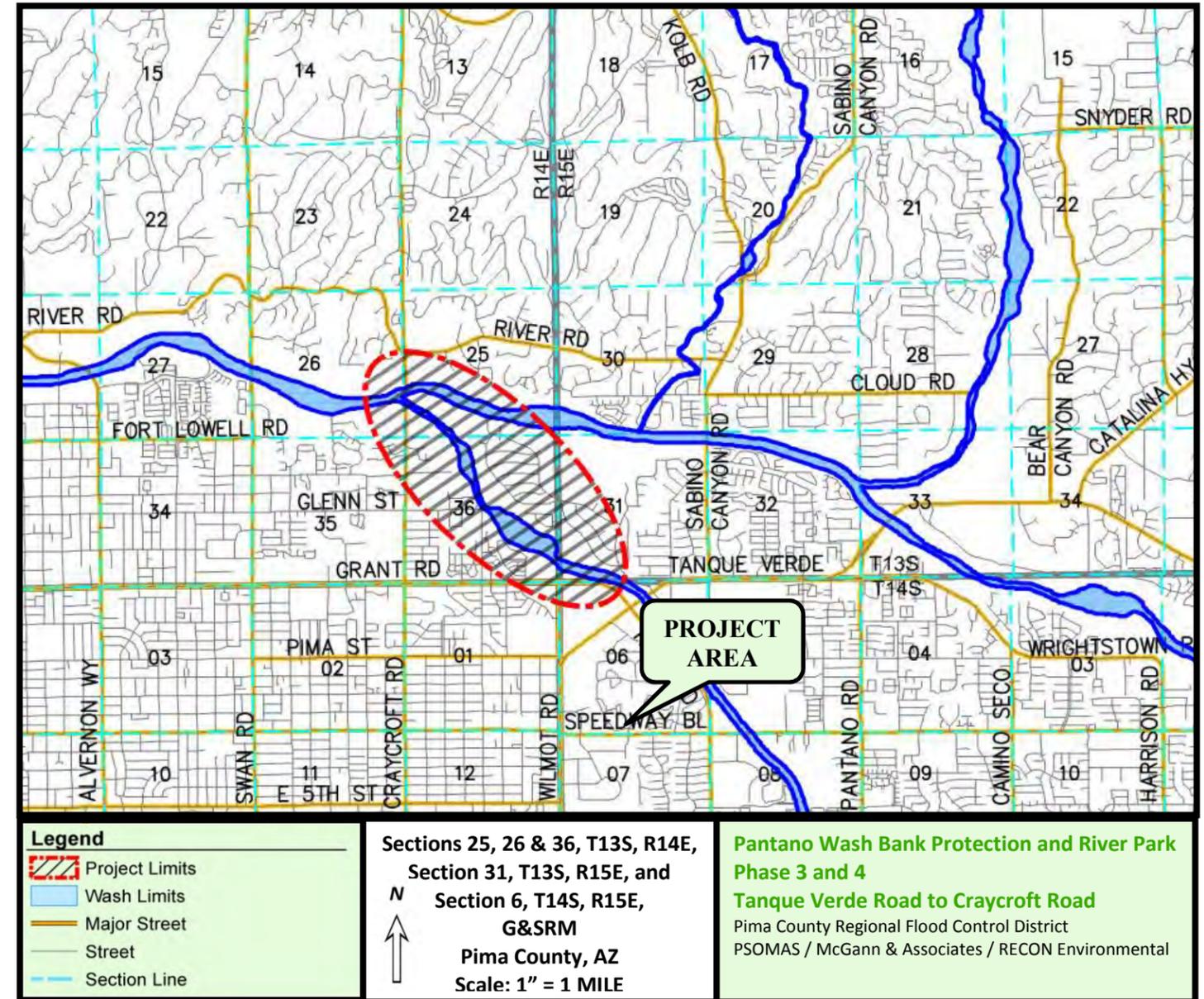
- Construct park elements that are visually open and appropriately lighted to provide for user safety in accordance with the principles of Crime Prevention through Environmental Design (CPTED).
- Provide for bicycle and pedestrian connections to the City of Tucson’s Fort Lowell Park in a manner consistent with the (2009) Master Plan for parks.
- Facilitate the on-going operation and maintenance of the project by providing appropriate access to all portions of the project as may be needed by maintenance personnel and maintenance vehicles.
- Provide facilities that enable equestrian users to safely access the park, ride on the soft-surface trail along the river bank, enter the channel, and ride within the Pantano Wash.
- Integrate public art into the project in a manner that enhances the project while minimizing the requirements for on-going maintenance.

**FLOOD CONTROL**

- Provide long-term bank stability measures and grade control where warranted to protect private property, public infrastructure, and future River Park and recreational features.
- Provide flood and erosion protection where feasible without adversely impacting channel hydraulics and minimizing impacts to important riparian habitat.
- Develop a design that minimizes impacts from tributary drainage.
- Provide adequate accommodations to allow for future channel maintenance and inspection.

**NATURAL AND CULTURAL RESOURCE PRESERVATION AND ENHANCEMENT**

- Develop a recommended design which minimizes impacts to the existing ecosystem within and adjacent to the project during both construction and long term operation.
- Identify and designate areas where existing vegetation will be Preserved-In-Place.
- Utilize appropriate and environmentally sound techniques to sustain new and existing vegetation within and along the project corridor including water harvesting, drywater systems, and utilization of reclaimed water for irrigation and selection of a site appropriate plant palette.
- Recommend measures to enhance the wildlife value of the project corridor by preserving native vegetation where feasible, by removing non-native and invasive plant specimens, and by planting additional native plants. Utilize onsite material such as concrete rubble to provided additional habitat for native species.
- Recommend a design which minimizes impacts to existing cultural resources and minimizes costs associated with cultural resources data recovery and mitigation to the extent practicable.



### **1.3 Relationship of Project to Pima Regional Trails Plan**

The Pima Regional Trail System Master Plan serves as the guiding document for the development of river parks, greenways, and trails in eastern Pima County. The current master plan, which updated an earlier Pima County trails plan, was approved by the Pima County Board of Supervisors in January 2011 and subsequently adopted by the City of Tucson, the Town of Oro Valley, the Town of Marana, and the Town of Sahuarita.

The completion of river parks along the Santa Cruz River, the Rillito River, the Canada del Oro Wash, and the Pantano Wash is a key recommendation of the Pima Regional Trail System Master Plan. The construction of the Pantano Wash River Park has been completed upstream of the current project limits. Similarly, the Rillito River Park has been completed downstream of the project limits. This 1.7 mile project will eliminate a gap and provide approximately 20 miles of uninterrupted linear park along the Rillito River and the Pantano Wash.

It is also noteworthy that Pima Regional Trail System Master Plan calls for the interconnection of the Santa Cruz, Rillito, and Pantano River Parks with the Julian Wash and Harrison Greenway to form a 60 mile long, non-motorized, multi-purpose loop trail around the Tucson metropolitan area. When completed, the Loop will function as an important community amenity, with more than one-third of the population of metropolitan Tucson living within ½ mile of the Loop or Loop extended pathways.

## **2.0 Facilities Program**

This section provides a summary of the proposed recreational amenities, flood control improvements, and other project features as developed through the detailed alternatives assessment and constraints analysis provided in subsequent sections. Figure 2.1.1, Public Facilities Master Plan, provides a conceptual overview of the overall project and is provided in Appendix A. A more design oriented view of the preliminary project design is provided in Appendix B – Concept Design Plans.

### **2.1 Improvements for Public Recreation**

Pathways and other related improvements will be constructed as part of this project. These improvements will provide opportunities for recreation, physical exercise, and alternate-modes of commuting. The scope and character of these improvements is outlined below.

#### **2.1.1 Paved Multi-Use Path**

A continuous, paved multi-use path is proposed for the west bank of the Pantano Wash. This path will be paved with asphaltic concrete. The pavement section will be in accordance with the recommendations of the project Geotechnical Report.

The width of the path will generally be 16' in accordance with current (2013) Pima County guidelines, but may be narrower at specific locations, such as street connections, bridge underpass or other constricted areas based on site specific constraints. To the greatest extent possible, the paved path will be ADA accessible with slopes along the centerline of the path not exceeding 5% and cross slopes not exceeding 2%.

The paved pathways will extend to walkways along the streets that cross the Pantano Wash and to plaza areas and parking lots associated with the River Park staging areas. East bank to west bank connectivity in the project reach will be facilitated by access ramps on both sides of the wash, just upstream of Costco, as well as a new grade control structure which may provide a stabilized surface if not covered with sediment. No all-weather east to west bank connection will be provided at this time.

#### **2.1.2 Soft-Surfaced Paths and Trails**

Adjacent to the paved path and continuous along the project corridor will be a soft-surfaced pathway or trail. This path will be surfaced with decomposed granite. In areas where space is limited, it will be constructed as a 4' wide to 8' wide shoulder adjacent to the paved path. Where there is more room, the soft-surfaced path will depart from the paved path and meander through landscaped areas or natural areas within the project corridor. Whenever feasible, the width of the soft surfaced path will be 8' wide in accordance with current Pima County standards.

Although the full build-out of the Pantano Wash River Park is not included the scope of the current project, the Pima Regional Trail System Master Plan calls for continuous pathways and/or trails along both sides of the Pantano Wash. As envisioned by the trails master plan, the east bank pathway or trail will ultimately connect to a pathway or trail along the south bank of the Tanque Verde Wash, connecting at the confluence of these two drainageways.

To temporarily address the east bank pathway concerns, a natural surface, single-track trail is proposed to extend from the termination of the new east bank soil cement to Fort Lowell Park. This trail will be constructed within the channel. As such, portions of the proposed trail will be useable only when the wash is not flowing. The trail will be approximately 8' wide and will be surfaced with native soil. Trail markers will be used to delineate the trail alignment.

The proposed single-track trail will be important in that it will allow users on the east bank of the Pantano Wash River Park to continue beyond the end of the existing paved path which currently terminates north of Tanque Verde Road. It will also provide an opportunity for a different type of trail experience. Users will be able to walk or jog on a narrow trail within the channel, away from urban development. It will provide a connection from the east bank of the Pantano Wash to the proposed staging area and to Fort Lowell Park.

#### **2.1.3 Staging Area**

The provision of safe and convenient access to the Pima County River Park system has been a key to the river park system's great success. To provide this safe and convenient access, the staging areas have been constructed at intervals along the river park corridors. Typical spacing between staging areas is approximately one-mile, although the actual spacing varies based on the availability of land for staging area construction. In some instances, larger staging areas are constructed further apart, with smaller local access points constructed in-between.

It is proposed that a primary staging area be constructed on a Pima County owned parcel located near the intersection of Sahuara Avenue and Glenn Street. The parcel will provide approximately 2.5 acres of useable land. Per the guidelines included in the Pima Regional Trails Master Plan, this staging area will include:

- An access drive from Sahuara Avenue
- A paved parking lot with 15 to 20 standard vehicle parking spaces
- Accessible walkways connecting the staging area with the River Park paved path
- Bicycle racks
- Benches and / or seat walls
- Trash receptacles
- Signs (Park Identification Signs, Trail Maps, Interpretive Signs, Regulatory Signs)
- Landscape Plantings and Irrigation System
- Post-and-cable barrier and / or fences with gates
- Drinking Fountain
- Equestrian facilities including a truck / equestrian trailer parking, mounting block, and adjacent access to the wash via a soil cement access ramp.

A concept plan for the development of the primary staging area is included in the Concept Design Plans in Appendix B. It should be noted that public input has indicated significant concern regarding the tendency for River Park restrooms to serve as places of congregation for the homeless. A restroom will therefore not be included in the proposed staging area.

In addition to the primary staging area at Sahuara Avenue and Glenn Street, secondary points of access and recreational nodes may be included at:

- Tanque Verde Road and the Pantano Wash
- Craycroft Road and the Pantano Wash
- Fort Lowell Park
- West bank of Pantano Wash at Grant Road (between Wilmot Road and Tanque Verde Road)

The location of these secondary nodes and access points are shown on Figure 2.1.1 in Appendix A, as well as the Concept Plan in Appendix B. Due to limited space, incorporation of these nodes may not be feasible, but is currently under evaluation. The access points at Tanque Verde Road, Craycroft Road and Grant Road will only be for pedestrians and bicyclists. The proposed paved pathways will connect to existing sidewalks and paths in these locations. No motor vehicle parking is proposed for these points of access.

Access to the Pantano Wash River Park from Fort Lowell Park will be coordinated with the City of Tucson Parks and Recreation Department and will be consistent with the Fort Lowell Park Master Plan. It is anticipated that existing parking spaces will be utilized. The scope of this project will include pathway connections from the existing parking spaces to the new paved river park path. Other improvements, such as signs and benches, may also be constructed within or at the boundary of Fort Lowell Park.

### **2.1.4 Gathering and Rest Nodes**

To make the River Park functional and attractive to the greatest number of users, it is proposed that trailside rest areas be constructed at intervals along the River Park corridor. These areas will provide users a comfortable place to stop and rest as they use the pathway system. They will also accommodate users, such as birders, who enjoy stopping along the path to enjoy the site's visual and biological resources.

To be successful, it is important that gathering and rest areas be physically separated from the path. This will eliminate conflict between bicyclists moving along the corridor and users who are stationary or moving at a slow rate of speed.

In addition to physical separation, shade and seating are important elements of successful trailside rest areas. Shade can be provided with the construction of a ramada structure, where there is adequate room, or shade trees where space is limited. Seating can consist of benches and/or seat walls. The actual amenities included in the staging area will depend on project costs and available funding

### **2.1.5 Trailside Planting and Irrigation**

Where feasible, existing specimen plants will be preserved-in-place. Where preservation-in-place is not possible and in locations where native plants have been removed, new plantings will be installed. These trailside plantings will utilize native plant species. They will serve to:

- Provide shade
- Enhance the visual character of the site
- Stabilize slopes and other ground surfaces
- Enhance the wildlife habitat value of the corridor
- Provide screening between the River Park and unattractive off-site land uses
- Mitigate for the loss of existing vegetation (as required by local codes and ordinances)

To ensure that the plants installed as part of the project survive and become established, an automatic, water-efficient, drip irrigation system will be installed. The source of water will be an existing reclaimed water main that extends west along Glenn Street and then south along Sahuara Avenue. A controller will be installed at the proposed staging area.

Due to the linear nature of the site, and the distances between the controller and the likely remote control valve locations, a two-wire path control system is proposed. This control system will be designed to meet Pima County standards. It will be compatible with the County's central control features and compatible with other irrigation control systems installed within the overall River Park network.

### **2.1.6 Public Art**

Public art will be integrated with the recreational facilities and site improvements constructed as part of this project. Existing Pima County policies and procedures will be utilized to select an artist to work with the design and engineering team. These policies provide flexibility with regard to the type and character of the art created. They also encourage the selected artist to consider, respond to, and respect both the natural Sonoran Desert environment and the built environment within which the art will be featured.

Materials that have previously been used successfully to construct public art within the Pima County River Park system include stone, concrete, masonry, durable metals, and similar materials. Wood and materials subject to ultraviolet degradation have not performed well and should be avoided.

The history of the site and existing site resources offer several potential themes for the development of the public art. These themes include;

- The pre-historic settlement and use of the river corridor
- Fort Lowell Park and its place in the history of Tucson and Arizona
- Riparian plants and plant communities within the Sonoran Desert
- Wildlife species that use the river corridor as habitat

Specific locations where art could be successfully integrated into the project include; the bicycle / pedestrian bridge at Rose Hill Wash, the proposed structures, pavements, walls, and fences at the staging area, and the entry monuments to be constructed at River Park entries.

The estimated budget for public art on this project is approximately \$75,000, or one percent (1%) of the preliminary construction cost estimate.

### **2.1.7 Emergency and Maintenance Vehicle Access**

By constructing recreational improvements along the corridor, the public will be encouraged to enter the site and use the pathways, trails, and other recreational facilities. These facilities will also need to be maintained. As such, emergency vehicle and maintenance vehicle access will be essential components of the project.

The paved pathway will serve as the principle route through the site for emergency vehicles. These vehicles could be as small as an ATV (all-terrain recreational vehicle) and as large as an ambulance. Gates or removable bollards will be provided where the path intersects with adjacent public streets. These access control elements will prevent private vehicles from entering the site while accommodating occasional access by emergency vehicles. The pavement cross-section for the multi-use path will be engineered to support the appropriate design vehicle. Occasional turn-around locations will be provided.

Maintenance vehicles up to and including pick-up trucks, will also need access to the River Park corridor. These vehicles will gain access to the site and will move along the corridor in a manner similar to emergency vehicles.

In addition to the maintenance of the River Park improvements, there will be an occasional need for large trucks, loaders, and similar construction equipment to enter the Pantano Wash channel to perform various maintenance tasks. Similarly, equestrians will need to enter and exit the channel. To address these needs, two new soil cement ramps will be constructed approximately 2,800 feet northwest of the Tanque Verde Road Bridge. One will be on the south (southwest) bank and the other on the north (northeast) bank. Additionally, a soil cement ramp will also be constructed adjacent to the staging area at Glenn Street and Sahuara Avenue. Access to these ramps will be along the paved multi-use pathway corridor. These ramps will complement existing ramps in the vicinity of Tanque Verde Road. Access to the channel will also be possible where the bank will not receive soil cement in the vicinity of Craycroft Road.

An additional point of access to the River Park will be considered at Station 25+50 on the Concept Plans, where a private road intersects the pathway.

The soil cement ramps will not only provide for maintenance vehicle access into the channel, they will also function as escape routes for pedestrians and equestrians who may be in the channel when storm events within the watershed produce surface water flow in the Pantano Wash.

## **2.2 Flood Control and Drainage Improvements**

### **2.2.1 Soil Cement Bank Protection**

Soil cement bank protection will be provided along selected reaches of the overall project limits to mitigate potential bank migration, stabilize linear park features, and minimize property impacts and acquisitions. The approximate extents and alignments of soil cement for the preferred alternative are shown on Figure 2.1.1, Public Facilities Master Plan (Appendix A) as well as the Concept Design Plans (Appendix B). A discussion of the various soil cement alternatives which were evaluated as part of this report is provided in Section 4.0.

The recommended alignment and extents of soil cement were based on a number of key issues and constraints including channel hydraulics, right-of-way, adjacent land-use, cultural resources, and biological resources. Within the Phase III limits, the proposed paved pathway will be located directly on top of soil cement. The top 1' of the usually eight-foot wide soil cement prism will be extended to allow the full paved path width to be placed on the soil cement. This provides a more stable surface for the paved path and prevents linear cracking that frequently occurs where paving straddles both soil cement and compacted earth. The soil cement toe-down will be set to accommodate both general scour during 100-year design storm and anticipated long-term bed degradation as discussed in Section 3.4.5. All soil cement slopes will be trimmed after placement to provide a finished appearance. Typical sections for soil cement bank protection along specific reaches of the project are provided in the Concept Design Plans – Appendix B.

The top of soil cement profile will be set a minimum 1' above the calculated 100-year water surface elevation. Additional height may be utilized as needed to provide a logical transition to adjacent existing grades and avoid excessive grading and steep slopes which require special treatment and/or have potential long term maintenance requirements. Preliminary profiles and cross-sections for the preferred soil cement alignment alternative are provided in the Concept Design Plans – Appendix B.

### **2.2.2 Tributary Drainage Improvements**

There are a number of small to moderate tributary drainage areas which impact the proposed project. Peak discharges for these tributary areas were determined and appropriate improvements were recommended. These improvements could include extension of existing structures, construction of new structures, placement of erosion protection, and localized grading to control and redirect flows. The locations and types of tributary drainage improvements are discussed in more detail in Section 3.5.1.

### **2.2.3 Water Harvesting**

Water harvesting will be utilized along and adjacent to the River Park alignment to assist in supporting new and existing vegetation. Harvesting features will be located and designed in a manner as to not pose a threat to paved pathways or have excessive retention periods and become an environmental nuisance.

### **2.2.3 Water Harvesting**

Water harvesting will be utilized along and adjacent to the River Park alignment to assist in supporting new and existing vegetation. Harvesting features will be located and designed in a manner as to not pose a threat to paved pathways or have excessive retention periods and become an environmental nuisance.

## **2.3 Ecosystem Protection and Enhancement**

The identification, protection and potential enhancement of existing ecosystem resources located within the project limits is a major goal of this project. An extensive existing conditions biological assessment has been completed to identify the location and nature of these resources within and adjacent to the potential area of impact. This effort included a detailed survey of existing vegetation by type and condition. The recommended alternative provides several ways in which to protect and preserve existing resources, including:

- Not utilizing soil cement within the Phase IV limits which will result in minimal impacts to valuable riparian resources in that reach.
- Obtaining a 100' corridor in the Phase IV limits north of Fort Lowell Park to provide flexibility in path alignments to avoid higher value existing vegetation.
- Limiting construction haul routes and material excavation to those areas with lower biological value and high densities of invasive species.
- Enforcing and maintaining preserve-in-place areas and designated haul routes throughout the duration of the project.

The project site has been reviewed for areas suitable for ecosystem restoration and enhancement, especially any with larger contributing watersheds in which water harvesting is a viable approach to sustaining the associated vegetation. Of particular interest is the area located just downstream of the Costco drainage outlet. This area is currently overgrown with invasive species, but could be cleaned out and replanted with appropriate native plants which would likely thrive due to the quantity of available stormwater. This area is currently owned by Costco and would require acquisition prior to construction. Additional suitable areas may be identified as formal design progresses.

## **3.0 Site Conditions and Constraints**

The following sections describe site conditions and constraints which impact project design, construction costs and the selection of the preferred alternative. The sections discuss existing conditions, project impacts, as well as requirements for implementation of the preferred alternative.

### **3.1 Land Ownership and Acquisitions**

#### **3.1.1 Existing Land Use and Property Ownership**

Existing land use and ownership within and adjacent to the project were evaluated to identify conditions that could potentially impact Project limits or scope. Existing land use within and adjacent to the project limits is highly varied. Land use within Phase III includes commercial and high-volume retail, low to high density residential development, and public park facilities. Within the Phase IV limits existing land use is primarily low density residential. Existing land ownership is shown on Figure 3.1.1.

The Pomas Survey Department has completed a Record of Survey (ROS) for the Project defining current land ownership, parcel lines, rights-of-way, and easements. Survey control has also been located and identified throughout the Project area and will be used as part of project design. The ROS has been reviewed by the Pima County Survey Department and recorded. The ROS will serve as the basis for the legal descriptions to be prepared as part of the property acquisition process. A copy of the recorded ROS has been provided in Appendix C.

#### **3.1.2 Easement and Right of Way Acquisition for Development**

A number of property acquisitions (partial and whole) as well as temporary construction easements (TCE) will be required to construct and maintain the Project. This includes both commercial and residential properties. The estimated property acquisitions and for the recommended concept design are shown on Figure 3.1.2. TCEs will be determined as part of formal design. Within the Phase III project limits the acquisitions on the west bank are generally from commercially developed or high density residential parcels. On the east bank acquisitions are all from the rear portions of residential lots. Most of the desired acquisitions are small and/or located within the channel or erosion setback limits making them undevelopable.

Acquisitions associated with the Phase IV preferred alternative are from residential properties along the bank. They include areas within the existing channel as well as overbank areas adjacent to residences in order to create the desired 100' wide top of bank River Park corridor. In the event bank protection is to be included in Phase IV significantly a different acquisition scheme will be required, the approximate extents of which are presented in Figure 4.1.3.

## **3.2 Site Development and Construction**

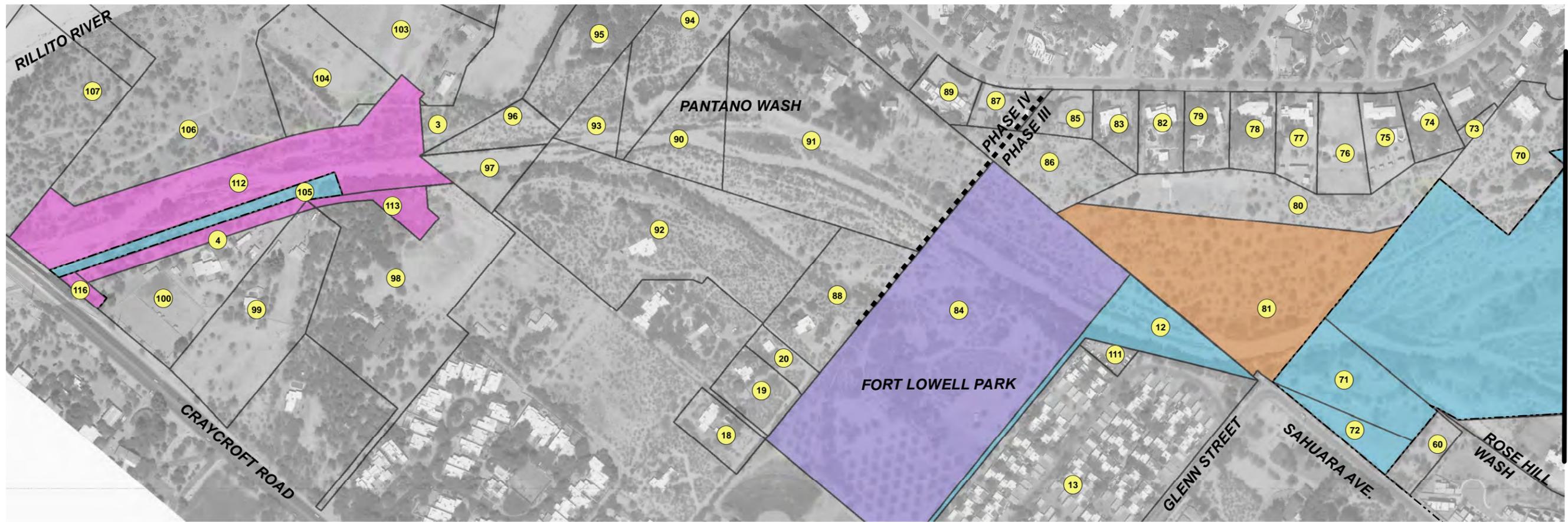
### **3.2.1 Construction Staging Area**

Projects which include the production and placement soil cement generally require a construction staging area of at least four to five contiguous acres. This area is required to accommodate material stockpiles, construction equipment, as well as the soil cement production plant. The preferred area would consist of already disturbed land within a publicly owned parcel(s), not be within the area of project improvements, have a minimal risk of flooding, and be located away from residential areas.

The areas within and adjacent to the project limits were examined to identify potentially suitable locations for a construction staging area. Highly suitable areas do not appear to be available which meet all of the criteria presented above. Potential locations which were identified to be on publically owned parcels include the proposed staging area located at Glenn Street and Sahaura Avenue, and some areas within the channel that are located on floodplain terraces and may not impacted by more frequent flood events. Additional possibilities may include privately owned parcels adjacent to the project.

### **3.2.2 Site Clean-Up and Restoration**

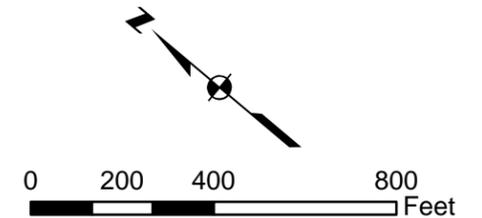
Certain portions of the project area contain significant amounts of trash and debris scattered along the banks and in the overbank areas. Clean concrete debris and riprap may be recycled and utilized in areas of erosion or for habitat augmentation. The remainder of material will be removed from the project site and taken to a local landfill which will likely need to be Pima County operated. At the time of construction, it is likely that Tangerine Landfill (located approximately 25 miles from the Project) will be the only County operated landfill accepting this type of waste. The Speedway Landfill, a privately operated facility, is located approximately one mile southeast of the project and accepts most, if not all, of the waste material types likely to be generated by this project. Utilization of this facility could result in significant cost savings to the project and may warrant further investigation



| PARCEL ID | PARCEL NUMBER | OWNER                            |
|-----------|---------------|----------------------------------|
| 5         | (NONE)        | PIMA COUNTY                      |
| 6         | (NONE)        | PIMA COUNTY                      |
| 7         | (NONE)        | PIMA COUNTY                      |
| 8         | (NONE)        | PIMA COUNTY                      |
| 9         | (NONE)        | PIMA COUNTY                      |
| 10        | (NONE)        | PIMA COUNTY                      |
| 11        | 11440097B     | ASH BRUCE & JANE FAMILY REVOC TR |
| 14        | (NONE)        | PIMA COUNTY                      |
| 21        | 114402900     | FAY W DAVID & TUESDAY D CP/RS    |
| 22        | 13316003C     | TANQUE VERDE GRANT LLC           |
| 23        | 133153180     | S & J 2000 CORPORATION LLC       |
| 24        | 133153170     | MC CALLUM JAMES L & TERI A CP/RS |
| 25        | 13316019B     | TV GRANT PAD LLC                 |
| 26        | 13316020Z     | PIMA COUNTY                      |
| 27        | 13316020Y     | CZD2 ASSOCIATES                  |
| 28        | 13316020X     | CHEMNIC LLC                      |
| 29        | 13316020W     | BNC NATIONAL BANK                |
| 30        | 13316020P     | BNC NATIONAL BANK                |
| 31        | 13316020T     | BNC NATIONAL BANK                |
| 32        | 133153530     | PIMA COUNTY                      |
| 33        | 13316001A     | PIMA COUNTY                      |
| 34        | 11440286R     | ALTIMA INVESTMENTS LLC           |
| 35        | 11440093B     | PIMA COUNTY                      |

| PARCEL ID | PARCEL NUMBER | OWNER                              |
|-----------|---------------|------------------------------------|
| 36        | 11440286Q     | FERPALTE GROUP LLC                 |
| 37        | 11440286H     | MARTIN-SUMMER PROPERTIES LLC       |
| 38        | 11440093A     | MARTINOVICH BRYAN REVOCABLE TR     |
| 39        | 11440286K     | PM - 6393 E GRANT LLC              |
| 40        | 11440286M     | MARTIN-SUMMER PROPERTIES LLC       |
| 41        | 11440286L     | LA CHOLLA PAD LLC                  |
| 42        | 11440286J     | EMET LLC                           |
| 43        | 11440286P     | MARTIN-SUMMER PROPERTIES LLC       |
| 44        | 11440094D     | SCHRADER ROGER C & ANN U TR        |
| 45        | 11440286N     | ALTIMA INVESTMENTS LLC             |
| 46        | 11440095C     | BUSH JOHN CHARLES & CAROL HAZEL TR |
| 47        | 11440098B     | BROWNE EVELYNE A                   |
| 48        | 11440099B     | HENDERSON GARY L & DIANA LEE TR    |
| 49        | 11440288A     | STINNETT KENNETH W & RENE K CP/RS  |
| 50        | 114401000     | STANDEN PHYLLIS M & JAMES R CP/RS  |
| 51        | 11440287C     | MC EVERS LYNN TR                   |
| 52        | 11440287D     | MC EVERS LYNN TR                   |
| 53        | 11016221A     | PRICE COMPANY                      |
| 54        | 110162200     | PANTANO ENTERPRISES INC            |
| 55        | 11440287E     | MC EVERS LYNN TR                   |
| 56        | 11440287B     | MAHONEY LIVING TR                  |
| 57        | 114402910     | TOUCHE FAMILY TR                   |
| 58        | 114402920     | MC GUIRE A BARRY & HOLLY CP/RS     |
| 59        | 114402930     | NOLEN STEVEN S & PATRICIA Z JT/RS  |

| PARCEL ID | PARCEL NUMBER | OWNER                                     |
|-----------|---------------|---|
| 60        | 110162140     | GOODMAN FAMILY LIMITED PARTNERSHIP LLP    |
| 61        | 110162090     | DAVENPORT LIVING TR                       |
| 62        | 110162180     | HSL OLD FARM APARTMENTS LLC               |
| 63        | 114402940     | CAMPBELL THOMAS S & LAURIE C JT/RS        |
| 65        | 11440295C     | LEE ROBERT B                              |
| 66        | 11440295B     | ARIZONA TITLE INSURANCE TR 8005           |
| 67        | 11440296A     | DAVENPORT LIVING TRUST                    |
| 68        | 11440297A     | STUDWELL JAMES R & HEALY VIRGINIA M CP/RS |
| 69        | 11440298A     | MC ELLIGOTT RICHARD G MAC & SHARON L TR   |
| 70        | 11440299A     | RATCLIFFE LINDA S                         |
| 71        | 110162110     | PIMA COUNTY                               |
| 72        | 110162120     | PIMA COUNTY                               |
| 73        | 11013002C     | BARRY STEVEN J & BLEAKNEY ARLENE A CP/RS  |
| 74        | 114401420     | DRACHMAN SALLY SPAID TR                   |
| 75        | 114401430     | HUTCHISON RANDAL                          |
| 76        | 114401440     | SPITZER ERIC J & KIMBERLY A JT/RS         |
| 77        | 114401450     | PERRY ELOISE W                            |
| 78        | 114401460     | LEMCKE RALPH A III & PATRICIA H REVOC TR  |
| 80        | 11013002C     | BARRY STEVEN J & BLEAKNEY ARLENE A CP/RS  |
| 81        | 11013002F     | UNISOURCE ENERGY CORPORATION              |
| 109       | 11440096A     | ANDERSON TODD R                           |
| 110       | 114403150     | PIMA COUNTY                               |
| 114       | (EASEMENT)    | PIMA COUNTY                               |



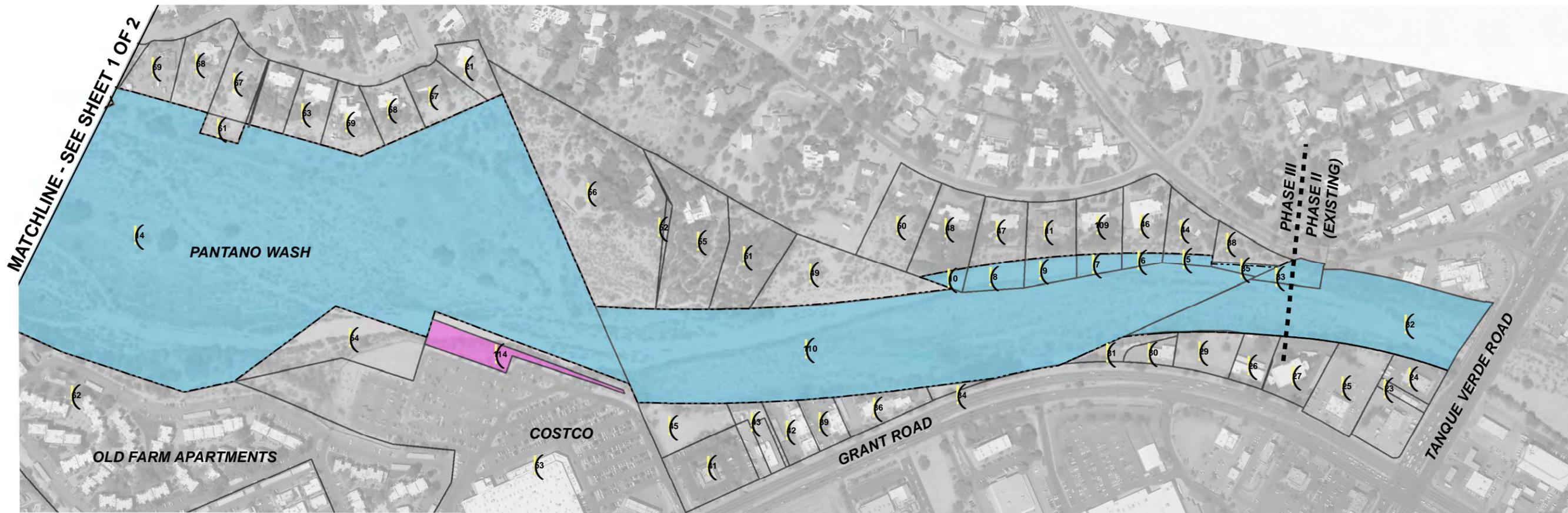
### LEGEND

- Existing ROW
- Easements (to Pima County)
- Parcel (Unisource)
- Parcel (City of Tucson)
- Parcel (Pima County)
- Parcel (Privately Owned)(No Shading)

### NOTES

### Pantano Wash Bank Protection and River Park - Phase 3 & 4

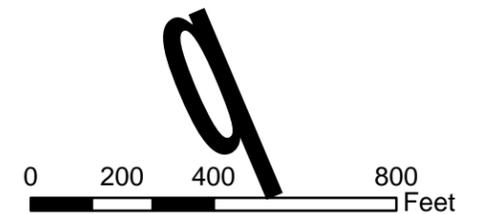
**FIGURE 3.1.1  
EXISTING LAND OWNERSHIP  
(SHEET 1 OF 2)**



| PARCEL ID | PARCEL NUMBER | OWNER                            |
|-----------|---------------|----------------------------------|
| 5         | (NONE)        | PIMA COUNTY                      |
| 6         | (NONE)        | PIMA COUNTY                      |
| 7         | (NONE)        | PIMA COUNTY                      |
| 8         | (NONE)        | PIMA COUNTY                      |
| 9         | (NONE)        | PIMA COUNTY                      |
| 10        | (NONE)        | PIMA COUNTY                      |
| 11        | 11440097B     | ASH BRUCE & JANE FAMILY REVOC TR |
| 14        | (NONE)        | PIMA COUNTY                      |
| 21        | 114402900     | FAY W DAVID & TUESDAY D CP/RS    |
| 22        | 13316003C     | TANQUE VERDE GRANT LLC           |
| 23        | 133153180     | S & J 2000 CORPORATION LLC       |
| 24        | 133153170     | MC CALLUM JAMES L & TERI A CP/RS |
| 25        | 13316019B     | TV GRANT PAD LLC                 |
| 26        | 13316020Z     | PIMA COUNTY                      |
| 27        | 13316020Y     | C2D2 ASSOCIATES                  |
| 28        | 13316020X     | CHEMNIC LLC                      |
| 29        | 13316020W     | BNC NATIONAL BANK                |
| 30        | 13316020P     | BNC NATIONAL BANK                |
| 31        | 13316020T     | BNC NATIONAL BANK                |
| 32        | 133153530     | PIMA COUNTY                      |
| 33        | 13316001A     | PIMA COUNTY                      |
| 34        | 11440286R     | ALTIMA INVESTMENTS LLC           |
| 35        | 11440093B     | PIMA COUNTY                      |

| PARCEL ID | PARCEL NUMBER | OWNER                              |
|-----------|---------------|------------------------------------|
| 36        | 11440286Q     | FERPALTE GROUP LLC                 |
| 37        | 11440286H     | MARTIN-SUMMER PROPERTIES LLC       |
| 38        | 11440093A     | MARTINOVICH BRYAN REVOCABLE TR     |
| 39        | 11440286K     | PM - 6393 E GRANT LLC              |
| 40        | 11440286M     | MARTIN-SUMMER PROPERTIES LLC       |
| 41        | 11440286L     | LA CHOLLA PAD LLC                  |
| 42        | 11440286J     | EMET LLC                           |
| 43        | 11440286P     | MARTIN-SUMMER PROPERTIES LLC       |
| 44        | 11440094D     | SCHRADER ROGER C & ANN U TR        |
| 45        | 11440286N     | ALTIMA INVESTMENTS LLC             |
| 46        | 11440095C     | BUSH JOHN CHARLES & CAROL HAZEL TR |
| 47        | 11440098B     | BROWNE EVELYNE A                   |
| 48        | 11440099B     | HENDERSON GARY L & DIANA LEE TR    |
| 49        | 11440288A     | STINNETT KENNETH W & RENE K CP/RS  |
| 50        | 114401000     | STANDEN PHYLLIS M & JAMES R CP/RS  |
| 51        | 11440287C     | MC EVERS LYNN TR                   |
| 52        | 11440287D     | MC EVERS LYNN TR                   |
| 53        | 11016221A     | PRICE COMPANY                      |
| 54        | 110162200     | PANTANO ENTERPRISES INC            |
| 55        | 11440287E     | MC EVERS LYNN TR                   |
| 56        | 11440287B     | MAHONEY LIVING TR                  |
| 57        | 114402910     | TOUCHE FAMILY TR                   |
| 58        | 114402920     | MC GUIRE A BARRY & HOLLY CP/RS     |
| 59        | 114402930     | NOLEN STEVEN S & PATRICIA Z JT/RS  |

| PARCEL ID | PARCEL NUMBER | OWNER                                     |
|-----------|---------------|---|
| 60        | 110162140     | GOODMAN FAMILY LIMITED PARTNERSHIP LLP    |
| 61        | 110162090     | DAVENPORT LIVING TR                       |
| 62        | 110162180     | HSL OLD FARM APARTMENTS LLC               |
| 63        | 114402940     | CAMPBELL THOMAS S & LAURIE C JT/RS        |
| 65        | 11440295C     | LEE ROBERT B                              |
| 66        | 11440295B     | ARIZONA TITLE INSURANCE TR 8005           |
| 67        | 11440296A     | DAVENPORT LIVING TRUST                    |
| 68        | 11440297A     | STUDWELL JAMES R & HEALY VIRGINIA M CP/RS |
| 69        | 11440298A     | MC ELLIGOTT RICHARD G MAC & SHARON L TR   |
| 70        | 11440299A     | RATCLIFFE LINDA S                         |
| 71        | 110162110     | PIMA COUNTY                               |
| 72        | 110162120     | PIMA COUNTY                               |
| 73        | 11013002C     | BARRY STEVEN J & BLEAKNEY ARLENE A CP/RS  |
| 74        | 114401420     | DRACHMAN SALLY SPAID TR                   |
| 75        | 114401430     | HUTCHISON RANDAL                          |
| 76        | 114401440     | SPITZER ERIC J & KIMBERLY A JT/RS         |
| 77        | 114401450     | PERRY ELOISE W                            |
| 78        | 114401460     | LEMCKE RALPH A III & PATRICIA H REVOC TR  |
| 80        | 11013002C     | BARRY STEVEN J & BLEAKNEY ARLENE A CP/RS  |
| 81        | 11013002F     | UNISOURCE ENERGY CORPORATION              |
| 109       | 11440096A     | ANDERSON TODD R                           |
| 110       | 114403150     | PIMA COUNTY                               |
| 114       | (EASEMENT)    | PIMA COUNTY                               |



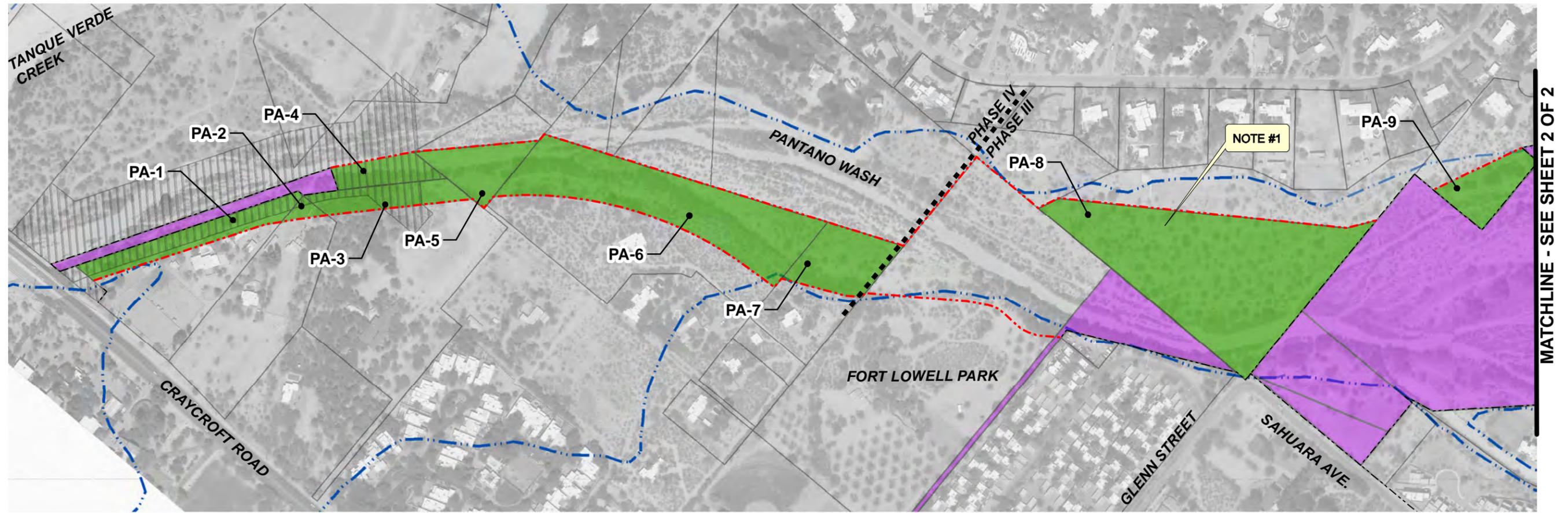
### LEGEND

- Existing ROW
- Easements (to Pima County)
- Parcel (Unisource)
- Parcel (City of Tucson)
- Parcel (Pima County)
- Parcel (Privately Owned)(No Shading)

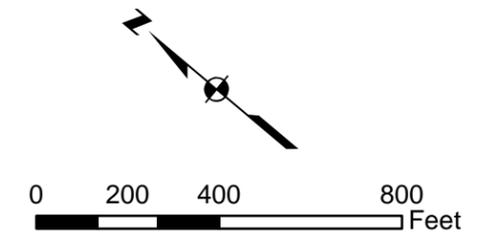
### NOTES

### Pantano Wash Bank Protection and River Park - Phase 3 & 4

#### FIGURE 3.1.1 EXISTING LAND OWNERSHIP (SHEET 2 OF 2)



| ACQUISITION (PA) | PARCEL NUMBER | OWNER                                 | AREA (SF) |
|------------------|---------------|---------------------------------------|-----------|
| 1                | 10922021L     | CARILLION REALTY CORP                 | 67082     |
| 2                | 10922021E     | CARILLION REALTY CORP                 | 7502      |
| 3                | 10922022B     | HAUSEMAN DEAN M III 50% & HAUSEMAN YO | 48693     |
| 4                | 10922020M     | RUSTAND CARSON B IRREVOC TR           | 37386     |
| 5                | 109220240     | OSBORNE JOHN E & DIANA K JT/RS        | 55979     |
| 6                | 11014002Q     | HASKELL JEFFREY & PAMELA CP/RS        | 239068    |
| 7                | 11014002P     | HARDY MARK A & SUSAN S JT/RS          | 69664     |
| 8                | 11013002F     | UNISOURCE ENERGY CORPORATION          | 399436    |
| 9                | 11440299A     | RATCLIFFE LINDA S                     | 53310     |



### LEGEND

- EXISTING ROW
- - - - - NEW ROW
- PROPERTY ACQUISITIONS (PA)
- · - · - 100-YEAR FLOODPLAIN (FEMA)
- ▨ EXISTING EASEMENT (TO PIMA COUNTY)
- PARCEL (PIMA COUNTY OWNED)
- PARCEL (PRIVATE)(NO SHADING)

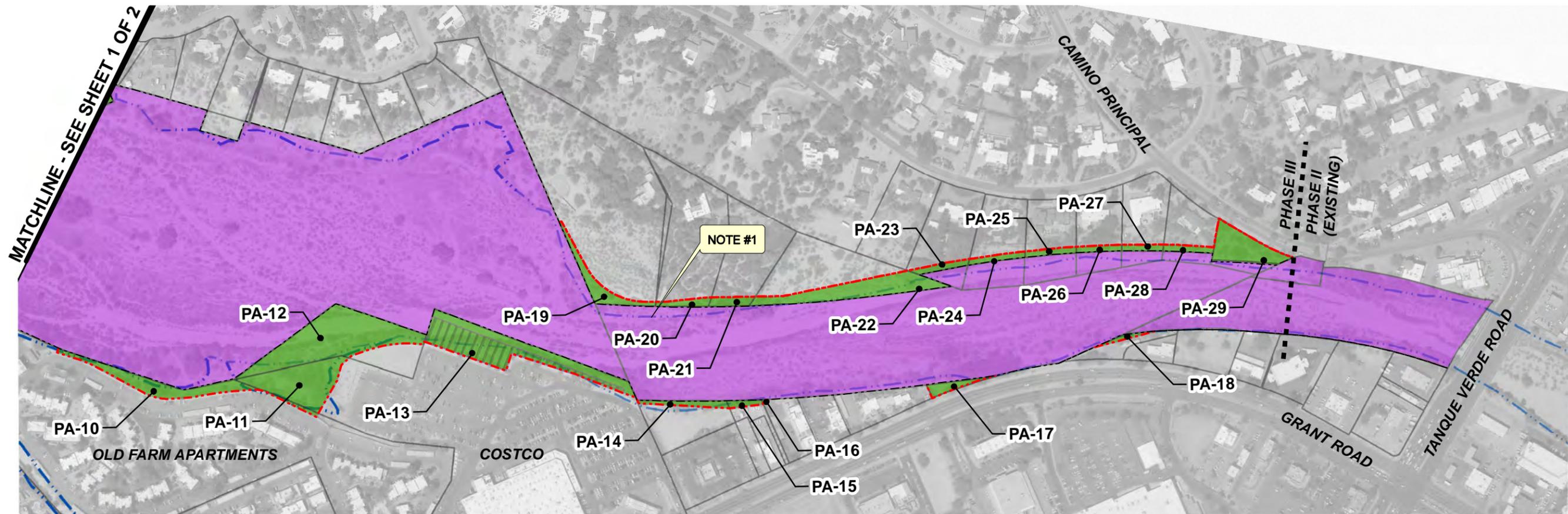
### NOTES

1. PROPOSED PROPERTY ACQUISITIONS BASED ON THE PREFERRED DESIGN ALTERNATIVE AS SHOWN HERE AND PRESENTED IN MORE DETAIL ON FIGURE 4.1.1 AND IN SECTION 4.0 OF THE REPORT

### Pantano Wash Bank Protection and River Park - Phase 3 & 4

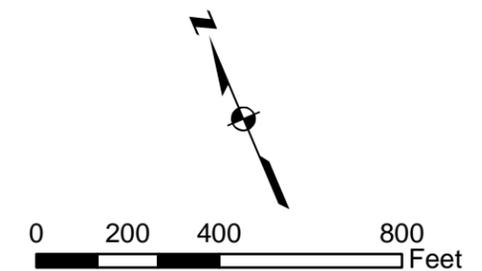
#### FIGURE 3.1.2 PROPOSED PROPERTY ACQUISITIONS (SHEET 1 OF 2)

Pima County Regional Flood Control District  
PSOMAS



| PARCEL ACQUISITION (PA) ID | PARCEL NUMBER | OWNER                        | AREA (SF) |
|----------------------------|---------------|------------------------------|-----------|
| 10                         | 110162180     | HSL OLD FARM APARTMENTS LLC  | 29128     |
| 11                         | 11016221A     | PRICE COMPANY                | 41573     |
| 12                         | 110162200     | PANTANO ENTERPRISES INC      | 73932     |
| 13                         | 11016221A     | PRICE COMPANY                | 62884     |
| 14                         | 11440286R     | ALTIMA INVESTMENTS LLC       | 62884     |
| 15                         | 11440286P     | MARTIN-SUMMER PROPERTIES LLC | 2897      |
| 16                         | 11440286J     | EMET LLC                     | 234       |
| 17                         | 11440286N     | ALTIMA INVESTMENTS LLC       | 6139      |
| 18                         | 13316020T     | BNC NATIONAL BANK            | 2269      |
| 19                         | 11440287B     | MAHONEY LIVING TR            | 3146      |
| 20                         | 11440287E     | MC EVERS LYNN TR             | 269       |

| PARCEL ACQUISITION (PA) ID | PARCEL NUMBER | OWNER                              | AREA (SF) |
|----------------------------|---------------|------------------------------------|-----------|
| 21                         | 11440287C     | MC EVERS LYNN TR                   | 1007      |
| 22                         | 11440288A     | STINNETT KENNETH W & RENE K CP/RS  | 22640     |
| 23                         | 11440099B     | HENDERSON GARY L & DIANA LEE TR    | 4859      |
| 24                         | 11440098B     | BROWNE EVELYNE A                   | 4611      |
| 25                         | 11440097B     | ASH BRUCE & JANE FAMILY REVOC TR   | 4153      |
| 26                         | 11440096A     | ANDERSON TODD R                    | 3728      |
| 27                         | 11440095C     | BUSH JOHN CHARLES & CAROL HAZEL TR | 3477      |
| 28                         | 11440094D     | SCHRADER ROGER C & ANN U TR        | 4312      |
| 29                         | 11440093A     | MARTINOVICH BRYAN REVOCABLE TR     | 6607      |



### LEGEND

- EXISTING ROW
- - - NEW ROW
- PROPERTY ACQUISITIONS (PA)
- 100-YEAR FLOODPLAIN (FEMA)
- ▨ EASEMENT (TO PIMA COUNTY)
- PARCEL (PIMA COUNTY OWNED)
- PARCEL (PRIVATELY OWNED)(NO SHADING)

### NOTES

1. PROPOSED PROPERTY ACQUISITIONS BASED ON THE PREFERRED DESIGN ALTERNATIVE AS SHOWN HERE AND PRESENTED IN MORE DETAIL ON FIGURE 4.1.1 AND IN SECTION 4.0 OF THE REPORT

### Pantano Wash Bank Protection and River Park - Phase 3 & 4

#### FIGURE 3.1.2 PROPOSED PROPERTY ACQUISITIONS (SHEET 2 OF 2)

Pima County Regional Flood Control District  
PSOMAS

### **3.2.3 Preliminary Earthwork Balance for Development**

Major soil cement projects require large amounts of backfill and aggregate material for construction. The cost of importing this material from an offsite source is significant, and therefore, the goal is to obtain the required material from within the Project area. Previous soil cement projects on the Pantano Wash have generally been successful in utilizing onsite materials without the need for offsite borrow. Embankment and general backfill can consist of any clean material excavated within the channel that is free of debris and excessive amounts of boulders or large cobbles. The material required for soil cement bank protection must satisfy a more stringent specification which can often be met through the mixing of onsite sources.

A preliminary earthwork balance analysis by project phase was completed to estimate the volume of aggregate material that will be required for construction. The tables on Figure 3.2.1 provide a summary of the earthwork balance including soil cement, structural excavation, drainage excavation, and backfill. An adjustment factor of 15% has been assumed for soil cement aggregate and backfill material to account for shrinkage and screening losses. For projects in which the native material contains a large percentage of cobbles and small boulders, a crushing plant can be utilized to reduce the percentage of screening losses. The drainage excavation and structural excavation volumes related directly to construction were used to estimate the additional volume of material that would need to be taken from within the channel to construct the project without the need for offsite borrow material.

Potential areas within the channel where sufficient volumes of suitable material likely exist above the elevation of the current low flow channel (or thalweg) are shown on Figure 3.2.1. It has been assumed that no material will be removed below the thalweg elevation. Additional considerations when identifying suitable material source areas include remaining outside the extents of the proposed Section 404 delineation, minimizing impacts to existing high quality biological resources, and remaining within public property.

## **3.3 Utilities**

### **3.3.1 Utility Identification and Base Mapping**

The Arizona Blue Stake system was initially consulted to identify potential utilities in the project area which are listed in Table 3.3.1. Requests were then made to each utility to provide system mapping and record drawings (where available) for their facilities within and adjacent to the project limits. The system mapping and record drawings were then used in conjunction with project topography, aerial photography and field observations to create a utility base map as shown on Figure 3.3.1.

The Psomas Survey Department reviewed title reports and other information to determine the location, extents and specific nature of existing utility easements within the Project. These easements and associated utilities can impose significant constraints on Project design and construction. Existing utility easements are also shown on the Record of Survey in Appendix C.

### **3.3.2 Special Utility Issues**

Utility conflicts for this project appear to be minimal and can be addressed by setbacks and avoidance. There are existing power poles within the wash and on the banks which will need to be protected in place and access must be maintained.

Potentially significant issues within the project limits which will require close coordination include an existing 12" reclaimed water main along the Glenn Street alignment and an existing 8" outfall sewer which crosses the wash approximately 1100' feet upstream of Craycroft Road (see Figure 3.3.1). Review of existing record drawings indicate the existing 12" reclaimed water main dips under the wash with depth and geometry which will allow the new soil cement to be constructed without impacting the main. The approximate location of the main is shown in plan and profile on the Concept Design Plans in Appendix B. The precise depth and location of the water main will need to be verified via potholing as part of formal design.

In the event it is decided that Phase IV will include soil cement, it will be necessary to provide a grade control structure to protect the existing 8" sewer shown on Figure 3.3.1. Record drawings indicate the sewer is approximately 5' below the existing channel thalweg and will be in direct conflict with the soil cement toe-down. The sewer will likely need to be reconstructed as ductile iron and extended through the new soil cement in casing on both banks. The new grade control would be built over the sewer and casing, and extended to depths to protect it from both local and long term scour.

RWRD has included in their long term planning documents the addition of a new outfall sewer along the same alignment as the existing 8" sewer. Although construction of the new outfall sewer is likely 10 years or more in the future, the design of a grade control structure to protect the existing 8" main may need to make accommodations for the future outfall sewer. This may include an empty casing which extends across the wash under the new grade control structure and through the new bank protection.

RWRD has also indicated a desire to locate an odor control facility for the 30" main in Sahuara Avenue at the proposed staging area. The facility would be underground with the exception of a small equipment building. The precise location of the facility has not been established but a meeting between RWRD and RFCD staff has occurred, resulting in the general consensus it can be accommodated within the site. Additional details for the facility will be presented in the formal construction documents.

### **3.3.3 Utility Connections for Development**

Requirements for utilities should be limited to the proposed staging area located at Glenn Street and Sahuara Avenue. It has been assumed that the irrigation controllers will also be located at this location, which is central to the project. Available record drawings and site survey indicate relatively convenient connections to the required utilities which include electric, potable water, and reclaimed water. A connection to the existing sewer system can be made in the event it is decided to include a restroom at the staging. However, modifications will likely need to be made to the existing potable and reclaimed water mains in Sahuara Avenue to facilitate the connection. Table 3.3.2 provides a summary of required utility connections along with any potential constraints or complications.



| PHASE III EARTHWORK SUMMARY (in cy)<br>(PREFERRED ALTERNATIVE) |               |
|--|---------------|
| DRAINAGE EXCAVATION (Area #1)                                  | 72870         |
| DRAINAGE EXCAVATION (Area #2)                                  | 33621         |
| DRAINAGE EXCAVATION (Along Banks)                              | 12500         |
| STRUCTURAL EXCAVATION  | 18251         |
| <b>TOTAL SOURCE</b>  | <b>137242</b> |
| SOIL CEMENT  | 61985         |
| GENERAL AND EMBANKMENT BACKFILL                                | 57356         |
| 15% SHRINKAGE AND SCREENING                                    | 17901         |
| <b>TOTAL DEMAND</b>  | <b>137242</b> |

| PHASE IV EARTHWORK SUMMARY (in cy)<br>(ALTERNATIVE #2 - WITH SOIL CEMENT) |              |
|---|--------------|
| DRAINAGE EXCAVATION (Area #3)   | 22087        |
| DRAINAGE EXCAVATION (Along Banks)   | 9992         |
| STRUCTURAL EXCAVATION   | 10088        |
| <b>TOTAL SOURCE</b>   | <b>42167</b> |
| SOIL CEMENT   | 31667        |
| GENERAL AND EMBANKMENT BACKFILL   | 5000         |
| 15% SHRINKAGE AND SCREENING   | 5500         |
| <b>TOTAL DEMAND</b>   | <b>42167</b> |

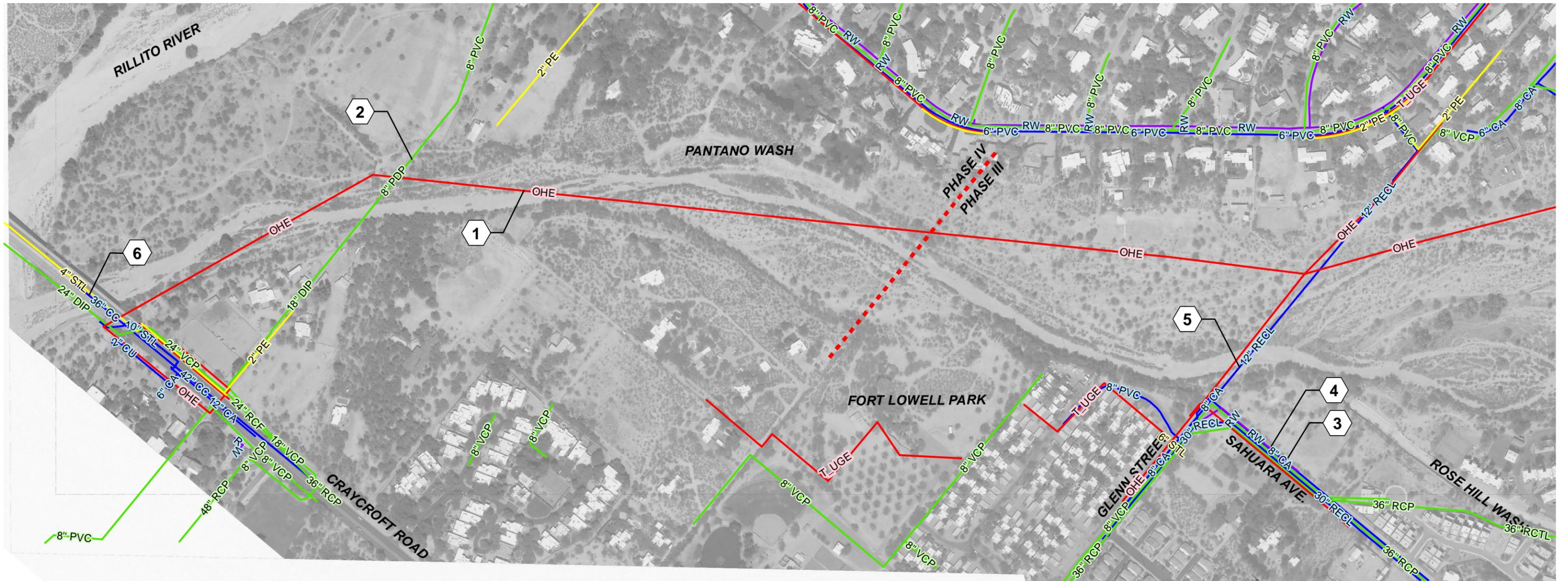
**LEGEND**

- POTENTIAL MATERIAL SOURCE AREA
- PROPOSED PJD LIMITS

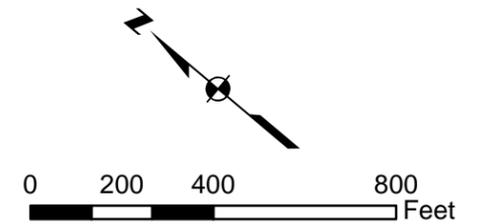
**NOTES**

**Pantano Wash Bank Protection and River Park - Phase 3 & 4**

**FIGURE 3.2.1  
PRELIMINARY EARTHWORK  
BALANCE**



SEE TABLE 3.3.1 IN REPORT FOR KEYNOTE EXPLANATION



**LEGEND**

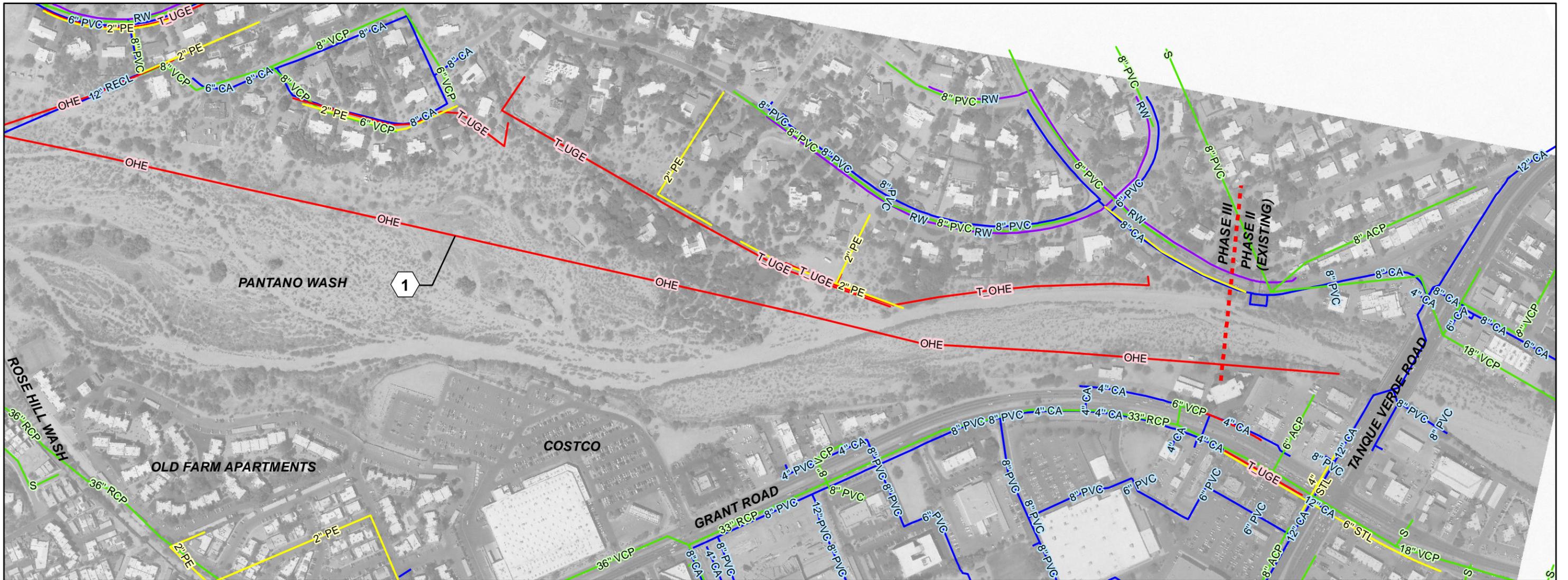
- Existing Potable Water
- Existing Reclaimed Water
- Existing Sewer
- Existing Electric
- Existing Gas

**NOTES**

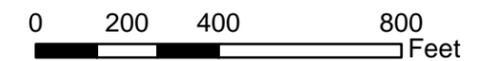
**Pantano Wash Bank Protection and River Park - Phase 3 & 4**

**FIGURE 3.3.1  
EXISTING UTILITIES MAP  
(SHEET 1 OF 2)**

Pima County Regional Flood Control District  
PSOMAS



SEE TABLE 3.3.1 IN REPORT FOR KEYNOTE EXPLANATION



**LEGEND**

- Existing Potable Water
- Existing Reclaimed Water
- Existing Sewer
- Existing Electric
- Existing Gas

**NOTES**

**Pantano Wash Bank Protection and River Park - Phase 3 & 4**

**FIGURE 3.3.1  
EXISTING UTILITIES - PHASE III  
(SHEET 2 OF 2)**

Pima County Regional Flood Control District  
PSOMAS

**Table 3.3.1 Summary of Existing Utilities and Potential Conflicts**

| Legend Number* | Utility Company                       | Description of Utility           | Proximity to Project  | Potential Conflicts/Constraints   | Situated in Easement or Right-of-Way,  |
|----------------|---------------------------------------|----------------------------------|---|---|--|
| 1              | Tucson Electric Power                 | Overhead Transmission            | A transmission line traverses Pantano Wash for the entire reach. Another line crosses the wash along the Glenn Street Alignment. Structures are spaced typically between 500 and 900 ft. apart. Overhead conductor is estimated to be 60 ft. minimum. | No direct conflicts anticipated. All structures that potentially fall within the project footprint will require protection in-place. Project design shall not impede vehicular access to a given structure. | Transmission lines are located in dedicated easements with the exception of a 1200 ft segment adjacent to River Orchard Condos which is located in a fee parcel owned by Unisource |
| --             | Southwest Gas                         | Various Southwest Gas Facilities | Located at various locations adjacent to the project  | No conflicts anticipated at this time   | --   |
| 2              | Regional Water Reclamation Department | 8-inch Gravity Sanitary Sewer    | Crosses Pantano Wash approximately 1100 ft upstream of Craycroft Road   | If soil cement is included as part of Phase IV improvements it will be in direct conflict with the sewer and likely require protection via a new grade control structure.                                   | Located in dedicated recorded easement   |
| 3              | Tucson Water                          | 8" Potable Water Main            | Located along Sahuara Avenue adjacent to Staging Area   | May be in conflict with Staging Area sewer connection   | Located in Sahuara Avenue Right-of-Way   |
| 4              |                                       | 8" Reclaimed Water Main          | Located along Sahuara Avenue adjacent to Staging Area   | May be in conflict with Staging Area sewer connection   | Located in Sahuara Avenue Right-of-Way   |
| 5              |                                       | 12" Reclaimed Water Main         | Located in Glenn Street alignment crossing Pantano Wash   | New soil cement toe-down may be in conflict with the existing water main.   | Located in dedicated recorded easement   |
| 6              |                                       | 36" Potable Water                | Craycroft Bridge over the Pantano Wash – a water main is known to cross the wash at the bridge.   | May be in conflict if new underpass is constructed. Locate and design so as to mitigate conflicts between proposed soil cement, potential ramp, and path.   | Located in Craycroft Road Right-of-Way   |
| --             | CenturyLink                           | Overhead and buried telephone    | Located at various locations adjacent to the project.   | No conflicts anticipated at this time   | --   |

\*See Utility Designations on Figure 3.3.1

**Table 3.3.2 Summary of Required Utility Connections**

| Utility Connection   | Description  | Point of Connection   | Coordination and Permitting Requirements   | Comments  |
|--|--|---|--|---|
| Potable Water  | New 3/4" meter to serve staging area drinking fountains. Could also serve restroom facility which is currently not part of the recommended design. | Existing 8" inch potable water main in eastern Sahuara Road right-of-way  | Request for meter and payment to Tucson Water  | No issues anticipated   |
| Reclaimed Water  | New 2" meter to provide irrigation for west bank linear pathway landscape features   | Existing 8" inch reclaimed water main in eastern Sahuara Road right-of-way  | Request for meter and payment to Tucson Water  | No issues anticipated   |
|  | Extend Phase II system to provide irrigation for east bank path extension  | Connect to existing 2" PVC irrigation mainline at terminal location shown on landscape plans for Project No. 5PWSTV | None – extension of existing system  | No issues anticipated   |
| Electrical Service   | New (+/-) 200 A service to supply power to restroom, site security / entry lighting, and irrigation controller(s) at staging area on west bank.    | Aerial drop from existing overhead electric in western right-of-way of Sahuara Road                                 | Application shall be made to the Tucson Electric Power for line extension following the Series 200 Electric Service requirements. A separate application shall be made to establish a new account and electrical service. Complimentary applications shall be made to the City of Tucson for construction permits related to the extension of electrical power and the new electrical service. | No issues anticipated   |
| Communication  | Telephone service for remote access to on-site controllers at staging area from central control work-station.                                      | Aerial drop from existing overhead communications in Sahuara Road   | Submit application to appropriate communications company   | Need to verify communications exists on adjacent power pole   |
| Sanitary Sewer<br>(Not part of currently recommended design) | New connection to public sewer system to service restroom in the event it is included in the design.   | Connect to existing 8" VCP in center of Sahuara Road  | Submit application, including request for capacity letter directed to the Planning Section of the RWRD. Submit manhole connection plans to RWRD Engineering Section for approval prior to construction.  | Existing sewer appears only be approximately 4.5 ft to flowline. Need to ensure finish floor elevations at the restroom allow for gravity flow. |

## 3.4 Pantano Wash Hydraulics and Scour

### 3.4.1 Current FEMA Status

The entire project reach is currently included in the effective FEMA Flood Insurance Study (FIS) for the City of Tucson. The reach is mapped as Zone AE in which base flood elevations have been determined. The reach also includes a designated floodway. Any encroachment into the existing regulatory floodway will require submittal and approval by FEMA of a Conditional Letter of Map Revision (CLOMR) application prior to construction, and a Letter of Map Revision (LOMR) after construction based on as-built conditions. The effective (FIS) mapping for the project limits are provided on Figure 3.4.1.

### 3.4.2 Hydraulic Modeling

The existing conditions HEC-2 model currently used by FEMA to determine the floodplain, floodway and base flood elevations for this reach of the Pantano Wash dates back to 1986. Since then, better topographic information has become available and various LOMRs and CLOMRs have been submitted, causing the effective floodplain and floodway to be remapped. Because the HEC-2 model has not been updated accordingly, a new existing conditions HEC-RAS model was prepared for the Project using HEC-RAS Version 4.1. Modification of the new model also allows for convenient assessment of hydraulic changes resulting from proposed project improvements.

The cross section locations and alignments used in the updated model as shown on Figure 3.4.2, correspond to three separate effective FEMA models; Rillito Creek (beginning just downstream of Craycroft Road), Pantano Wash (between Craycroft Road and Tanque Verde Road), and a recent CLOMR model for the Pantano Wash prepared as part of Phase II improvements. The topography at each cross section was updated utilizing 2008 Pima Association of Governments (PAG) topography (NAVD88). The PAG data was compared to the project specific topography data generated in 2013 and determined to be reasonably similar and appropriate for the purposes of the HEC-RAS analysis. There have been no flood events or development in the floodplain which has significantly modified topographic conditions within the channel.

Additional cross sections were inserted between the updated effective FIS sections to refine the Pantano Wash modeling along the study reach. In addition, sections were added between the Rillito Creek and the Pantano Wash to model the Craycroft Road Bridge. The new modeling includes multiple profiles, n-values that are consistent with the values used in the effective FIS modeling, and application of the lateral flow option to approximate the loss of flow to the Tanque Verde Creek just upstream of the Rillito Creek confluence. The model included five flow profiles representing the 5-, 10-, 25-, 50-, and 100-year events. The 10-, 50-, and 100-year profiles are based on the effective discharges from the current FIS. The 5-year and 25-year discharges were approximated from a regression analysis of the effective 10-, 50-, 100-, and 500-year values. The design discharge utilized for the project in the effective FEMA 100-year peak discharge of 32,000 cfs.

The results of the 100-year model in terms of the extent and depth of flooding are shown on Figure 3.4.2. Velocities associated with the 100-year event are shown on Figure 3.4.3. The results for the 25-year event are also provided on Figures 3.4.4 and 3.4.5, as the project may include pathway features within a portion of the 100-year floodplain limits but outside the limits of the more frequent events. A more detailed technical

description of the hydraulic modeling as well as the HEC-RAS output files are provided in Appendix D – Pantano Wash Hydraulic Modeling Report.

Existing conditions within the wash range from highly entrenched areas, such as the reach between Craycroft Road to just north of Fort Lowell Park, to very wide and shallow floodplain, as demonstrated in the reach between Rose Hill Wash and Costco. Bank conditions range from near vertical earthen slopes to very gentle slopes or existing soil cement. Vegetation in the channel also varies from nearly bare to highly dense.

An assessment of the post-project hydraulic conditions has also been completed based on the proposed extents of new soil cement and channel modifications as discussed in Section 3.4.6.

### 3.4.3 Scour and Geomorphic Assessment

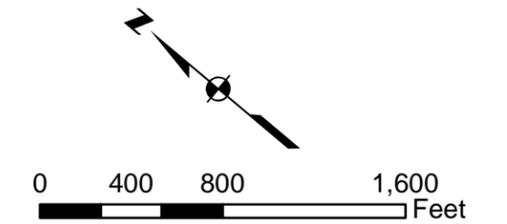
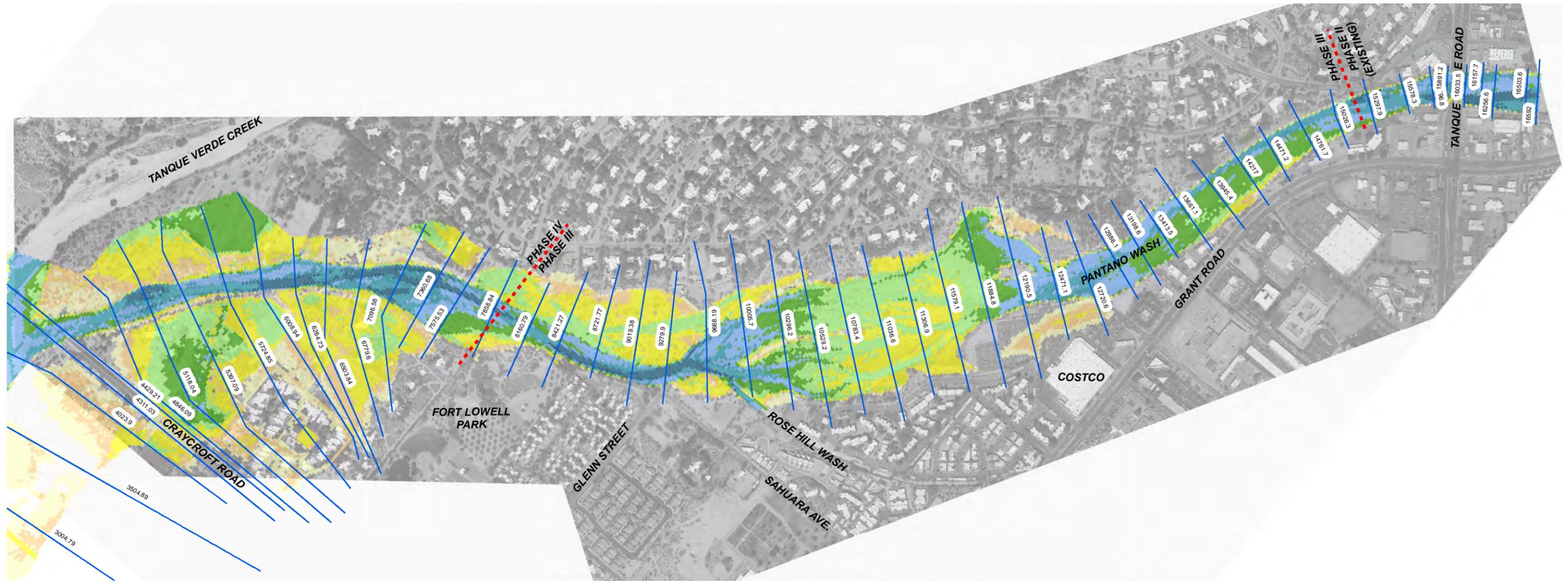
A scour and geomorphic assessment was completed to determine how the channel has changed over time, and what impact potential future changes might have on the project assumptions and design. The assessment included both a qualitative and quantitative analysis for lateral bank erosion and vertical aggradation/degradation. This section provides a summary of the results of that assessment. A detailed explanation of the methodologies, calculations and results is provided in Appendix D – Drainage Report. For the purposes of the geomorphic assessment, the overall project has been divided into five distinct sub-reaches as shown on Figure 3.4.4. These reaches are referenced in the discussion that follows.

#### 3.4.3.1 Historic Lateral Bank Migration

Historic lateral shifts in the main channel were documented from a series of nine historic aerial photographs (1936, 1941, 1953, 1960, 1980, 1983, 1998, 2005, and 2008) and the 1986 topographic mapping used for the effective FIS. The historic documents were compared to USGS flow records from an inactive gage at Tanque Verde Road and an active gage Broadway Boulevard in an attempt to match lateral movements to peak discharges. Only historic flow peaks in excess of the 10-year peak discharge (8400 cfs) were included in the comparison. The noted historical channel changes are summarized in table 3.4.1. Copies of the historic aerial photographs showing the historic limits of bank migration are provided in Appendix D – Drainage Report (Figure 4).

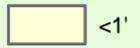
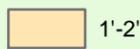
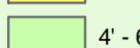
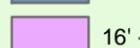
As noted in the table, most of the significant bank migration has occurred in the upper reaches (Reach 4 & 5) of the project limits. This includes adjacent to the Costco property (prior to development), and along the Tucson Country Club Estates in the narrow portion of the channel just downstream of Tanque Verde Road. The reaches downstream of Costco have been generally stable since at least 1980, which can be attributed largely to the heavy vegetation which lines the banks as well as lower flow velocities in the wider portions of the channel. The exception is a portion of the east bank just upstream of the Craycroft Road Bridge, which has experienced approximately 50' of loss since circa 1998. This area of erosion appears to have some correlation with increased vegetation in the adjacent channel which may be deflecting flow and causing higher velocities along that portion of the bank.





**LEGEND**

**FLOW DEPTHS (FT)**

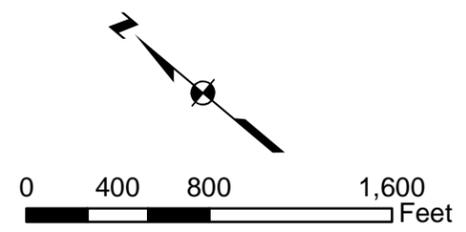
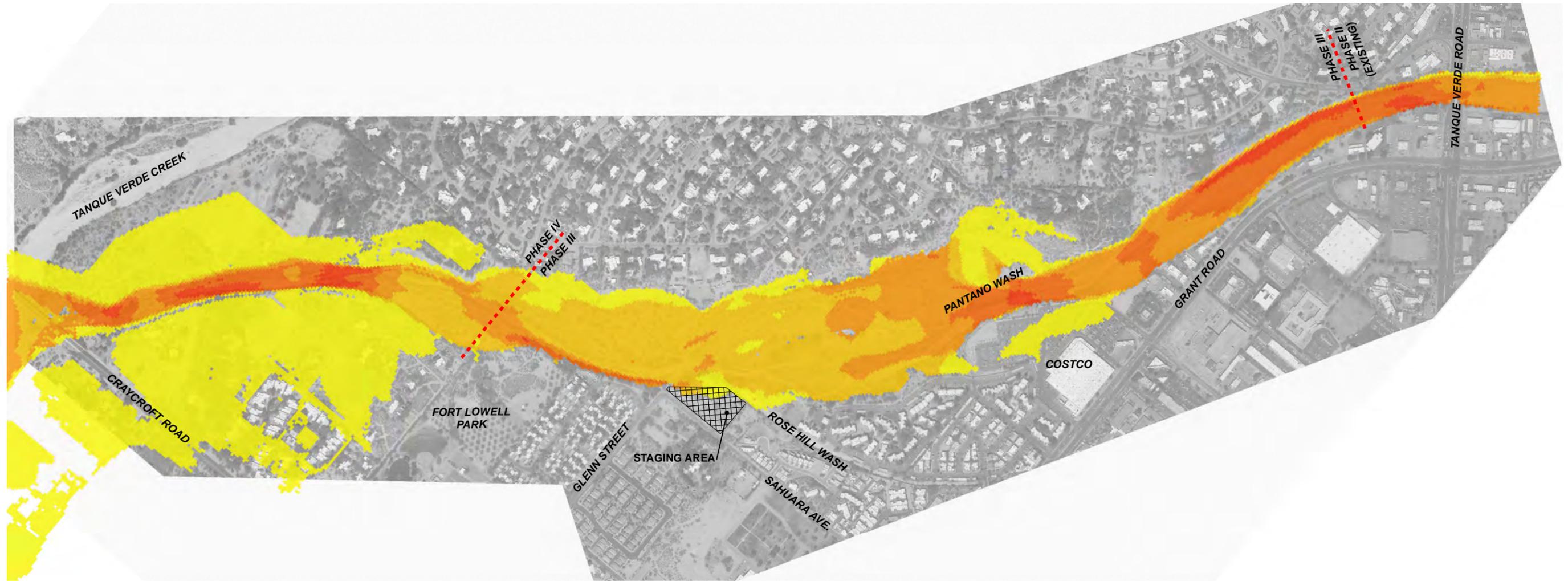
|   |   |  |
|---|---|--|
|  <1'     |  8' - 10'  |  HEC-RAS Sections |
|  1'-2'   |  10' - 12' |  |
|  2'-4'   |  12' - 16' |  |
|  4' - 6' |  16' - 20' |  |
|  6' - 8' |  20' - 24' |  |

**NOTES**

**Pantano Wash Bank Protection and River Park - Phase 3 & 4**

**FIGURE 3.4.2  
EXISTING 100-YEAR FLOODPLAIN  
DEPTHS AND EXTENTS**

Pima County Regional Flood Control District  
PSOMAS



**LEGEND**

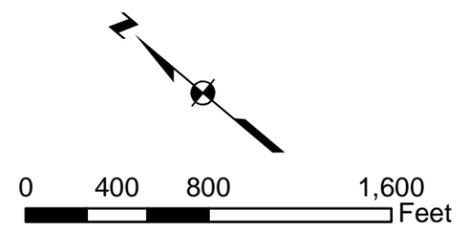
**FLOW VELOCITIES (FT/SEC)**

|        |         |
|--------|---------|
| 0 - 4  | 12 - 16 |
| 4 - 8  | 16 - 20 |
| 8 - 12 | >20     |

**NOTES**

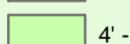
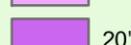
**Pantano Wash Bank Protection and River Park - Phase 3 & 4**

**FIGURE 3.4.3**  
**EXISTING 100-YEAR FLOODPLAIN VELOCITIES**



**LEGEND**

**FLOW DEPTHS (FT)**

|   |   |   |
|---|---|---|
|  <1'     |  8' -10'   |  Sediment Reach Boundary |
|  1'-2'   |  10' - 12' |   |
|  2'-4'   |  12' - 16' |   |
|  4' - 6' |  16' - 20' |   |
|  6' - 8' |  20' - 24' |   |

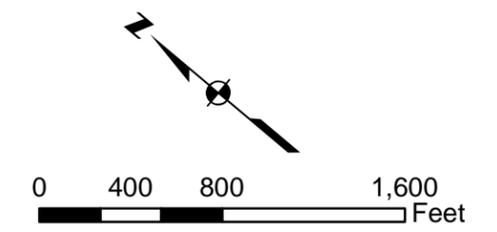
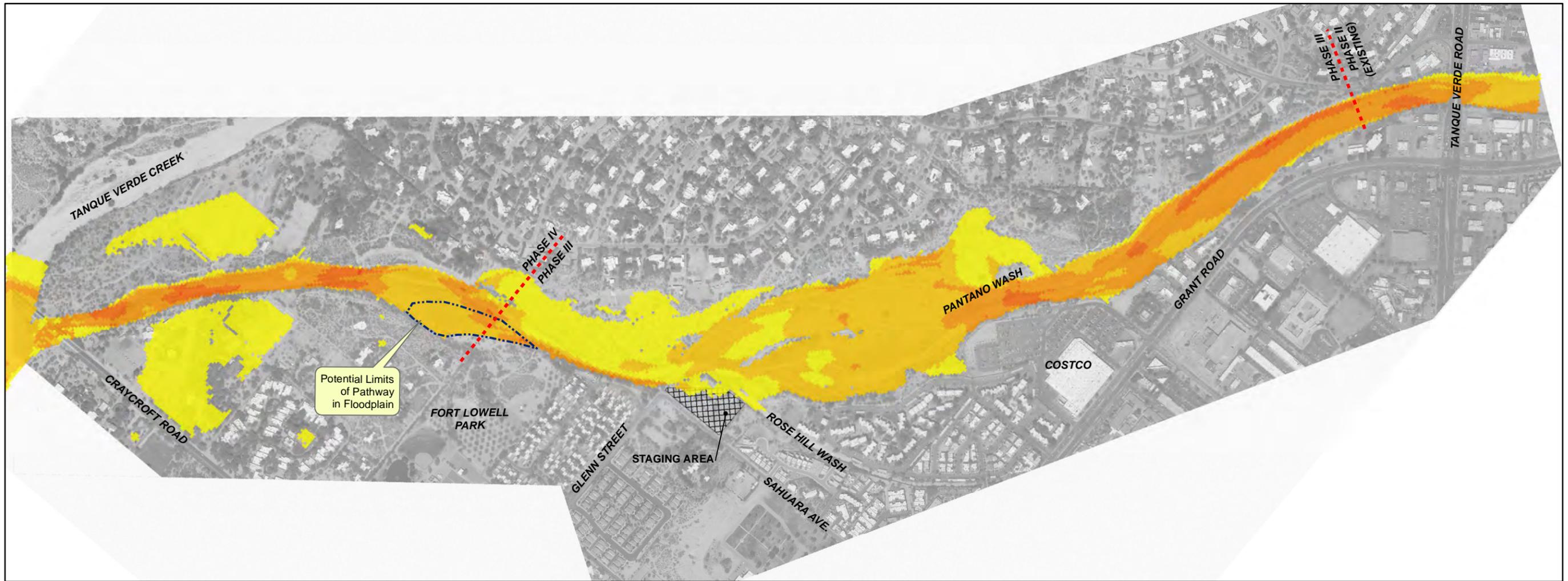
**NOTES**

1.

**Pantano Wash Bank Protection and River Park - Phase 3 & 4**

**FIGURE 3.4.4  
EXISTING 25-YEAR FLOODPLAIN  
DEPTHS AND EXTENTS**

Pima County Regional Flood Control District  
PSOMAS



**LEGEND**

**FLOW VELOCITIES (FT/SEC)**

|        |         |
|--------|---------|
| 0 - 4  | 12 - 16 |
| 4 - 8  | 16 - 20 |
| 8 - 12 | >20     |

**NOTES**

- 1.

**Pantano Wash Bank Protection and River Park - Phase 3 & 4**

**FIGURE 3.4.5  
EXISTING 25-YEAR FLOODPLAIN  
VELOCITIES**

Pima County Regional Flood Control District  
PSOMAS

**Table 3.4.1 Summary of Historic Channel Changes**

| Period    | Max Recorded Flow |        | Observation  |
|-----------|-------------------|--------|--|
|           | Date              | cfs    |  |
| 1936-1941 | 8/13/1940         | 9,200  | 50-100 feet of movement along the west bank (near what is currently the Costco Warehouse).   |
| 1941-1953 | --                | --     | No significant flows or movement noted; sand & gravel mining begins.   |
| 1953-1960 | 8/12/1958         | 20,000 | ~100 feet of movement along the west bank (near what is currently the Costco Warehouse); sand & gravel mining expands downstream along east bank.  |
| 1960-1980 | 8/20/1971         | 12,800 | No significant erosion; extensive sand & gravel mining with localized diversion of flows; Rose Hill Wash realigned with 1000 feet of bank restoration downstream of new confluence; fill encroachment by sand & gravel operators along bank adjacent to future Costco site; fill encroachment to accommodate expanded portion of Country Club Estates subdivision. |
| 1980-1983 | 9/22/1981         | 9700   | 100-150 feet of movement along east bank into the Country Club Estates subdivision; sand & gravel mining area washed out.  |
|           | 10/1/1983         | 11,000 |  |
| 1983-1986 | --                | --     | No significant flows or movement noted; Country Club Estates erosion area along east bank restored.  |
| 1986-1998 | 7/24/1990         | 1,0000 | No significant movement noted.   |
| 1998-2005 | 8/31/1999         | 8,490  | No significant movement noted.   |
| 1998-2008 | --                | --     | ~50 feet of erosion along portion of east bank just upstream of Craycroft Road   |
| 2005-2008 | 7/31/2006         | 15,900 | 50-75 feet of movement on the east bank into the Country Club Estate subdivision, just downstream of the reach impacted in 1983.   |

**3.4.3.2 Historic Channel Aggradation / Degradation**

The qualitative streambed aggradation/degradation analysis included a comparison of the 1936, 1986, and 2008 flow line profiles. The extents of the wash reaches referenced below are shown on Figure 3.4.4. Based on the results of that comparison, significant degradation (6-10 feet) was noted between 1936 and 1986 along the entire study reach. The most significant degradation (10 feet) was noted in the upstream portion of Reach 2. The upstream portion of Reach 1 showed the least degradation (6 feet) and the upstream portion of Reach 4 degraded approximately 9 feet. However, degradation has been limited to the upstream portion of the study reach (i.e., Reach 4 and 5) with an average of approximately 3 feet since 1986. During that same period, little or no degradation (i.e., less than one foot) was noted in the lower portion of the study reach (Reach 1 and 2) and alternating areas of minor aggradation/degradation (i.e., +/- one foot) was noted in the middle portion of the study reach (Reach 3). Therefore, it appears that the lower and middle portions of the study reach have remained fairly stable over the 22-year period between 1986 and 2008; whereas, the upper portion is still showing a tendency towards degradation.

**3.4.4 Sediment Transport and Scour Analysis**

A sediment-transport analysis was completed by JE Fuller to estimate the required toe-down depth of the proposed soil cement based on the single event scour depth and the anticipated long term degradation along the project reach. It was also used to determine the need, location and toe down depth of grade controls required to stabilize the channel slope. A detailed description of the methodologies and results of the analysis is provided in Appendix D – Drainage Report. A summary of the methodologies, relevant results and recommendations is presented below.

**3.4.4.1 Single Event Scour Analysis**

Single event scour was computed using a combination of HEC-RAS sediment transport capabilities and the City of Tucson methodologies. HEC-RAS was used to calculate the general scour ( $Z_{gs}$ ) component as recommended for regional water courses in the City of Tucson *Standards Manual for Drainage Design and Floodplain Management in Tucson, Arizona* (SMDDFM). HEC-RAS allows the user to select the sediment transport equation(s) to be utilized and the Yang equation was selected. Previous studies conducted by the University of Arizona have shown that the Yang equation provides results that are reasonably consistent with post-flood measurements of scour and deposition in the Pantano Wash and Rillito River systems (see references in Appendix D – Drainage Report). The remaining scour components as presented in Table 3.4.2 were calculated using the HEC-RAS output for relevant hydraulic parameters and the scour equations provided in the SMDDFM.

**Table 3.4.2 Summary of Computed Single-Event Scour Depths (Z) by Reach**

| Reach    | $Z_{gs}$ | $Z_a$ | $Z_{bs}$ | $Z_{lft}$ | $Z_t$ | Safety Factor | $Z_t$ (ft) |
|----------|----------|-------|----------|-----------|-------|---------------|------------|
|          | (ft)     | (ft)  | (ft)     | (ft)      |       |               |            |
| 1        | 0.1      | 2.9   | 0.0      | 2.0       | 5.0   | 1.3           | 6.5        |
| 2        | 0.4      | 1.1   | 3.7      | 2.0       | 7.2   | 1.3           | 9.4        |
| 3        | 0.0      | 1.0   | 2.5      | 2.0       | 5.5   | 1.3           | 7.2        |
| 4        | 0.1      | 2.0   | 0.3      | 2.0       | 4.4   | 1.3           | 5.7        |
| 5        | 0.6      | 3.3   | 0.0      | 2.0       | 5.9   | 1.3           | 7.6        |
| Average: |          |       |          |           |       |               | 7.3        |

$Z_{gs}$  = General Scour       $Z_{lft}$  = Low Flow Thalweg  
 $Z_a$  = Anti-dune Scour       $Z_t$  = Total Scour  
 $Z_{bs}$  = Bend Scour

**3.4.4.2 Equilibrium Slope and Long Term Degradation Analysis**

In addition to single event scour, potential long term scour (or bed degradation) must be examined to establish the additional toe-down that may be required for the soil cement. It is also required to assess the need for grade control structure(s) along the project reach to provide long term stabilization. A combination of findings in the historic the data review (see Section 3.4.3.2) and theoretical analysis using the Zeller-Fullerton procedure was used to estimate the long-term equilibrium slope of the channel and potential long term degradation. A detailed description of the Zeller-Fullerton analysis is provided in Appendix D – Drainage Report.

The results of the Zeller-Fullerton analysis indicate estimated long term degradation ranging from 0.0' (aggradation) in Reach #1 to 5.1' at the upper portion of Reach #5 at the existing Phase II grade control structure. These values are generally consistent with what is indicated by the review historic bed elevation profiles in that the lower and middle reaches of the study area have remained fairly stable over the 22-year period between 1986 and 2008, while the upper portion is still showing a tendency towards degradation.

### 3.4.5 Scour Recommendations

JE Fuller provided recommendations for soil cement toe-down depths along the length of the project which were incorporated into the 30% Concept Plans. A minimum depth of 8' from finished flowline is recommended at all locations which is consistent with other similar projects and RFC standard practice. The calculations did indicate shallower toe-down depths for significant portions of the project. Deeper toe-down depths were calculated in areas of bends and higher velocity flows, such as adjacent to the River Orchard Townhomes. The recommendations assume the construction of an additional grade control structure as discussed below. A more detailed presentation of the toe-down depth calculations is provided in Appendix D- Drainage Report.

An additional grade control is recommended near the downstream end of Reach #4 (see Figure 4.1.1) where the channel abruptly transitions from a narrower incised channel to a broader and shallower floodplain. The results of the geomorphological assessment indicates the transition is a vertically stable point as evidenced by the abrupt change in channel grade from approximately 0.40% to 0.64%. As observed in historical profile data and in the equilibrium slope calculations, the steeper channel reaches upstream of the transition will be more prone to vertical degradation, where flatter downstream channel reaches have been generally stable and considered to be at or close to the equilibrium slope. The depth of the new grade control is recommended to be 17.0' which includes both local, single event drop scour as well as anticipated long term degradation. A more detailed discussion of the scour recommendations is provided in Appendix D – Drainage Report.

### 3.4.6 Proposed Hydraulic Conditions

Post-project conditions for the preferred concept design were evaluated through modification of the new existing conditions HEC-RAS model. The proposed conditions model reflects new soil cement alignments as well as the channel grading required to provide reasonable access and haul routes during construction. The estimated extents of excavation required to obtain material for producing soil cement were also reflected in the model. Delineation of potential material excavation areas included input from the project environmental consultant (RECON) on which locations would have the least impact on existing biological resources.

A comparison of existing to proposed flow depths is provided in Table 3.4.3 and indicates no significant impact or lowering of WSELs at most cross sections. The exception is the reach adjacent to Costco where the proposed design includes some channel encroachment to minimize right-of-way acquisitions and accommodate existing development constraints. Additional refinement of the channel grading may be completed as part of formal design and CLOMR process to increase channel conveyance in the reach and reduce the overall impacts to the existing conditions WSELs.

**Table 3.4.3 Summary of Proposed Conditions Hydraulics**

| XSEC ID  | Existing |          | Proposed |          | Difference<br>WSEL | FEMA FIS<br>ID | FEMA FIS<br>WSEL |
|----------|----------|----------|----------|----------|--------------------|----------------|------------------|
|          | WSEL     | Vel Chnl | WSEL     | Vel Chnl |                    |                |                  |
| 15891.24 | 2503.22  | 11.88    | 2503.22  | 11.88    | 0.00               | --             | --               |
| 15796.79 | 2499.74  | 17.88    | 2499.75  | 17.87    | 0.01               | --             | --               |
| 15578.32 | 2497.69  | 17.96    | 2497.67  | 17.99    | -0.02              | U              | 2499.88          |
| 15297.92 | 2495.66  | 17.04    | 2495.40  | 17.51    | -0.26              | --             | --               |
| 15026.33 | 2495.67  | 13.59    | 2492.63  | 17.41    | -3.04              | T              | 2495.38          |
| 14761.69 | 2493.31  | 15.98    | 2489.67  | 17.11    | -3.64              | --             | --               |
| 14471.16 | 2491.43  | 15.32    | 2487.17  | 13.14    | -4.26              | S              | 2491.48          |
| 14217.03 | 2489.49  | 14.22    | 2486.49  | 12.06    | -3.00              | --             | --               |
| 13945.41 | 2487.62  | 14.11    | 2486.31  | 9.77     | -1.31              | R              | 2487.58          |
| 13661.13 | 2486.25  | 11.65    | 2485.94  | 9.20     | -0.31              | --             | --               |
| 13413.54 | 2485.98  | 9.66     | 2485.28  | 9.99     | -0.70              | Q              | 2483.58          |
| 13198.58 | 2483.66  | 13.72    | 2484.72  | 10.48    | <b>1.06</b>        | --             | --               |
| 12986.07 | 2483.81  | 10.32    | 2484.59  | 9.39     | <b>0.78</b>        | P              | 2482.28          |
| 12720.63 | 2483.44  | 9.46     | 2483.69  | 10.70    | <b>0.25</b>        | --             | --               |
| 12471.12 | 2481.39  | 13.07    | 2482.55  | 12.20    | <b>1.16</b>        | O              | 2477.88          |
| 12190.51 | 2478.42  | 16.29    | 2479.42  | 16.16    | <b>1.00</b>        | --             | --               |
| 11884.76 | 2474.10  | 13.60    | 2474.09  | 13.75    | -0.01              | N              | 2470.68          |
| 11579.10 | 2470.07  | 10.99    | 2469.83  | 11.21    | -0.24              | --             | --               |
| 11306.91 | 2468.25  | 9.12     | 2467.92  | 9.16     | -0.33              | M              | 2467.68          |
| 11036.61 | 2467.00  | 8.45     | 2466.43  | 9.08     | -0.57              | --             | --               |
| 10783.37 | 2465.46  | 9.34     | 2464.92  | 9.38     | -0.54              | L              | 2465.18          |
| 10529.18 | 2465.25  | 6.33     | 2464.59  | 6.69     | -0.66              | --             | --               |
| 10296.20 | 2464.85  | 6.50     | 2464.20  | 6.55     | -0.65              | K              | 2464.68          |
| 10005.66 | 2464.59  | 5.72     | 2463.97  | 5.67     | -0.62              | --             | --               |
| 9668.19  | 2463.80  | 7.27     | 2463.27  | 7.05     | -0.53              | --             | --               |
| 9279.90  | 2462.19  | 9.62     | 2462.02  | 8.79     | -0.17              | J              | 2461.08          |
| 9019.38  | 2460.87  | 9.68     | 2460.09  | 10.71    | -0.78              | --             | --               |
| 8721.77  | 2458.87  | 10.75    | 2458.11  | 10.86    | -0.76              | I              | 2458.18          |
| 8421.27  | 2457.70  | 9.48     | 2457.06  | 9.25     | -0.64              | --             | --               |
| 8160.79  | 2455.39  | 11.86    | 2454.61  | 12.22    | -0.78              | H              | 2453.78          |
| 7858.84  | 2454.65  | 7.72     | 2454.80  | 6.65     | 0.15               | --             | --               |
| 7575.53  | 2454.01  | 8.03     | 2454.01  | 8.03     | 0.00               | G              | 2451.28          |
| 7360.68  | 2453.94  | 6.99     | 2453.94  | 6.99     | 0.00               | --             | --               |
| 7096.58  | 2453.40  | 8.18     | 2453.40  | 8.18     | 0.00               | F              | 2450.58          |
| 6779.60  | 2449.74  | 15.98    | 2449.74  | 15.98    | 0.00               | --             | --               |
| 6503.84  | 2447.36  | 16.80    | 2447.36  | 16.80    | 0.00               | E              | 2446.38          |
| 6264.73  | 2447.25  | 11.76    | 2447.25  | 11.76    | 0.00               | --             | --               |
| 6008.94  | 2445.21  | 14.49    | 2445.21  | 14.49    | 0.00               | D              | 2445.08          |
| 5724.85  | 2442.97  | 16.12    | 2442.97  | 16.12    | 0.00               | --             | --               |
| 5397.09  | 2441.30  | 15.35    | 2441.30  | 15.35    | 0.00               | C              | 2441.58          |
| 5118.04  | 2441.26  | 9.28     | 2441.26  | 9.28     | 0.00               | --             | --               |
| 4846.09  | 2437.65  | 15.99    | 2437.65  | 15.99    | 0.00               | B              | 2439.18          |
| 4429.21  | 2434.94  | 7.25     | 2434.94  | 7.25     | 0.00               | --             | --               |

It should be noted that the WSELs calculated in the updated existing conditions HEC-RAS model are significantly higher than the effective FIS values in the reach adjacent to Costco (see Table 3.4.5). The most likely cause is the lack of required ineffective flow encroachments in the effective FIS model. These encroachments are needed to accurately model the abrupt expansion of the channel and presence of the caliche island adjacent to Costco. The updated existing conditions model indicates there would be a minor break out and ponding into the Costco parking lot (see Figure 3.4.2) and the presence of levee type conditions for several cross-sections. A test model was completed in which the caliche island was removed and ineffective flow encroachments adjusted accordingly. The WSELs in the cross-sections of concern dropped significantly and more closely matched the effective FIS values.

The existing caliche island has been identified as potential valuable habitat and the preference is to allow it to remain. However, if its presence results in potential increased breakout along Costco during the design event that cannot be sufficiently mitigated through channel grading at other locations, removal of the feature may require consideration. Potential habitat losses associated with the removal of the caliche island can be mitigated as part of the Riparian Habitat Mitigation Plan.

### **3.5 Tributary Drainage**

#### **3.5.1 Major Tributary Drainage Features**

Large tributary drainage to the project is limited to the Rose Hill Wash which has its confluence with the Pantano Wash on the west bank just upstream of the Glenn Street alignment. The Rose Hill Wash watershed was analyzed as part of the effective Flood Insurance Study (FIS) for Pima County. The watershed drains approximately 2.1 square miles and has a 100-year peak discharge of 2926 cfs at its confluence with the Pantano Wash. The Rose Hill Wash is a fully-lined concrete channel when it enters the Pantano Wash floodway. However, approximately 130 feet of the outlet channel is unlined at its confluence with the main Pantano Wash channel.

Under proposed conditions the confluence of Rose Hill Wash with Pantano Wash will be stabilized with soil cement. Two options have been considered for crossing the Rose Hill Wash with the proposed paved pathway. The first would consist of crossing over a cast-in-place reinforced box culvert sized to convey the 100-year peak discharge in Rose Hill wash with minimal impacts to the regulatory water surface elevations. The second option would utilize a pedestrian bridge to span the existing channel. The relative costs and potential construction issues with each option are discussed in more detail in Section 4.1.4.

#### **3.5.2 Localized Drainage Conditions**

The project area includes numerous small localized watersheds which drain towards Pantano Wash and must be accounted for in the design. Flow from these watersheds enters Pantano Wash at both discreet points of concentration and as shallow sheet flow. Psomas completed a preliminary analysis of offsite drainage conditions along those reaches of the bank where these flows may impact the proposed soil cement and River Park features to determine if cross-drainage structures may be needed. Contributing offsite watershed areas were determined using primarily project specific topographic data generated in December 2012. Elevation data obtained from PAG was utilized in areas where localized watersheds extended beyond the limits of the project specific topographic data. 100-year peak discharges were estimated for each offsite

watershed using the Pima County methodology as outlined in their manual entitled "Hydrology Manual for Engineering Design and Flood Plain Management within Pima County, Arizona." The results of the offsite watershed delineation as well as the peak discharge analysis are provided on Figure 3.5.1. Peak discharge calculation sheets for each of the offsite watershed concentration points have been provided in Appendix E.

Flow at each concentration point potentially impacting project improvements will need to be conveyed to the Pantano Wash via extension of existing pipes, new culverts and scuppers, or by other means as described below and summarized in Table 3.5.1. Erosion control measures may also be required to ensure that any existing issues are corrected and new problems are avoided or properly mitigated. The proposed structures as presented assume the formal design is based on the preferred alternative as discussed in Section 4.0.

##### **3.5.2.1 West Bank Tributary Drainage**

Concentration Point 1 conveys runoff from a portion of a commercial lot into the Pantano Wash through a PVC down drain pipe which extends through the existing channel bank. Flow ponds and is conveyed into the existing pipe by an earthen berm. The pipe should be extended through the new soil cement, or a stabilized swale ditch constructed and flow conveyed through the soil cement via a scupper.

Concentration Point 2 is an area where there is evidence of erosion caused by concentrated flow from a commercial property. A stabilized swale should be constructed from the edge of the parking lot to the pathway, and a scupper used to convey runoff through the soil cement and into the wash.

Concentration Point 3 is an existing stormdrain outlet consisting of 3-30" RCPs. The stormdrain collects flow along Grant Road. The pipes should be extended with the same size pipe and material. It is assumed that the existing system hydraulics will not be impacted by the relatively short extension.

Concentration Points 4, 5, 6 and 7 each convey runoff from commercial properties directly into the wash via concrete spillways. Each spillway should be extended or reconstructed and flow conveyed under the paths into the wash and through a scupper.

Concentration point 8-1 and 8-2 are locations where there is evidence of erosion caused by concentrated flow. A stabilized swale and scupper to convey flow under the paths and through the soil cement is proposed at each concentration point.

Concentration Point 9 is an existing 48" RCP outlet for a roadway stormdrain system. This pipe will be extended through the proposed soil cement bank protection.

Concentration Point 10 is an RCBC outlet to an existing stormdrain system which conveys runoff from the Costco parking lot. Runoff from Concentration Point 10 is combined with flows from Concentration Point 11. Runoff from the residential area adjacent to Costco is collected at an existing grate inlet in the paved area access lane and discharged through a stormdrain pipe just to the north. The combined flows will be conveyed through the proposed soil cement through 4-48" RCP.

Concentration Point 12 is an existing concrete spillway which discharges to the northeast. It is proposed to extend the concrete spillway to a new scupper to convey flow under the pathways and through the soil cement.

Concentration Point 13 is an area where runoff from the residential property has concentrated and resulted in an eroded ditch which flows to the north into the wash. A constructed ditch and scupper is proposed to convey flow under the pathways and through the soil cement bank protection.

Concentration Point 14 is the outlet of the Rose Hill Wash into the Pantano Wash. The preferred option is to extend the paved pathway over the wash using an 85' clear span pedestrian bridge which should have no impact on the existing channel hydraulics. Flow will be conveyed through the proposed soil cement via 6-10'x7' RCBCs.

Concentration Point 15 currently drains as sheeflow and under proposed conditions will flow directly over the pathway and/or be concentrated at one or more scuppers for conveyance beneath the path and through the soil cement.

Concentration Point 16 is proposed to consist of a stormwater harvesting basin with an 18" overflow pipe extending through the soil cement to the wash. The new basin will collect runoff from most of the proposed staging area including the paved parking.

Concentration Point 17 conveys runoff from adjacent residential areas along Glenn Street and Sahuara Avenue to an existing grate inlet which discharges to the north into the Pantano Wash via a 48 CMP. At a minimum, an extension of the existing pipe through the proposed soil cement bank protection is required. Upsizing of the grate and pipes to handle additional flow, as well as curbing along the roadway to contain and guide flow to the inlet may be evaluated and considered as part of formal design.

Concentration Point 18-1 and 18-2 are located at the northeast corner of the River Orchard Condominiums. Flows at Concentration Point 18-1 come from a shallow ditch along the northern boundary of the condominiums which collects and conveys flow east. Flows reaching Concentration Point 18 are conveyed from condominiums through the existing parking/storage area at the northeast corner of the development. Flows from both concentration points will be combined and conveyed through the new soil cement via 2-48" RCP with a drop inlet.

Concentration Point 19 is located at the confluence of two ditches which convey runoff from a portion of the subdivision along Glenn Street as well as from a portion of Fort Lowell Park. 2-48" RCPs are required to convey the flows under the proposed pathways.

Concentration Point 20 consists of a small watershed which collects flow from a portion of the recently constructed Craycroft Road underpass as well as a portion of the bridge deck above via several deck drains. Flow concentrates at a low point along the path under the bridge and is discharged directly to the wash through a 4" PVC pipe. Field observations indicate the potential for ponding on the pathway at the inlet of the 4" pipe due to a tendency for debris clogging as well as the flowline elevation. The need and feasibility of upsizing the existing 4" pipe will be further evaluated as part of formal design.

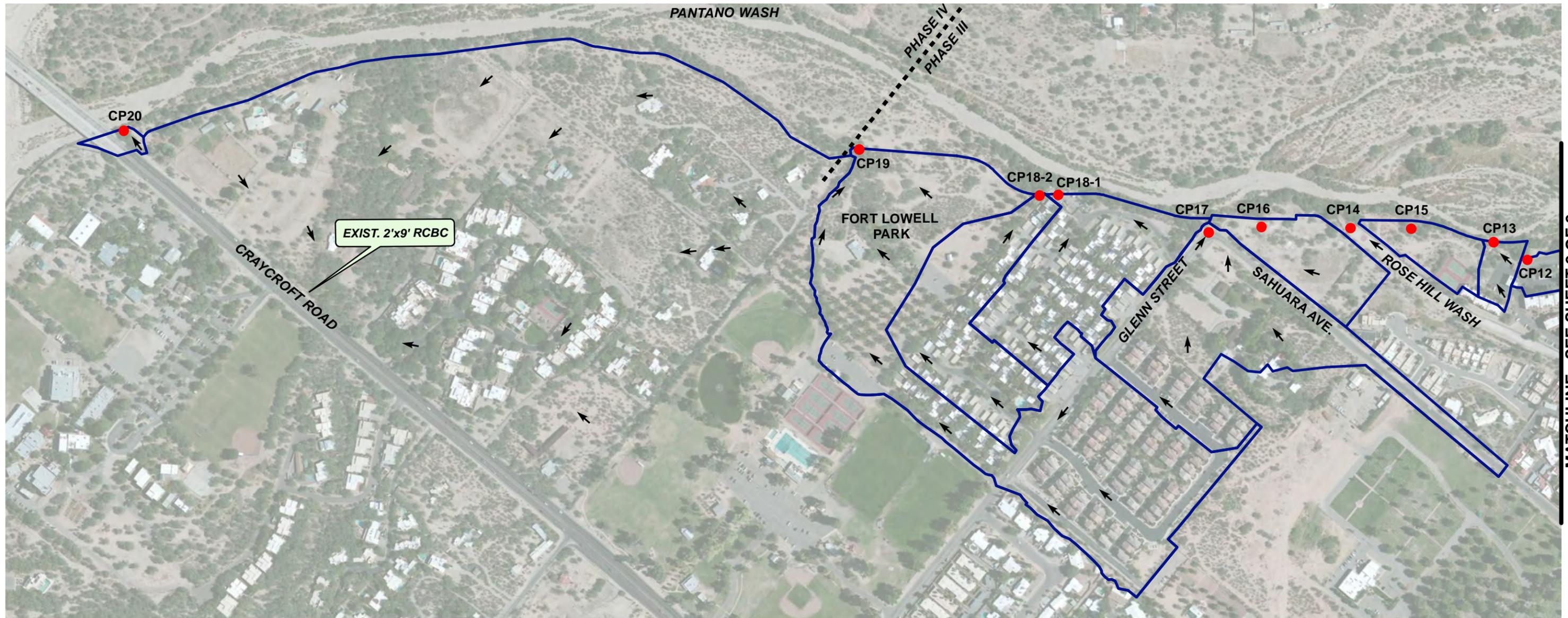
### 3.5.2.2 East Bank Tributary Drainage

Tributary drainage areas on the east bank within areas of proposed Phase III improvements are characterized by sheetflow conditions and a lack of defined points of concentration. It has been assumed that flow will primarily be allowed to pass directly over the pathways. However, scuppers may be located and sized as part of formal design, or "field fit" during construction similar to completed upstream phases where flow patterns were poorly defined and changed as a result of construction. The approximate extents of tributary drainage areas which may impact the preferred design as discussed in Section 4.0 have been delineated on Figure 3.5.1, Sheet 2.

**Table 3.5.1 Summary of Peak Discharges and Drainage Structures**

| Basin ID | Area (ac) | Q10 (cfs) | Q100 (cfs) | Existing Outfall Structure | Proposed Structure   |
|----------|-----------|-----------|------------|----------------------------|--|
| CP1      | 0.3       | 1.4       | 2.8        | PVC Pipe                   | Extend Pipe or Construct New Spillway/Scupper                                |
| CP2      | 0.8       | 4.0       | 8.0        | None                       | New Spillway/Scupper   |
| CP3*     | --        | --        | --         | 3-30" RCP                  | Extend 3-30" RCP   |
| CP4      | 0.2       | 0.9       | 1.9        | Spillway                   | Extend Spillway/New Scupper  |
| CP5      | 0.5       | 2.7       | 5.3        | Spillway                   | Extend Spillway/New Scupper  |
| CP6      | 0.6       | 2.8       | 5.6        | Spillway                   | Extend Spillway/New Scupper  |
| CP7      | 0.5       | 2.5       | 4.9        | Spillway                   | Extend Spillway/New Scupper  |
| CP8-1    | 0.3       | 1.5       | 3.1        | None (Localized Erosion)   | New Spillway/Scupper   |
| CP8-2    | 0.4       | 1.9       | 3.7        | None (Localized Erosion)   | New Spillway/Scupper   |
| CP9*     | --        | --        | --         | 1-48" RCP                  | Extend 48" RCP   |
| CP10     | 18.6      | 94        | 187        | None (Localized Erosion)   | New 4-48" RCP for Combined CP10/CP11 Flows<br>Existing RCP at CP11 to remain |
| CP11     | 6.0       | 30        | 61         | 30"RCP                     |  |
| CP12     | 3.8       | 19        | 38         | Spillway                   | Extend Spillway/New Scupper  |
| CP13     | 0.9       | 3.4       | 7.5        | Eroded Ditch               | New Channel/Scupper  |
| CP14*    | --        | --        | 2926       | Concrete Channel           | Pedestrian Bridge  |
| CP15     | 1.9       | 5.3       | 13         | None (Sheetflow)           | Sheetflow over new path and/or new scupper(s)                                |
| CP16     | 3.5       | 10        | 23         | Eroded Ditch               | 18" outflow pipe from new water harvesting basin                             |
| CP17     | 12.5      | 33        | 74         | CMP                        | Drop Inlet/New 48" RCP   |
| CP18-1   | 8.3       | 40        | 80         | Earthen Ditch              | Combine Flow into Drop Inlet/New 2-48" RCP                                   |
| CP18-2   | 7.9       | 26        | 57         | Pavement Flow              |  |
| CP19     | 22.4      | 53        | 117        | Ditch                      | New 2-48" RCP  |
| CP20     | 0.3       | 1.5       | 2.9        | 4" PVC Pipe                | Need for upsizing to be evaluated during formal design                       |

\*Larger offsite watershed with existing outfall structure to be extended. No peak discharges calculated.

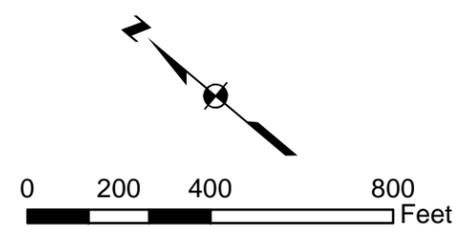


**LEGEND**

- CONCENTRATION POINTS
- TRIBUTARY WATERSHED BOUNDARY
- ↑ DIRECTIONAL FLOW ARROW
- - -> SHEETFLOW CONDITION

**NOTES**

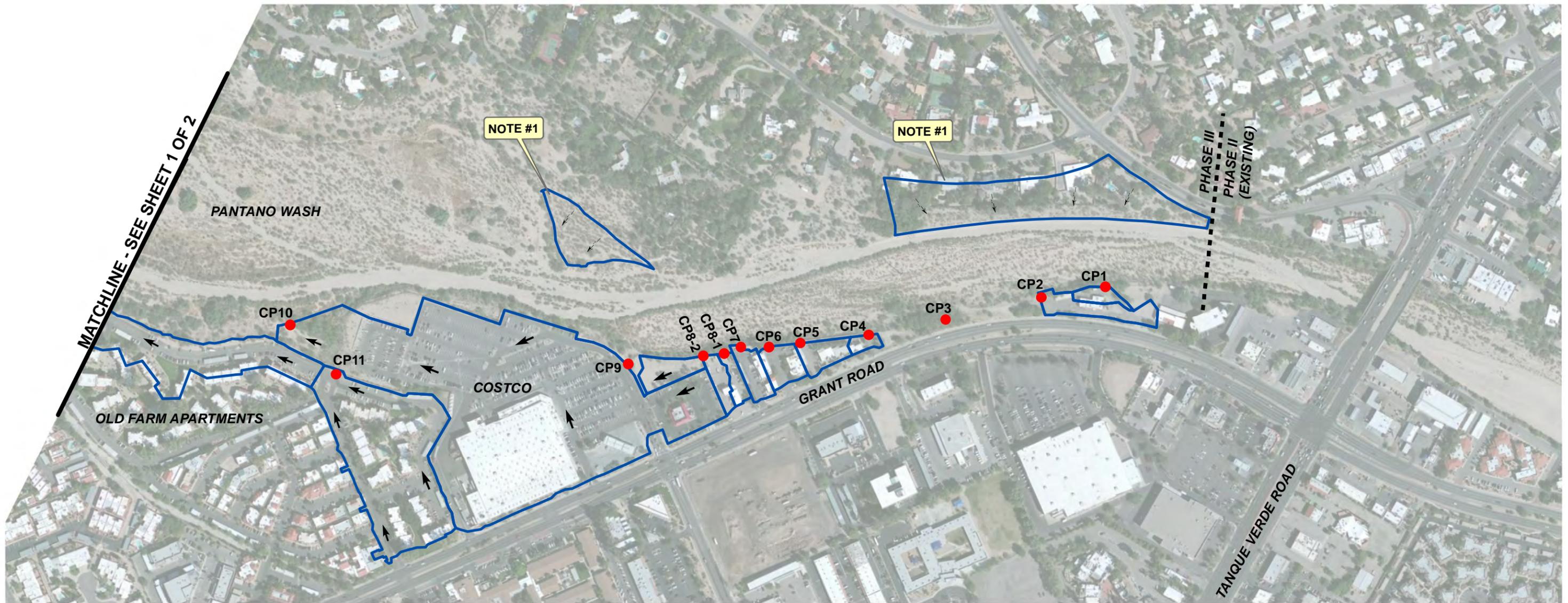
| Basin ID | Area (ac) | Q10 (cfs) | Q100 (cfs) | Existing Outfall Structure | Proposed Structure                                     |
|----------|-----------|-----------|------------|----------------------------|--|
| CP1      | 0.3       | 1.4       | 2.8        | PVC Pipe                   | Extend Pipe or Construct New Spillway/Scupper          |
| CP2      | 0.8       | 4         | 8          | None                       | New Spillway/Scupper                                   |
| CP3*     | --        | --        | --         | 3-30" RCP                  | Extend 3-30" RCP                                       |
| CP4      | 0.2       | 0.9       | 1.9        | Spillway                   | Extend Spillway/New Scupper                            |
| CP5      | 0.5       | 2.7       | 5.3        | Spillway                   | Extend Spillway/New Scupper                            |
| CP6      | 0.6       | 5.6       | 2.8        | Spillway                   | Extend Spillway/New Scupper                            |
| CP7      | 0.5       | 4.9       | 2.5        | Spillway                   | Extend Spillway/New Scupper                            |
| CP8-1    | 0.3       | 3.1       | 1.5        | None (Localized Erosion)   | New Spillway/Scupper                                   |
| CP8-2    | 0.4       | 3.7       | 1.9        | None (Localized Erosion)   | New Spillway/Scupper                                   |
| CP9*     | --        | --        | --         | 1-48" RCP                  | Extend 48" RCP   |
| CP10     | 18.6      | 94        | 187        | None (Localized Erosion)   | New 4-48" RCP for Combined CP10/CP11 Flows             |
| CP11     | 6         | 30        | 61         | 30" RCP                    | Existing RCP at CP11 to remain                         |
| CP12     | 3.8       | 19        | 38         | Spillway                   | Extend Spillway/New Scupper                            |
| CP13     | 0.9       | 3.4       | 7.5        | Eroded Ditch               | New Channel/Scupper                                    |
| CP14*    | --        | --        | 2926       | Concrete Channel           | Pedestrian Bridge                                      |
| CP15     | 1.9       | 5.3       | 13         | None (Sheetflow)           | Sheetflow over new path and/or new scupper(s)          |
| CP16     | 3.5       | 10        | 23         | Eroded Ditch               | 18" outflow pipe from new water harvesting basin       |
| CP17     | 12.5      | 33        | 74         | CMP                        | Drop Inlet/New 48" RCP                                 |
| CP18-1   | 8.3       | 40        | 80         | Earthen Ditch              | Combine Flow into Drop Inlet/New 2-48" RCP             |
| CP18-2   | 7.9       | 26        | 57         | Pavement Flow              |  |
| CP19     | 22.4      | 53        | 117        | Ditch                      | New 2-48" RCP  |
| CP20     | 0.3       | 1.5       | 2.9        | 4" PVC Pipe                | Need for upsizing to be evaluated during formal design |



Pantano Wash Bank Protection and River Park - Phase 3 & 4

FIGURE 3.5.1  
TRIBUTARY DRAINAGE MAP  
(SHEET 1 OF 2)

Pima County Regional Flood Control District  
PSOMAS



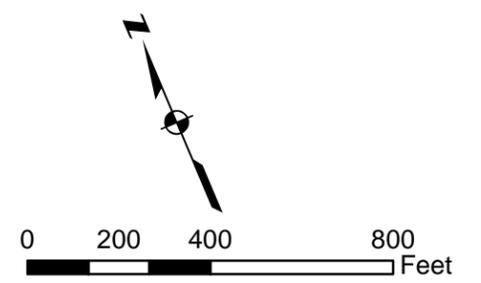
**LEGEND**

- CONCENTRATION POINTS
- TRIBUTARY WATERSHED BOUNDARY
- ↑ DIRECTIONAL FLOW ARROW
- > SHEETFLOW CONDITION

**NOTES**

1. TRIBUTARY WATERSHED CHARACTERIZED BY POORLY DEFINED SHEETFLOW CONDITIONS. DRAINAGE STRUCTURES (IF REQUIRED) WILL BE DETERMINED AS PART OF FORMAL DESIGN AND ADJUSTED DURING CONSTRUCTION AS NEEDED TO MATCH FIELD CONDITIONS.

| Basin ID | Area (ac) | Q10 (cfs) | Q100 (cfs) | Existing Outfall Structure | Proposed Structure                                     |
|----------|-----------|-----------|------------|----------------------------|--|
| CP1      | 0.3       | 1.4       | 2.8        | PVC Pipe                   | Extend Pipe or Construct New Spillway/Scupper          |
| CP2      | 0.8       | 4         | 8          | None                       | New Spillway/Scupper                                   |
| CP3*     | --        | --        | --         | 3-30" RCP                  | Extend 3-30" RCP                                       |
| CP4      | 0.2       | 0.9       | 1.9        | Spillway                   | Extend Spillway/New Scupper                            |
| CP5      | 0.5       | 2.7       | 5.3        | Spillway                   | Extend Spillway/New Scupper                            |
| CP6      | 0.6       | 5.6       | 2.8        | Spillway                   | Extend Spillway/New Scupper                            |
| CP7      | 0.5       | 4.9       | 2.5        | Spillway                   | Extend Spillway/New Scupper                            |
| CP8-1    | 0.3       | 3.1       | 1.5        | None (Localized Erosion)   | New Spillway/Scupper                                   |
| CP8-2    | 0.4       | 3.7       | 1.9        | None (Localized Erosion)   | New Spillway/Scupper                                   |
| CP9*     | --        | --        | --         | 1-48" RCP                  | Extend 48" RCP   |
| CP10     | 18.6      | 94        | 187        | None (Localized Erosion)   | New 4-48" RCP for Combined CP10/CP11 Flows             |
| CP11     | 6         | 30        | 61         | 30" RCP                    | Existing RCP at CP11 to remain                         |
| CP12     | 3.8       | 19        | 38         | Spillway                   | Extend Spillway/New Scupper                            |
| CP13     | 0.9       | 3.4       | 7.5        | Eroded Ditch               | New Channel/Scupper                                    |
| CP14*    | --        | --        | 2926       | Concrete Channel           | Pedestrian Bridge                                      |
| CP15     | 1.9       | 5.3       | 13         | None (Sheetflow)           | Sheetflow over new path and/or new scupper(s)          |
| CP16     | 3.5       | 10        | 23         | Eroded Ditch               | 18" outflow pipe from new water harvesting basin       |
| CP17     | 12.5      | 33        | 74         | CMP                        | Drop Inlet/New 48" RCP                                 |
| CP18-1   | 8.3       | 40        | 80         | Earthen Ditch              | Combine Flow into Drop Inlet/New 2-48" RCP             |
| CP18-2   | 7.9       | 26        | 57         | Pavement Flow              |  |
| CP19     | 22.4      | 53        | 117        | Ditch                      | New 2-48" RCP  |
| CP20     | 0.3       | 1.5       | 2.9        | 4" PVC Pipe                | Need for upsizing to be evaluated during formal design |



**Pantano Wash Bank Protection and River Park - Phase 3 & 4**

**FIGURE 3.5.1 TRIBUTARY DRAINAGE MAP (SHEET 2 OF 2)**

### 3.5.3 Water Harvesting

There is a significant opportunity for water harvesting along portions of the project reach utilizing both “onsite” and “offsite” runoff. This water source can support both existing and proposed vegetation and will be utilized at all location where practical. All water harvesting features will have appropriate setbacks from paths, soil cement, other features to ensure no negative impacts.

There are two areas of note where stormwater harvesting is will be implemented. The first is the staging area where runoff from the parking lot will be conveyed to a landscaped basin. Flows in excess of the basin capacity will discharge to Pantano Wash via an overflow pipe extended through the adjacent soil cement. The second location is the stormwater outfall at the Costco parking lot. Runoff will be allowed to pond in the low lying area between the parking lot and the new soil cement. This area will likely serve as a riparian mitigation area to offset some of the native vegetation losses elsewhere on the project.

## 3.6 Biological Resources

This section provides a brief summary of the existing biological resources of the Project area. Further information, including a full discussion and more detailed description of these resources is found in RECON’s March 2013 *Biological Resources, Pantano Wash Bank Protection and River Park, Phase III and V, Final Report* which has been attached as Appendix F.

### 3.6.1 Important Riparian Habitat

The Maeveen Marie Behan Conservation Lands System (CLS) of the Sonoran Desert Conservation Plan (SDCP) was designed to protect biodiversity and provide land use guidelines consistent with the conservation goal of the SDCP. The CLS identifies land designations based on biological values and establishes specific guidelines for open space conservation. One CLS category occurs within the Pantano Phases III and IV study area—Important Riparian Area (IRA; Figure 3.6.1). IRAs are essential elements in the CLS and are valued for their higher water availability, vegetation density, and biological productivity. In addition to the inherent high biological value of these water-related communities, IRAs and their associated upland areas provide a strong basis for linkages and landscape connections.

An IRA is characterized by hydroriparian, mesoriparian, and/or xeroriparian biological communities. Hydroriparian communities generally exist in areas where vegetation is supported by perennial watercourses or springs. Mesoriparian communities generally exist in areas where vegetation is supported by perennial or intermittent watercourses or shallow groundwater. Xeroriparian communities generally exist in areas where vegetation is supported by ephemeral watercourses. The majority of the study area is characterized as hydromesoriparian or mesoriparian H according to SDCP IRA mapping (see Figure 3.6.1). Within the study area, the Pantano Wash flows intermittently in response to precipitation events, and there is an area of shallow groundwater identified in SDCP maps present at the northwestern extent of the study area at Craycroft Road. Much of the vegetation in the study area is dominated by velvet mesquite (*Prosopis velutina*), which is characteristic of the mesoriparian H classification.

### 3.6.2 Vegetation

All plant species observed within the study area were noted, and plants that could not be identified in the field were collected for identification with taxonomic keys. Perennial non-native invasive plant species were specifically mapped within the study area. See the draft Existing Biological Resources Report in Appendix F (RECON 2013) for a full list of species observed.

#### 3.6.2.1 Vegetation Communities

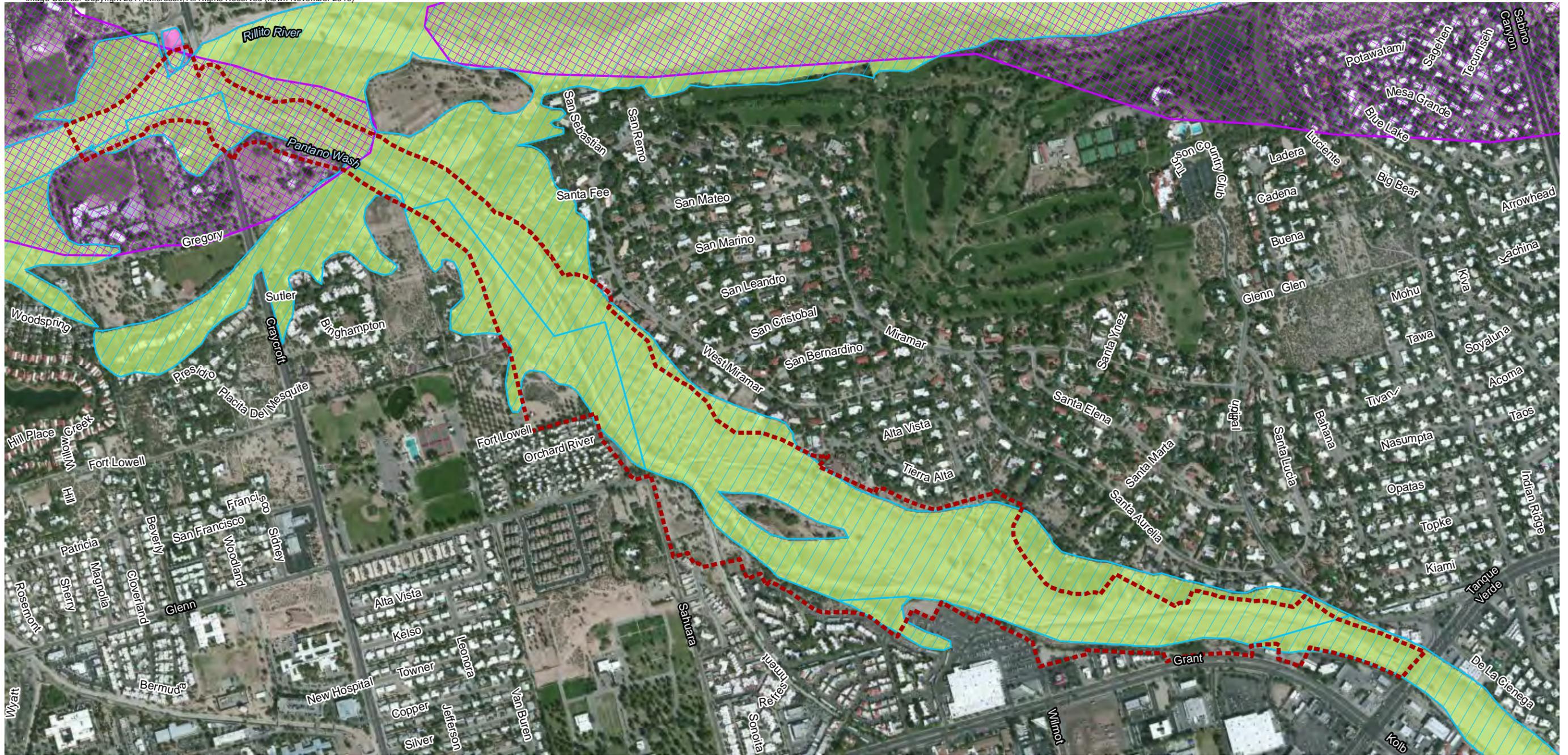
There are four main vegetation communities present throughout the study area: Sonoran desertscrub, Sonoran interior strand, mesquite woodland, and Sonoran riparian scrub. These communities intermix/intergrade in many locations as shown on Figure 3.6.2. Descriptions of the various communities are provided below in Table 3.6.1, as well as a summary of the acreages by vegetation community/cover type.

**Table 3.6.1 Vegetation Communities and Cover Types Present in the Study Area**

| Vegetation Community / Cover Type | Approximate Acreage within Study Area |
|-----------------------------------|---------------------------------------|
| Sonoran Interior Strand           | 63.6                                  |
| Mesquite Woodland                 | 54.4                                  |
| Unvegetated Channel Bottom        | 26.8                                  |
| Sonoran Riparian Scrub            | 18.1                                  |
| Sonoran Desertscrub               | 12.3                                  |
| Disturbed / Developed             | 9.1                                   |

The Sonoran desertscrub vegetation community occurs at the highest elevations of the overbank areas and comprises approximately 12.3 acres within the study area. Tree species include blue paloverde (*Parkinsonia florida*) and velvet mesquite, and the predominant shrub is creosote (*Larrea tridentata*). Commonly encountered cactus species include chain-fruit cholla (*Cylindropuntia fulgida*) and fishhook barrel cactus (*Ferocactus wislizenii*).

The Sonoran interior strand vegetation community is associated with the sandy bottom low-flow channel of the Pantano Wash and includes the unvegetated channel bottom. The total potential distribution of this vegetation community within the study area includes the sum of these areas, or 90.4 acres. Expanses of flood-adapted shrubs include burrobrush (*Hymenoclea monogyra*) and desert broom (*Baccharis sarothroides*). Native trees include velvet mesquite and desert willow (*Chilopsis linearis*). There are also extensive areas of non-native invasive trees (notably athel tree [*Tamarix aphylla*] and Mexican paloverde [*Parkinsonia aculeata*]), as well as two invasive grass species: buffelgrass (*Pennisetum ciliare*) and Johnson grass (*Sorghum halepense*). This community supports a diverse array of ephemeral plants, including the native floodplain annual Palmer’s amaranth (*Amaranthus palmeri*).



**LEGEND**

- |  |   |
|--|---|
|  STUDY AREA                   | <b>RIPARIAN HABITAT - IRA UNDERLYING CLASSIFICATIONS</b>  |
|  SDCP IMPORTANT RIPARIAN AREA |  XERORIPARIAN D                      |
|  SHALLOW GROUNDWATER AREA     |  HYDROMESORIPARIAN OR MESORIPARIAN H |

0 250 500 750 1,000 Feet



**Pantano Wash Phases 3 and 4**

**FIGURE 3.6.1: SDCP IMPORTANT RIPARIAN AREAS AND SHALLOW GROUNDWATER**



**LEGEND**

- |  |   |   |
|--|---|---|
|  STUDY AREA | <b>VEGETATION CLASSIFICATION</b>  |  SONORAN RIPARIAN SCRUB     |
|  |  SONORAN DESERT SCRUB    |  UNVEGETATED CHANNEL BOTTOM |
|  |  SONORAN INTERIOR STRAND |  DISTURBED/DEVELOPED        |
|  |  MESQUITE WOODLAND       |   |

0 250 500 750 1,000 Feet



**Pantano Wash Phases 3 and 4**

**FIGURE 3.6.2  
EXISTING VEGETATION  
COMMUNITIES**

The mesquite woodland vegetation community occurs on the upper floodplain terraces and comprises approximately 54.4 acres of the study area. It is characterized by individual and scattered clumps of velvet mesquite trees (and sometimes paloverde [*Parkinsonia florida* and *P. aculeata*]), as well as wolfberry (*Lycium andersoni*) and chain-fruit cholla). There are several areas of impressive intact old-growth catclaw acacia (*Acacia greggii*) trees, especially on the eastern bank of the study area.

The Sonoran riparian scrub vegetation community comprises approximately 18.1 acres of the study area. This vegetation community is characterized by an overstory of native trees (velvet mesquite, blue paloverde, and catclaw acacia), as well as non-native trees (Mexican paloverde and African sumac [*Rhus lancea*]). There are isolated pockets of riparian trees (cottonwood, Arizona ash, Arizona walnut, and canyon hackberry [*Celtis reticulata*]), notably toward the confluence with Tanque Verde Wash. The dense shrub layer contains natives such as wolfberry and seepwillow (*Baccharis salicifolia*). Areas of mesquite bosque also occur.

### 3.6.2.2 Vegetation Diversity

One hundred two plant species were observed within the study area, including 73 native species and 29 non-native species. Because this is not based on a complete floristic inventory (which would span several seasons and multiple years), many additional species (especially annuals) are likely present within the flora in the study area during different seasons and years. See the draft Existing Biological Resources Report in Appendix F (RECON 2013) for a full list of species observed.

### 3.6.2.3 Non-native Invasive Plant Species

Invasive plant species are prevalent within the study area, many of which may require active post-project management. The areas upstream of the project are a continuous seed source and will be a continuous ongoing maintenance to minimize invasive species in the project limits will be required. RFCD intends to manage the area to keep it as close to the natural condition as practicable. Perennial woody invasive plant species were mapped and the resulting maps (Figures 3.6.3 through 3.6.5 are meant to give a general idea of the scope and locations for invasive species. See the draft Existing Biological Resources Report (RECON 2013) in Appendix E for a full list of invasive species observed.

### 3.6.3 Existing Wildlife Values

A diverse suite of wildlife species is characteristic along and adjacent to riparian systems, where riparian areas serve as high-value habitat corridors. Riparian areas provide vital wildlife linkages between stream/wash systems and surrounding uplands and mountain ranges. It is estimated that 90 percent of desert wildlife rely on riparian areas at least occasionally or for at least some part of their life cycles (USFWS 2001). Intact riparian gallery forests are floristically and structurally diverse, and they provide a wide variety of insects, feeding zones, and nesting sites for birds (Powell and Steidl 2000). Different bird species use different niches and zones within the vegetation community (Wilbur 2005). USFWS recognizes that the majority of Arizona's federally listed threatened and endangered species rely on riparian systems for survival (USFWS 2001). Not surprisingly, many of Pima County's Priority Vulnerable Species are associated with riparian areas. River corridors and riparian areas inherently connect the landscape they run through, and they are especially important in areas of fragmented habitats. In the arid southwest, including Arizona, riparian areas are heavily used by a variety of wildlife species as breeding habitat, water sources,

cover, and linkages between natural open spaces. This connectivity provides the contiguous habitat necessary to sustain viable populations of sensitive and far-ranging species in the Sonoran Desert.

Wildlife movement corridors and habitat linkages are areas that connect suitable wildlife habitat areas in a region otherwise fragmented by rugged terrain, changes in vegetation, or human disturbance. Corridors are generally local pathways connecting short distances usually covering one or two main types of vegetation communities. Linkages are landscape level connections between very large core areas and generally span several thousand feet and cover multiple habitat types. Natural features such as canyon drainages, ridgelines, or areas with vegetation cover provide corridors and linkages for wildlife travel. The habitat connectivity provided by corridors and linkages is important in providing access to mates, food, and water, allowing the dispersal of individuals away from high population density areas, and facilitating the exchange of genetic traits between populations (Beier and Loe 1992).

The Pantano Wash conveys stormwater flows from a large watershed that includes tributaries of the Rincon Mountains. The Tanque Verde Wash conveys flows from both the Rincon and Santa Catalina mountains. The river/wash bottoms and associated uplands of these watercourses and their tributaries constitute a key corridor network for wildlife living in and traveling through the Tucson Basin. The Pantano Wash also acts as one of the primary wildlife movement corridors within urban Tucson for both avian and terrestrial wildlife species. As it intersects the Rillito River, it provides connectivity for habitat south and east of Tucson, along the river corridors until the Rillito River meets the Santa Cruz River west of Tucson.

### 3.6.3.1 Special Status Wildlife Species

#### 3.6.3.1.1 Federally Listed Species

No federally listed species are likely to occur within the study area, and only one candidate for federal listing, the Sonoran population of the desert tortoise (*Gopherus agassizii*) has a moderate or high potential to occur. The Sonoran desert tortoise is likely to utilize the Pantano Wash, especially the areas with incised caliche ledges.

#### 3.6.3.1.2 Arizona Game and Fish Department Heritage Data Management System

Maternity colonies of Mexican free-tailed bats (*Tadarida brasiliensis*) are known to occur under a number of bridges in the City of Tucson. At the Tanque Verde Bridge (structure number 9569), at the south end of the Project's study area, the 1999 survey recorded a large maternity colony of Mexican free-tailed bats (>5,000 individuals) (Wolf and Shaw 2002). There is potential for continued use of this bridge by Mexican free-tailed bats year-round, but especially during summer months (June through September) when maternity colonies are active.

Cactus Ferruginous Pygmy-owl (*Glaucidium brasilianum cactorum*) is not expected to occur within the study area. There are no recent records of this species in the area, and no suitable nesting cavity habitat for this species within the study area. Due to the isolated nature of the study area, i.e. surrounded by urbanized land, and distance from currently known populations, this species is not expected to forage within the study area.





**LEGEND**

- STUDY AREA
- INVASIVE SPECIES**
- GIANT REED
- LEHMANN'S LOVEGRASS
- TICK GRASS
- FOUNTAIN GRASS
- SALT CEDAR

0 250 500 750 1,000  
Feet



**Pantano Wash Phases 3 and 4**

**FIGURE 3.6.4  
NON-NATIVE INVASIVE SHRUBS  
AND GRASSES WITH LIMITED  
DISTRIBUTION**



**LEGEND**

- STUDY AREA
- INVASIVE SPECIES**
- BUFFELGRASS
- JOHNSON GRASS
- BUFFELGRASS AND JOHNSON GRASS

0 250 500 750 1,000  
Feet



**Pantano Wash Phases 3 and 4**

**FIGURE 3.6.5  
NON-NATIVE INVASIVE  
PERENNIAL GRASSES WITH  
EXTENSIVE DISTRIBUTION**

**3.6.3.1.3 Priority Vulnerable Species**

Abert’s towhee (*Pipilo aberti*) was detected within the study area during general biological surveys. This species is likely to nest in the study area within the mesquite woodland vegetation.

Rufous-winged Sparrow (*Peucaea carpalis*) is likely to forage and nest within the study area within the perennial grasses and shrubs on the floodplains and terraces.

Swainson’s Hawk (*Buteo swainsoni*) is likely to forage within the study area within the more open vegetation on the floodplains and terraces. A few scattered cottonwood and willow trees that are present along the banks and adjacent to the study area may provide suitable nesting habitat for this species as well.

Burrowing owls (*Athene cunicularia hypugaea*) would most likely be found within the study area in the overbank areas with Sonoran desertscrub or mesquite woodland vegetation. Several potential (but unoccupied) burrows were observed, as well as fence posts at the appropriate height for perching.

Merriam’s mesquite mouse (*Peromyscus merriami*) could potentially be present within the Sonoran riparian scrub and/or mesquite woodland vegetation communities in the study area.

Giant spotted whiptails (*Aspidocelis burti stictogramma*) could potentially be present within the Sonoran riparian scrub and/or mesquite woodland vegetation communities in the study area.

**3.6.4 Potential Project Impacts**

**3.6.4.1 Construction Impacts**

- Impacts to Pima County regulated native plants and Important Riparian Habitat may occur during construction of the projects. After finalization of the pathway and bank protection locations, projected impacts to these resources will be quantified.
- Small, terrestrial species, such as reptiles or small mammals, may be present within the project footprint during construction. Work will be conducted during daylight hours, and these small, terrestrial species are generally expected to move out of harm’s way during construction along the path; although impacts may still occur to some species.
- Trees or large shrubs that would provide nesting habitat for avian species may be impacted by the project. If these trees/shrubs are removed/trimmed during the avian breeding season, impacts may occur to avian species that are regulated under the Migratory Bird Treaty Act.
- Burrowing owl burrows may be present within the project footprint near overbank areas with Sonoran desert scrub or mesquite woodland vegetation. Burrowing owls can occur within burrows year-round and grading or vegetation removal may impact this species. If any grading or vegetation removal is conducted during the burrowing owl breeding season of March through July, impacts may occur to nests of this species.

- No impacts are expected to occur to Mexican free-tail bats roosting under the Tanque Verde Bridge. The proposed construction will begin approximately 750 feet north of the bridge, where the current soil cement and improved pathways end. This 750-foot buffer between daytime construction activities and the bridge is expected to minimize any construction noise or vibrations that could impact the bats. In addition, no construction would be conducted at night when the bats are foraging.

**3.6.4.2 Long Term Project Impacts**

No long-term impacts to biological resources are anticipated due to the proposed project. Although vegetation and wildlife habitat will be temporary disrupted during project construction, mitigation for these impacts, as directed and approved by the resource agencies, will restore the function and values of these resources.

**3.6.5 Opportunities and Strategies for Protection and Enhancement**

The biological and habitat features in the study area with the highest priority for preservation in project design and construction are described below in Table 3.6.2 and shown in Figure 3.6.6.

**Table 3.6.2 Biological and Habitat Resources with High Priority for Preservation**

| Biological Resource               | Rationale  | Mitigation Considerations  |
|-----------------------------------|--|--|
| Sonoran Riparian Scrub Vegetation | This high value mesoriparian vegetation community is a declining resource in Pima County and a priority in SDCP conservation.  | Impacts to these resources may be mitigated through the landscape plan for the project, but habitat value would not meet current existing conditions for many years. Conversely, the addition to trailside irrigation with reclaimed water may improve these resources in the longer term. Maintenance practices would need to consider the habitat value of the vegetation. |
| Old Growth Catclaw Trees          | These old-growth trees are unusual in their size and maturity, and provide uncommon habitat benefits for a variety of wildlife species.  |  |
| Relict Cottonwood Trees           | The mature cottonwood trees are the tallest trees in the study area and are valuable perching and nesting areas for many birds, including raptors.   |  |
| Caliche Overhangs                 | Caliche overhangs occur in only one area of the study area and provide natural cover and shade that could be used by a variety of wildlife species, including the Sonoran desert tortoise. | The habitat value of this natural feature would be difficult to recreate in project design.  |
| Riprap and Rock Piles             | Rocks and riprap used to stabilize the eastern bank are a valuable habitat resource for spiny lizards and small mammals.   | Disturbance of this resource could result in direct mortality of wildlife and/or remove it as a habitat resource. Duplication of this type of habitat resource, on the other hand, could easily be incorporated into project design.   |



Areas considered medium priority preservation areas (see Figure 3.6.6) include islands of vegetation within the Pantano Wash channel bottom (Sonoran interior strand) are often used by lizard species. Areas dominated by native vegetation (as opposed to buffelgrass, Johnson grass, and Mexican paloverde) should be considered for preservation with priority over infested and/or unvegetated areas.

Areas of unvegetated channel bottom (see Figure 3.6.6) have the least biological resources of any area within the study area. From a habitat perspective, project disturbance in these areas is preferred over disturbance in areas with higher biological values.

The recreational multi-use path that is proposed to traverse the study area will also provide trailside habitat opportunities. The landscape design will be developed to specifically capitalize on the availability of irrigation water for dense and diverse native plantings and incorporation of water harvesting features.

### 3.6.5.1 Design Methods and Controls

General guidelines for providing trailside habitat for Tucson’s birds and lizards were developed by an interdisciplinary team of Pima County personnel in *Pima County Trails System Guidelines for Native Species: Reconciliation of Habitat Needs and Trail Design* (Pima County n.d.), including:

- Provide a variety of (native) plants
- Create a mosaic of open and mass-planted areas that include plants of various sizes and active growing seasons
- Provide structural diversity by including ground cover, shrubs, and trees in the planting design
- Ensure that thorny plants are sited at least 3 feet from the trail edge
- Ensure that maintenance practices encourage habitat values (e.g., allow “unmaintained” areas, allow mistletoe to grow in trees)
- Allow piles of rocks and debris as well as snags and dead wood to persist
- Avoid use of insecticides

### 3.6.5.2 Construction Methods and Controls

- Project will utilize strictly enforced construction access and haul routes which the contractor will be required to demarcate for the duration of the project. These routes will be designed to minimize impacts to valuable biological resources.
- Areas within the project to be utilized for aggregate source material for soil cement and backfill will be carefully selected to the extent practical to minimize impact and loss of valuable biological resources.
- Prior to finalization of this BDR, the County will meet with the City of Tucson and resource agencies to determine what local native plants and riparian habitat ordinances and guidance will be applied to the project, and the associate plans to avoid, minimize, and mitigate impacts to vegetation will be prepared.
- In order to prevent mortality to wildlife during construction, vehicles should drive slowly and cautiously during ingress and egress along the Pantano Wash, as well as while working within the project limits.

- If vegetation clearing or trimming of trees occurs during the general avian breeding season (March through August), a qualified biologist will conduct a nest survey prior to vegetation removal to determine if any active bird nests are observed within the shrubs/trees to be removed. If a nest is present and the species is migratory (and therefore subject to the Migratory Bird Treaty Act), the qualified biologist will coordinate with agencies to determine how to proceed with construction.

### 3.6.5.3 Invasive Species Management

Non-native invasive species are prevalent throughout the study area and have the potential to negatively impact the biological resources in the study area. An effective management program for invasive plants will enhance the biological values of the project area.

### 3.6.6 Riparian Mitigation Coordination Approach

#### 3.6.6.1 Anticipated Impacts

RECON performed detailed surveys for biological resources, including native plants that are protected under the Pima County and City of Tucson’s Native Plant Protection Ordinance (NPPO) programs. A number of tree and shrub species that are protected/regulated under the County and City NPPO guidelines are present within the Project limits. Table 3.6.3 identifies native plant species recorded within the project limits during the native plant inventory that could be impacted by construction.

**TABLE 3.6.3  
PROTECTED NATIVE PLANT SPECIES WITHIN THE PROJECT ROW**

| Scientific name                 | Common Name            |
|---------------------------------|------------------------|
| <i>Acacia constricta</i>        | white-thorn acacia     |
| <i>Acacia greggii</i>           | catclaw acacia         |
| <i>Carnegia gigantea</i>        | saguaro                |
| <i>Celtis reticulata</i>        | canyon hackberry       |
| <i>Chilopsis linearis</i>       | desert willow          |
| <i>Ferocactus wislizenii</i>    | fishhook barrel cactus |
| <i>Fraxinus velutina</i>        | velvet ash             |
| <i>Lycium sp.</i>               | wolfberry              |
| <i>Parkinsonia florida</i>      | blue palo verde        |
| <i>Parkinsonia microphyllum</i> | foothills palo verde   |
| <i>Prosopis velutina</i>        | velvet mesquite        |
| <i>Salix gooddingii</i>         | Goodding's willow      |
| <i>Zizyphus obtusifolia</i>     | gray thorn             |

Where possible and practical, the path and other projects features will be located in a way that avoids some of the protected trees and shrubs. Additional biological resources recorded within the study area that are protected under the NPPO, such as the Arizona walnut tree (*Juglans major*), or features that may provide habitat for wildlife species, such as the caliche overhang and rock/concrete rubble piles, would be avoided entirely by the project would not require mitigation.

### 3.6.6.2 Regulatory Approach

The project includes parcels owned by Pima County, City of Tucson and private parties. As a result, the riparian mitigation approach will need to accommodate both Pima County and City of Tucson riparian mitigation requirements. A meeting was held on July 10, 2013 to consult with representatives from both City of Tucson and RFCD and achieve consensus on the appropriate mitigation guidelines to be applied to the Project. The primary points and conclusions from that meeting are as follows:

- Carla Danforth (RFCD – Water Resources) was asked which of the upland and/or riparian Pima County regulations she would prefer to see utilized for the project and she indicated that use of the Pima County Regional Flood Control District’s Regulated Riparian Habitat Mitigation Standards and Implementation Guidelines (PCRFCDD 2011) would be most appropriate approach as opposed to the County’s NPPO standards. Mitigation will be calculated based on the overall number of acres to be disturbed. A minimum number of plantings is also calculated, based on the acreage of disturbance.
- Joe. Linville (City of Tucson) stated that the County regulations are generally more stringent than the City’s, and as long as the proposed mitigation meets or exceeds the City guidelines, he would support using the County’s mitigation format and guidelines. However, since the City approach is based on plant counts as opposed to acreage it was agreed that a memorandum would be provided to the City documenting the approximate number of impacted plants and the associated replacement quantities to ensure general compliance with City requirements in those areas under their jurisdiction.
- The City requested and will be provided an opportunity to review the mitigation plans in order to review, concur, and/or comment. Designated progress submittals will be provided to City staff as well as invitations to project coordination meetings.

### 3.6.6.3 Mitigation Approach

Once the footprint of project impacts for the soil cement, River Park and associated features is finalized, the acreage of disturbance of designated riparian habitat will be calculated. Appropriate requirements from Pima County and City of Tucson regulations will then be applied to determine the acreage of mitigation required as well as the number of plantings required. For lands that remain under the jurisdiction of the City of Tucson, the number of individual plants to be preserved in place or salvaged for transplanting will also be calculated.

The ability to mitigate within the project limits is constrained as much available space consists of a narrow corridor situated between the active Pantano Wash channel and existing residential or commercial development. Vegetation will be mitigated/restored within the project limits to the extent feasible, but the acreage of land available may not provide enough opportunities for RFCD to fulfill their mitigation obligations. Total required mitigation for impacts to protected plants and vegetation communities may be achieved through a combination of the following on-site and off-site measures:

- Restore native vegetation within habitat temporarily disturbed during construction activities.

- Create new habitat within and adjacent to the project limits in locations that are currently disturbed but have suitable hydrology and other elements necessary for planting success.
- Restore/enhance existing habitat within and adjacent to the project limits by removing non-native invasive plant species and replacing them with native plants when feasible.
- Pay an in-lieu fee and/or preserve off-site mitigation lands to achieve required mitigation if the amount of habitat enhancement/restoration/creation opportunities on and adjacent to the site does not completely fulfill the mitigation requirement.

The Project design team will work closely with RFCD to identify all of the land that within and adjacent to the project limits which is suitable and available to perform habitat restoration and enhancement. A large number of non-native invasive species, such as Mexican paloverde (*Parkinsonia aculeate*), giant reed (*Arundo donax*), and buffelgrass (*Pennisetum ciliare*) are present within the study area and present habitat enhancement opportunities throughout the ROW and adjacent lands. Another mitigation opportunity includes a portion of the City of Tucson’s Fort Lowell Park; currently, much of this area lacks vegetative cover due to grading or surface disturbance that has occurred and would benefit from habitat restoration or enhancement.

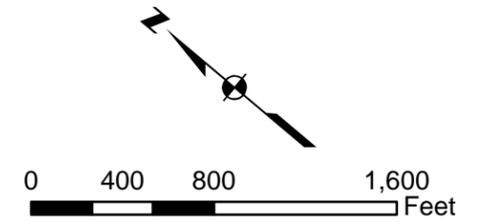
A Riparian Mitigation Plan will be prepared to identify the details of mitigation implementation and locations. This Riparian Mitigation Plan will be incorporated into detailed Landscape Plans that will provide the graphical detail of the location and approach to the proposed mitigation, along with a technical memorandum that provides a narrative of the impact/mitigation analysis performed, details on how the mitigation acreages and numbers are derived, and additional discussion relating to the locations and criteria for mitigation implementation.

In addition to the Pima County Riparian Mitigation Plan, a technical memorandum to the City of Tucson Cover will be prepared to analyze requirements of the City of Tucson’s Native Plant Preservation Standards and describe how the proposed mitigation strategy would meet or exceed the City’s requirements on City of Tucson properties.

## 3.7 Corps of Engineers Section 404 Permitting

The Project will require a Clean Water Act Section 404 permit from the United States Army Corps of Engineers (USACOE) and Section 401 State Water Quality Certification from the Arizona Department of Environmental Quality (ADEQ) due to the extent of channel disturbance and potential permanent loss of Waters of the US. The request for the individual permit should occur as soon as the 50% design plans are complete and the Project footprint and areas of permanent and temporary disturbance have been established and are not subject to significant change.

Ecoplan has submitted PJD request to RFCD for review as shown on Figure 3.7.1. The PJD included the main Pantano Wash channel as well as the Rose Hill Wash at the confluence with Pantano Wash. Once approved by RFCD the PJD package will be sent to the Corps for review and approval. The RFCD has presented the preliminary design and impact calculations to the USACOE to ensure the proper approach to impact avoidance and mitigation.



**LEGEND**

- Proposed PJD Limits
- Area of Potential Effects

**NOTES**

- 1.

**Pantano Wash Bank Protection and River Park - Phase 3 & 4**

**FIGURE 3.7.1  
PRELIMINARY JURISDICTIONAL  
DELINEATION AND CULTURAL  
SURVEY LIMITS**

Pima County Regional Flood Control District  
PSOMAS

The disturbance limits for the individual Section 404/401 permit should be selected to allow for unimpeded access and construction in the channel for the construction of bank protection as well as for the removal and transport of material for backfill and soil cement production. The requested limits for the individual Section 404/401 permit should extend to the limits of the PJD as shown on Figure 3.7.1. Permanent disturbance of the channel will be limited to the minimum extents practicable while allowing for the necessary access for construction and transport of material and equipment. Mitigation requirements are expected to be fulfilled through in-lieu fee for off-site mitigation.

### **3.8 Cultural Resources**

The area of potential effects (APE) as depicted on Figure 3.7.1 was surveyed for cultural resources. One new site, AZ BB:9:434 (ASM) was located, and portions of the Hardy site and a historic irrigation system also were recorded within the APE. Because these cultural resources may be adversely affected by the proposed work, cultural mitigation at these sites is necessary. Cultural mitigation would include a program of exploratory test excavation, followed by additional data recovery excavations if subsurface features are found. Pima County will consult with the Arizona State Historic Preservation Office (SHPO) on the proposed mitigation measures to ensure they adequately mitigate the adverse effects of the proposed work.

The presence of an overlap between the PJD limits, identified cultural sites, and disturbance related to project construction requires compliance with Section 106 of the Federal National Historic Preservation Act (NHPA). Previous experience with Section 106 consultation efforts has shown it can extend the project design schedule by 18 months or more when compared to similar projects where coordination and consultation is strictly through Pima County Office of Sustainability and Conservation (OSC) and SHPO. There currently does not appear to be any overlap of proposed PJD limits, mapped cultural resource sites and the conceptual design, which would suggest there will be no federal nexus for this project. However, the PJD limits have not been approved yet by the Corps of Engineers and a final determination of the presence or absence of a federal nexus will be made upon that approval.

### **3.9 Coordination with Outside Agencies**

#### **3.9.1 City of Tucson**

A portion of the project will extend through City of Tucson property, and more specifically Fort Lowell Park. RFCD staff and the project design team have met with City of Tucson Parks and Recreation staff on two occasions to discuss the proposed Pantano Wash Phase IV project. The relevant points of discussion from those meetings were as follows:

- City staff spent several years in close coordination with local residences and key stakeholder groups developing a Master Plan for Fort Lowell Park. The design of the Pantano Wash Phase IV project must be consistent and in compliance with the Fort Lowell Park Master Plan. City staff is unlikely to consider design elements which appear to deviate from the Master Plan. For example, any type of temporary or permanent pathway that would bring River Park users through Fort Lowell Park to provide a connection to Craycroft Road would not be considered acceptable.

- City Staff believes coordination and consultation with user groups and other stakeholders will be key in achieving approval of the proposed River Park design through Fort Lowell Park. They indicated this process will be time-consuming, but that careful and well planned coordination will save time over the course of the project. City staff believes they can help facilitate the process given their history with local residents and stakeholders.
- City staff believes that local residents and stakeholder groups will expect some form of recreational node and/or interpretive display along the proposed paved path within Fort Lowell Park, and that this amenity will be subject to input from these groups. Appropriate connections to the existing or proposed pathway system within the park must also be provided as part of the Pantano Wash Phase III project. Design concepts for improvements within the Fort Lowell Park property should be well developed and reviewed by City staff (and possibly key stakeholder groups) prior to presentation at any public meetings.

The project design team has obtained an overlay of the Fort Lowell Park Master Plan and developed a concept design which is consistent with that document. This overlay has been included on the Public Facilities Master Plan (Figure 2.1.1, Appendix A). It should be noted that the Fort Lowell Park Master Plan was initiated and funded using 2004 Pima County Bond funds and that this work was overseen by the joint city/county Fort Lowell Restoration Advisory Committee.

#### **3.9.2 Pima Trails Association**

Pima Trails Association (PTA) is a non-profit, volunteer trails advocacy organization composed of hikers, equestrians and mountain bikers whose purpose is to protect and preserve trails in Pima County. Within the context of new River Park projects, their focus is primarily on providing input to ensure a design which adequately addresses the needs of equestrian users.

The project concept design was presented to Sue Clark of PTA to obtain her input and she believes that equestrian facilities are warranted at the project given its location and proximity to other equestrian facilities. She indicated a desire to see as much separation as reasonable between the paved and DG paths, and that RFCD should take this into consideration when defining the extents of property acquisition.

### **3.10 Traffic Impacts**

Concerns were raised during the course of the public input process (see Section 3.11) regarding the impacts to existing neighborhood traffic counts due to construction of the River Park staging area on Sahuara Avenue near Glenn Street. In response to these concerns, traffic counts were collected to assess existing conditions along both Sahuara Avenue north of Grant Road, and Glenn Street east of Fort Lowell Park. Counts were also collected at the existing River Park staging area located on the north side of the Rillito River at Swan Road to provide counts which may be generally representative of what will be observed at the proposed Pantano Wash Phase III staging area. The purpose of these counts was to provide a reasonable estimation of the quantity and time distribution of traffic which might be observed at the proposed staging area. Counts were taken at all locations from Thursday through Sunday to provide data on both weekday and weekend traffic. A summary of the data has been presented in 15-minute increments on Figure 3.10.1, and includes the anticipated additional vehicles based on the Swan Road staging area counts. The overall

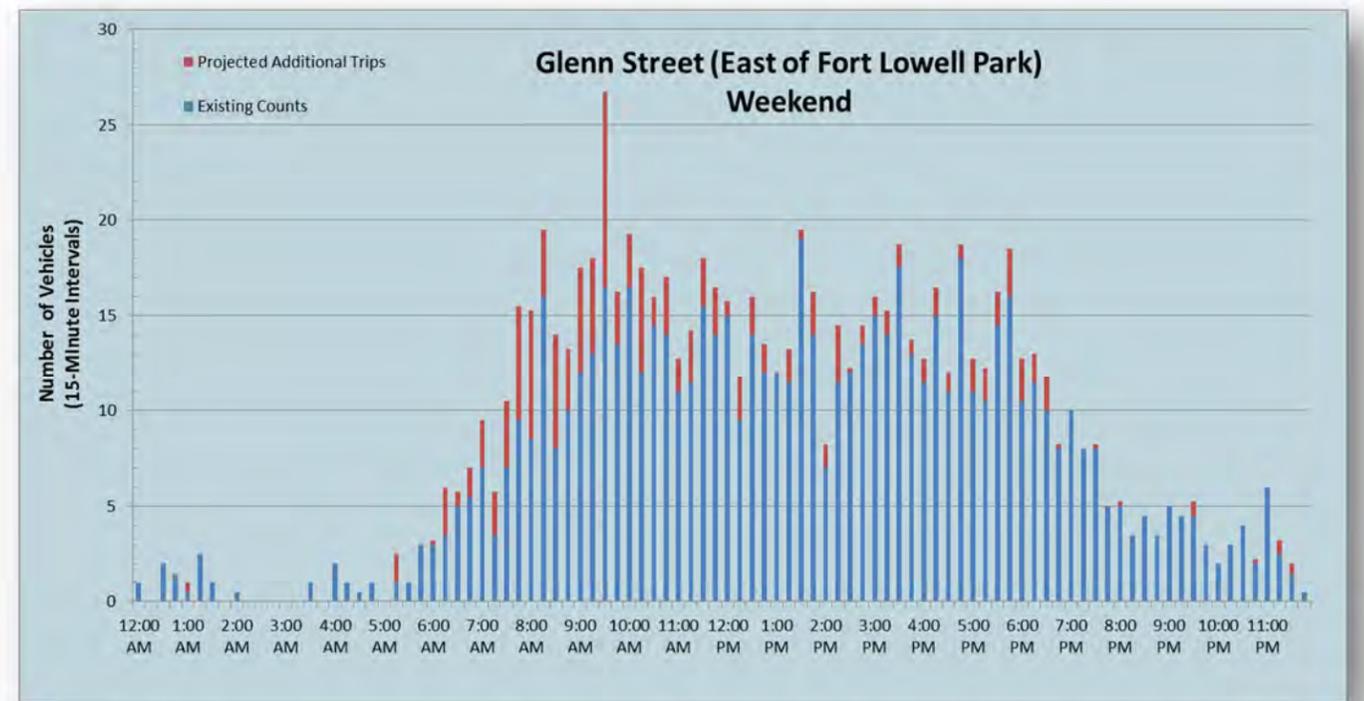
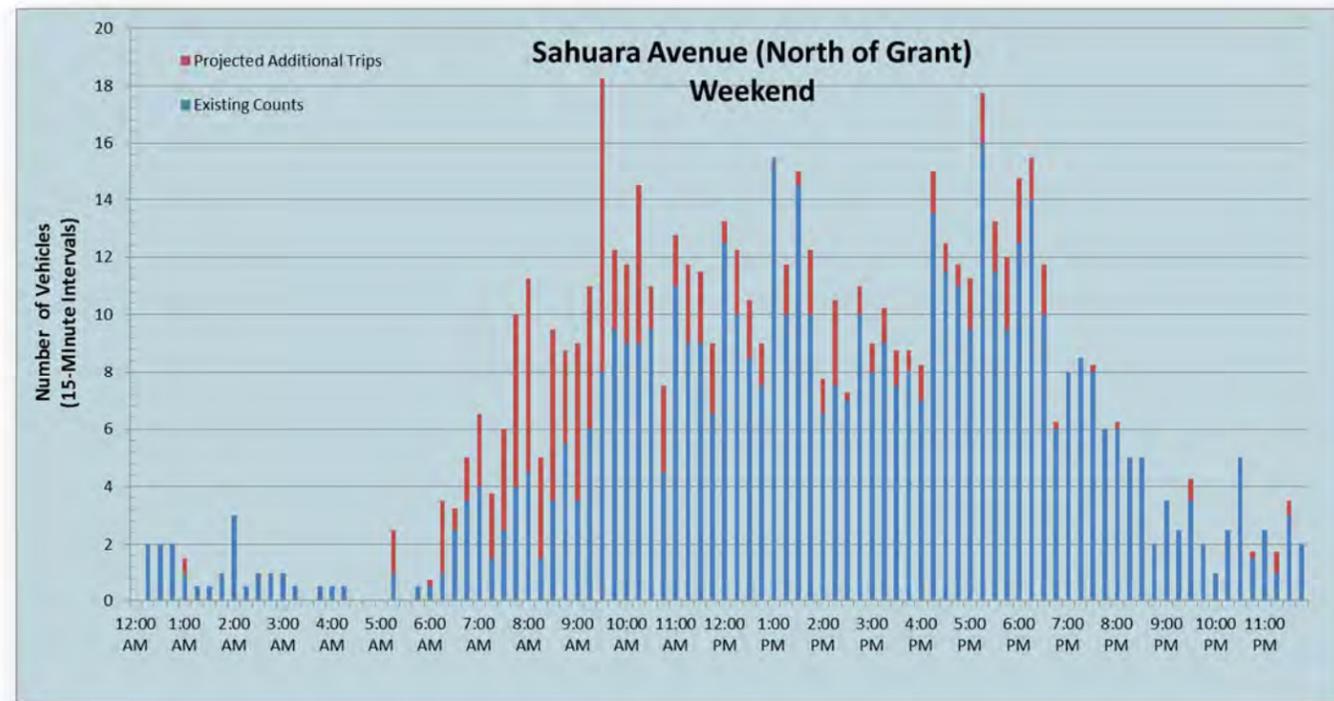
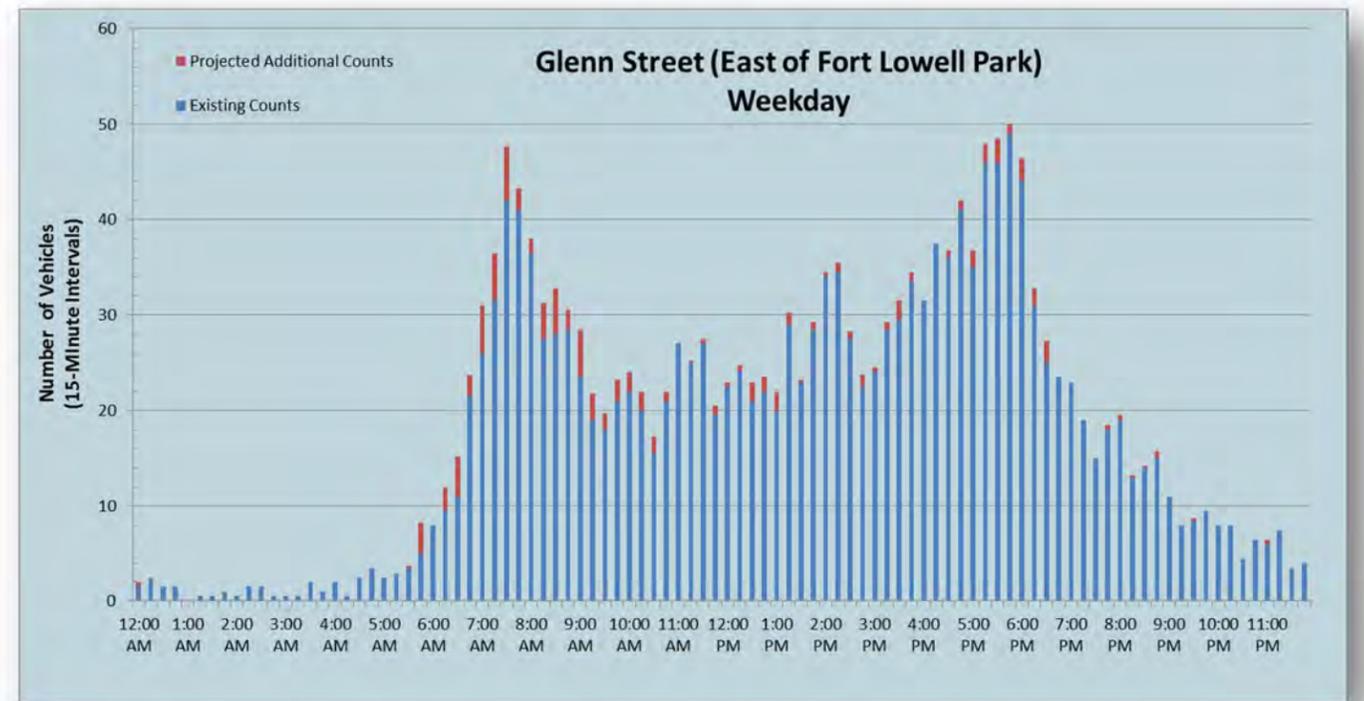
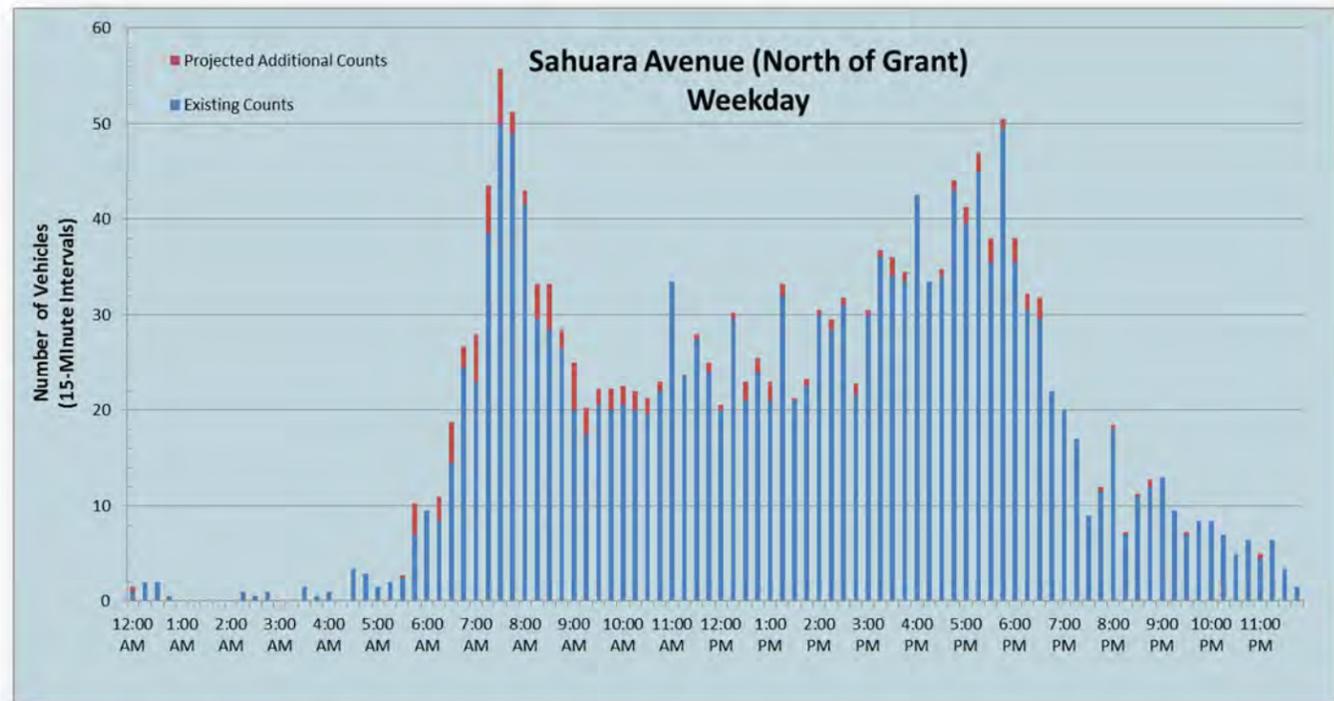
counts observed at the Swan Road staging area were split evenly between Sahuara Avenue and Glenn Street.

Available data from ADOT was also reviewed to assess the frequency and nature of accidents along Sahuara Avenue and Glenn Street, and at their intersections with Grant Road and Craycroft Road. Data was available for the years 2007 to 2011 and included information on accidents for which a police report was filed. Both the Grant Road and Craycroft Road intersections averaged approximately 3.2 accidents annually with an average of 1.3 injuries. There have been two reported accidents and two injuries along Glenn Street and none reported on Sahuara Avenue during the five year period. There was a single fatality at Grant Road and Sahuara Avenue involving a pedestrian. These statistics appear to be average when compared to other similar nearby intersections and major residential streets.

### **3.11 Public Input**

A public meeting was held on August 27, 2013 to obtain input from residents and land owners adjacent to the project. The meeting began with an overall description of the project elements and was then opened up to questions and comments in the public forum. The Consultant design team and RFCDD management was also available to answer questions one-on-one related to specific elements of the project. Comment forms were distributed to the public and collected for review and consideration by RFCDD staff. A number of design changes were made in direct response to public input and are described below.

- The restroom at the staging area was removed from the design in response to concerns of use by the homeless.
- The number of parking spaces at the staging area was reduced by 50% to limit usage and traffic, and also resulted in a larger buffer between Sahuara Avenue and the paved parking.
- In order to better assess potential project impacts, preliminary traffic counts and accident data were collected for Sahuara Avenue and Glenn Street and their intersections with Grant Road and Craycroft Road. Traffic counts were also collected at the existing Swan Road River Park staging area to provide representative data of what increases might be observed as a result of the Phase III staging area.
- The soil cement alignment adjacent to River Orchard Townhomes was pushed further into the channel to avoid the need for a property take from the common area and to maximize preservation of existing trees on the bank.



**Figure 3.11.1**  
Preliminary Traffic Counts

## 4.0 Alternatives Assessment

The primary objective of the alternatives assessment was to identify conceptual alignments and potential recreational amenities of a new River Park system. Additionally, recommendations for bank protection improvements required to support River Park development and provide erosion protection for adjacent properties were developed. Each of the design alternatives was evaluated within the context of site specific project conditions and constraints including those as presented in Section 3.0. The conditions and characteristics of the Phase III and Phase IV project reaches are markedly different and are discussed individually below.

### 4.1 Phase III Alternatives Assessment

#### 4.1.1 West Bank Pathways and Bank Protection Alternatives

##### 4.1.1.1 General Project Design Conditions

The Phase III limits on the west bank extend from the termination of the Phase II soil cement to the north end of Fort Lowell Park. Most of the west bank within this phase is fully developed with minimal setback from top of the existing bank to private property lines and/or existing parking areas and access lanes. Some level encroachment into the channel will be unavoidable to achieve a River Park corridor of reasonable width. However, there is also the need to minimize encroachment at certain locations where the 100-year flood elevation is near or at the top of bank and loss of conveyance cannot be offset through channel excavation. The horizontal alignment is tightly constrained and any feasible alternative needs to balance accommodating the minimum desired River Park corridor with available right-of-way and allowable channel encroachment.

The use of bank protection along Fort Lowell Park is not being considered due to impacts to existing cultural and biological resources and the impacts to the overall character of the park. Additionally, this reach has not experienced significant lateral bank migration. The maximum northerly extent of potential bank protection would be just north of the River Orchard Townhomes development. It would only encroach into Fort Lowell Park far enough to provide a logical termination which cannot be achieved along the River Orchard Townhomes due to right-of-way constraints. The paved and DG paths would be extended past the bank protection through the remainder of Fort Lowell Park. A preliminary alignment and connections to existing and future paths in the park have been formulated in cooperation with City of Tucson Parks and Recreation staff and will continue to be refined through the formal design process.

##### 4.1.1.2 Preferred Alternative

The preferred alternative for the Phase III west bank is to locate the paved pathway on new soil cement bank protection for the entire reach. This approach is consistent with the previous two upstream project phases which demonstrated similar conditions and constraints. Soil cement has proven to be both durable and low maintenance in the desert environment and provides a suitable surface for paved pathway improvements. The ability to construct at a 1:1 slope minimizes encroachment into the channel as well as the number and size of potential property acquisitions. Soil cement also provides the ability to construct stable access ramps into the channel and a tie-in for potential grade control structures. The conceptual

horizontal alignment for the west bank is shown on Figure 4.1.1, and in more detail on the Concept Plans in Appendix B. Only minor adjustments to the horizontal alignment are anticipated for formal design and should not have a significant impact on project cost. Therefore, additional alignment alternatives have not been evaluated.

Obtaining the minimum desired 100' corridor for this project is not practical given the level of existing development and need to minimize channel encroachment. The minimum recommended River Park corridor along this section includes a 16' paved path placed directly on the soil cement, an 8' DG path directly adjacent to the paved path, and a narrow buffer area (4' to 8') for some landscape plantings to provide some screening for the adjacent properties. Typical sections for the corridor are provided on Figure 4.1.1 and in the Concept Plans in Appendix B. The narrow buffer area will also accommodate the slopes required for any grade transitions between the paths and adjacent existing grade. Where possible, separation should be provided between the paved and DG pathways. This separation will likely occur at only a few discreet locations in the reach extending from the Phase II tie-in to the north side of the Costco property. The remainder of the alignment to the north offers more opportunity for path separation as shown on Figure 4.1.1 and the Concept Plans.

There are two segments of existing soil cement located upstream of Costco. The feasibility of utilizing these existing segments was evaluated as a potential cost savings measure. It was determined that construction of new soil cement in front of the existing segments was the preferred alternative as the existing segments do not provide a sufficient corridor for the River Park without encroachment into adjacent parking areas.

In developing the concept design for the soil cement profile, elevations were initially set approximately 1' above the calculated 100-year water surface elevation consistent with RFCDC criteria for flood protection. Preliminary cross-sections and required grading extents were then reviewed to determine if a reasonable tie-in could be made to existing grade given right-of-way constraints, the proposed River Park design, and regulatory floodplain conditions. Adjustments were then made to the profile to avoid unacceptable grades in the River Park corridor, slopes which require special treatment, or retaining walls.

The preliminary top of soil cement profile for the west bank is shown on the Concept Plans in Appendix B. Of the approximately 6,400 LF of new soil cement on the west bank, 4,450 LF has a top of soil cement elevation of 1' to 3' above the 100-year WSEL. This level of freeboard was considered acceptable for planning purposes but may be evaluated further during formal design. The remaining 1,950 LF is consistently 3' to 6' above the 100-year WSEL and is discussed further below to provide justification for the costs potentially associated with the additional soil cement. The alternatives to raising the soil cement are taking more right-of-way to accommodate the required backslope, or the construction of retaining walls or stabilized slopes along the reach.

There are two discreet reaches with soil cement profiles significantly higher than required for flood control purposes. These are discussed below and referenced to the stationing provided on the Concept Plans. The first reach extends from approximately Sta 78+00 to Sta 85+50 and is adjacent to the Costco property. The concept profile was generally set to match existing grades at proposed right-of-way, which range from approximately 3' to 5' feet above the 100-year WSEL in the reach. The proposed concept profile facilitates the development of the River Park corridor utilizing new soil cement and adjacent existing land to minimize the amount of required fill and encroachment into the channel.

The second reach extends from approximately Sta 102+00 to the point of connection with the Phase II improvements at Sta 114+40. The concept profile was generally set to match grades along existing right-of-way which average 4' to 5' above the 100-year WSEL. Matching these existing elevations allows the River Park corridor in this reach to “straddle” the proposed soil cement prism and adjacent developed bank which minimizes fill and encroachment into the channel. It also facilitates some meandering of the DG path as shown on Figure 4.1.1 and the Concept Plans.

There is a reach which extends from the south bank of Rose Hill Wash at the confluence with Pantano Wash for approximately 500 feet south (Sta 61+50 to Sta 66+50) where the existing bank is lower than the 100-year WSEL. Flow from the Pantano Wash during the regulatory event would break out to the west and be contained by west bank of Rose Hill Wash, as depicted in the effective FEMA mapping for the area (see Figure 3.4.1). The soil cement profile along this reach will likely need to be at or just above existing bank elevations to facilitate grading for the paved pathway and pedestrian bridge, and not create a levee type condition. The design as presented on the Conceptual Plan will not significantly impact the existing regulatory floodplain in this area.

#### **4.1.1.3 Alternative Option #1**

This option consists of construction of the multi-use pathway without construction of bank protection or any form of encroachment into the channel for the entire project reach, or at least for significant segments. The main advantage of this option would be the reduced project costs achieved by not constructing bank protection, assuming they are not completely offset or exceeded by the additional property acquisitions. The feasibility of this option was assessed by first delineating the existing bank and incrementally offsetting the alignment to determine if a potentially suitable corridor exists. It was immediately evident that with the exception of short discreet reaches there is not sufficient distance between the bank and existing development (i.e. parking areas, access lanes, perimeter walls) to develop even a narrow corridor for just a paved pathway. No further consideration should be given to this alternative.

#### **4.1.1.4 Alternative Option #2**

This option consists of channel encroachment to create the River Park corridor utilizing the same top of bank alignment as the preferred alternative. However, stabilization of the resulting bank slopes would be accomplished with riprap bank protection. Depending on the flow depths, flow velocities, riprap sizing and overall required quantities, this approach can be more cost effective than utilizing soil cement.

Dumped riprap is generally placed on a 3:1 slope or flatter for stability. This would result in significantly greater encroachment into the channel when compared to the typical 1:1 slope used for soil cement bank protection. Based on an average bank height of 15' there would be an additional 30' of encroachment along the length of the project. There are significant reaches along the Phase III limits where the increases in WSELs due to the additional encroachment could be problematic, such as along the Costco property.

The required  $D_{50}$  for the riprap is 18” to 30” based on City of Tucson sizing methodology and 100-year flow velocities. It is typically difficult to find the required angular rock at this size and at the quantities required for this project (~12,600 CY). Unit cost data for large riprap available from the Arizona and Texas transportation departments indicate a unit cost of approximately \$85/CY. This equates to a per foot cost of approximately \$239/LF given an average bank height of 15' and a 4' toe-down depth. This cost is significantly more than the estimated \$150/LF for soil cement under similar conditions. It is recommended

that this alternative not be given further consideration due to the project impacts, cost differential with soil cement, and potential difficulty in obtaining the riprap in the size and quantities required for this project.

### **4.1.2 East Bank Pathways and Bank Protection Alternatives**

#### **4.1.2.1 General Project Design Conditions**

Phase III extends north from the termination of the Phase II limits for approximately 2700 feet. It terminates at a point adjacent to Costco where the channel abruptly widens to the east and the nearly vertical bank transition into flatter slopes. Conditions on the east bank in Phase III are significantly different than the west bank in that development consists of low density residential and there are no inhabitable structures or improvements directly adjacent to the banks. There is existing soil cement on the east bank extending approximately 2000' north from Tanque Verde Road which includes the Pantano Wash Phase II improvements that tie into a section of bank protection associated with the Tucson County Club.

The east bank of the wash is unprotected and nearly vertical north of the existing soil cement to the end of the proposed Phase III improvements. It is recommended this reach be protected for approximately 1300' north to the end of the Phase III limits. Although excessive lateral bank migration has not been observed in this reach, there is evidence of some erosion, and the potential for reflective scour due to construction of soil cement on the adjacent west bank could be increased resulting in accelerated bank loss. Reflective scour should not be an issue on the east bank past the end of the Phase III improvements. The much wider channel and the shallow floodplain adjacent to the unprotected bank will dissipate erosive energy and result in much lower flow velocities.

#### **4.1.2.2 Preferred Alternative**

The recommended alternative for Phase III east bank consists of extending the existing soil cement 1300' to the end of the Phase III limits. Paved pathway would then be extended directly on top of the existing and new soil cement from the termination of the Phase II pathway. As with the west bank, the horizontal alignment is constrained by the need to balance encroachment into the channel, with establishing the minimum desired River Park corridor and minimizing adjacent property acquisitions. The use of soil cement along the currently unprotected segment best meets these goals. The horizontal alignment of both the existing and proposed soil cement is shown on Figure 4.1.1, and in more detail on the Concept Plans in Appendix B. Examination of this reach has revealed that obtaining the typically desired 100' River Park corridor is not practical in this reach due to excessive impacts to existing properties. A reduced width of 50' appears to be practical and result in minimum impacts to property owners. Acquisitions will be required from the rear portion of the residential properties along the entire proposed pathway extension. The acquisitions generally range from 20' to 25' in width to and appear to be outside of rear property walls, or beyond the “actively” utilized portions of the impacted parcels.

The recommended River Park corridor along this reach includes a 12' paved path placed directly on the soil cement, 16' landscape area, 8' DG path, and a narrow buffer (4' to 8') for additional landscape plantings inside the proposed right-of-way to provide visual screening for the adjacent residential properties. Typical sections showing the proposed River Park corridor are provided on Figure 4.1.1 for both the existing and proposed soil cement scenarios. The 16' landscape area could be reduced where needed to provide a larger buffer area to accommodate slope transitions to existing adjacent grade. The typical paved path width of

16' has been reduced to 12' to minimize the overall area required for acquisition. The use of a 16' path is not considered necessary for this relatively short dead end segment. The 12' width matches the existing pathway width upstream of Tanque Verde Road and is not anticipated to experience a high volume bicycle traffic given the nature of connectivity to the west bank at the termination of the paved path.

The top of soil cement profile along this reach was initially set to approximately 1' above the 100-year WSEL, consistent with RFCD criteria for flood control improvements. Review of preliminary cross-sections and grading limits indicated raising the overall profile to be 2' to 3' feet above the 100-year WSEL provided a much more favorable transition to existing grade at right-of-way, and appears to be justified given the limited width of the River Park corridor and relatively minimal increase in construction cost of approximately \$27,000. The preliminary profile for the east bank is shown on the Concept Plans in Appendix B.

As discussed in Section 2.1.2, the project will include a natural surface trail which extends from the termination of the Phase III paved path on the east bank north to a point of connection to the proposed paved path adjacent to Fort Lowell Park (See Figure 4.1.1). The precise alignment for the single-track path is very flexible and will be adjusted based on field conditions to avoid key vegetation and low flow channels within the overall wash extents. Properties acquisitions will be required from Unisource and a single adjacent private parcel to ensure the path is located within public right-of-way and outside of the main low-flow channel of the wash.

#### **4.1.2.3 Alternative Option #1**

An alternative River Park corridor for the east bank has been evaluated in the event that property acquisitions along the corridor become too costly or time consuming. The alternative follows the same paved path and soil cement alignment, but consists of only the paved path directly on the soil cement and an approximately 4' buffer to existing right-of-way. This alternative can be constructed with limited property acquisitions and temporary construction easements to address slope modifications. It does not allow for significant landscape buffer, decomposed pathway and other river park improvements that enhance the value of the river park experience.

#### **4.1.3 Phase III Recreational Amenities**

RFCD wishes to have at least one main staging area for the project which includes parking, seating areas and equestrian facilities. A review of existing land ownership, parcel size, public access, utilities and other site conditions indicates the most likely location for the main staging area is at an existing Pima County owned parcel located at Glenn Street and Sahuara Avenue. A preliminary layout for the staging area is presented in the Concept Plans in Appendix B. The usable area within the parcel is approximately 2.5 acres which is adequate for the intended use. There are additional areas on the west bank which may be suitable for other recreational amenities and are shown on the Public Facilities Master Plan in Appendix A. These may include a seating area adjacent to Costco, informational displays and seating area at Fort Lowell Park, and public art features. There will likely not be any staging areas or significant amenities recommended for the east bank pathway due to limited right-of-way.

#### **4.1.4 Rose Hill Wash Crossing**

Two alternatives were evaluated for the crossing of Rose Hill Wash at the confluence with Pantano Wash. The first alternative consists of a new 6-10'x7' RCBC extending through the new soil cement. The soil cement would be formed around the box and a new headwall utilized on both ends. Construction of the box would be complicated as a result of the large skew angle between the soil cement and RCBC, as well as modification to the existing Rose Hill Wash concrete lined channel to provide transitions to the RCBC headwalls. The second alternative consists of a 12' wide pedestrian bridge that would be placed across the Rose Hill Wash lined channel. The bridge would be clear span with an approximate length of 85 feet. The soil cement at the end of the lined channel would be "wrapped" to match the existing vertical concrete walls. The overall width of the channel at the confluence would remain unchanged resulting in no adverse hydraulic impacts. A concept layout of the bridge is provided on the Concept Plans in Appendix B.

A preliminary estimate developed by Structural Concepts indicates the cost of the bridge at approximately \$130,000. The estimated cost for the RCBC based on recent contractor bids on similar work is \$165,000. In addition to overall costs, additional advantages to the pedestrian bridge include aesthetics and hydraulics.

### **4.2 Phase IV Alternatives Assessment**

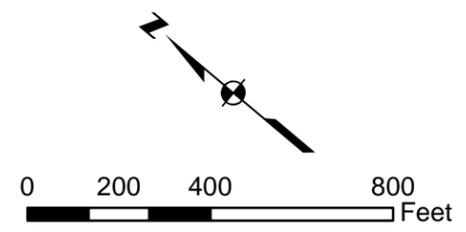
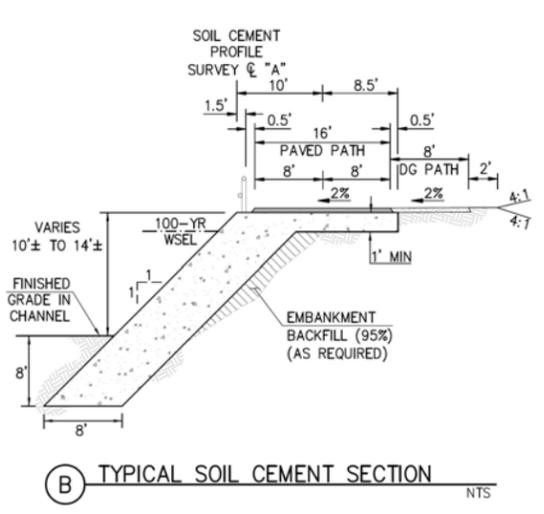
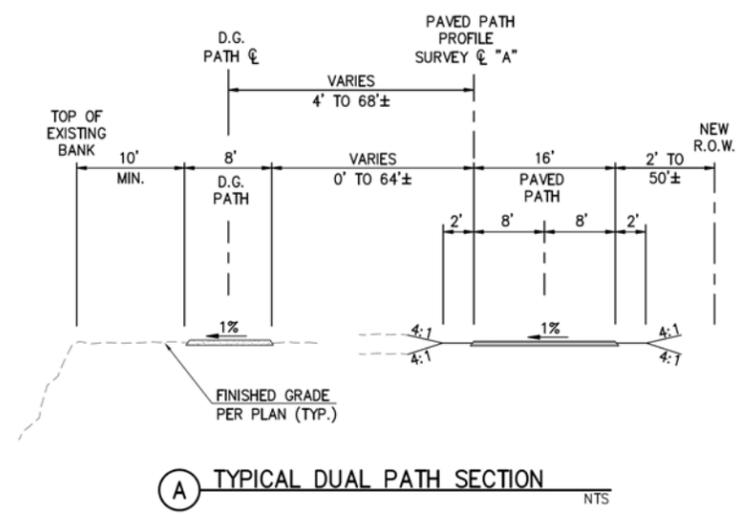
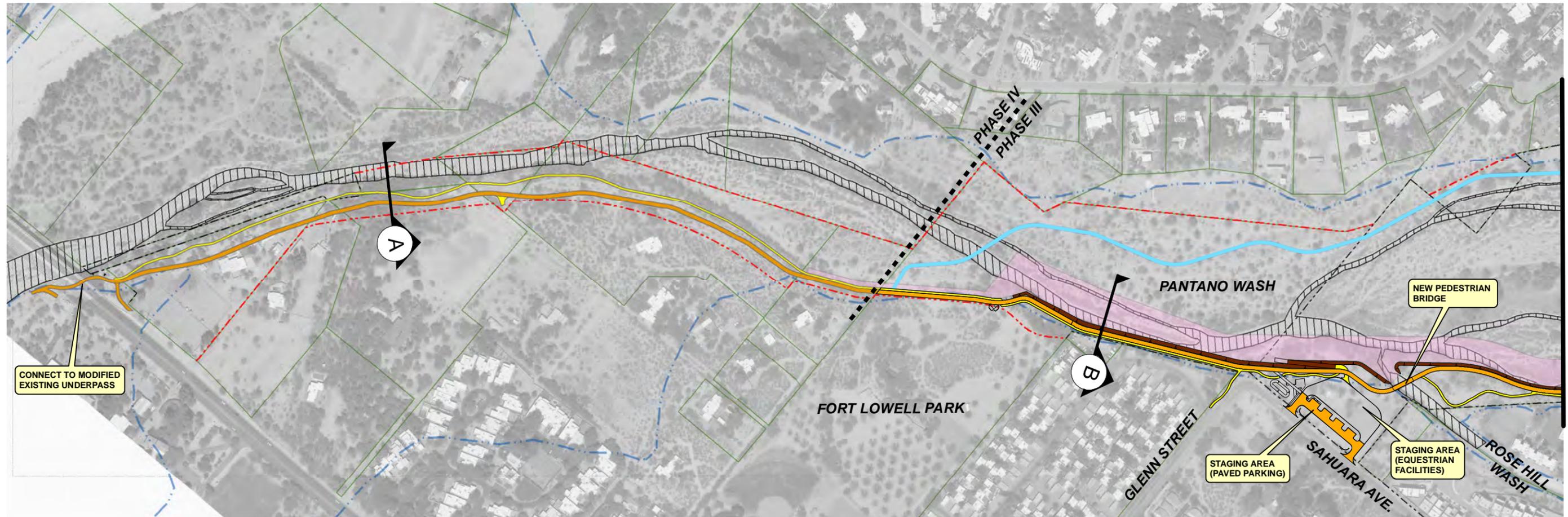
#### **4.2.1 Pathways and Bank Protection Alternatives**

##### **4.2.1.1 General Project Design Conditions**

The Phase IV project limits extend from the north property line of Fort Lowell Park to the existing underpass and paved pathways at Craycroft Road. Existing development within Phase IV is sparse, rural residential in nature (1 to 4 acre lots), and generally homes and outbuildings are not located immediately adjacent to the bank. Numerous acquisitions from private land owners will be required regardless of the alternative selected.

JE Fuller completed an assessment of historic channel bank migration in the project reach. The results of this assessment indicate that the west bank has been stable since at least 1953. The east bank has experienced some localized erosion which was first noticeable in 1998 but is occurring adjacent to completely undeveloped land located in a FEMA floodplain. The general stability of the banks in the Phase IV reach appears to be largely due to the existing heavy vegetation, which would be preserved as part of the preferred alternative as discussed below. The preservation of existing vegetation is also a significant asset to the overall river park experience and provides the reach with a more natural feel.

Based on the above assessment, the use of bank protection for the protection of private property does not appear to be warranted in this reach. Additionally, construction of bank protection within the Phase IV limits would have extensive impacts on existing biological resources, resulting in the need for costly mitigation measures related to local riparian mitigation ordinances and Corps of Engineers 404 permitting requirements. Impacts to cultural resources could also be significant and require costly data recovery and mitigation. The reaction of the general public to the loss of this prime riparian habitat would also likely be negative.



**LEGEND**

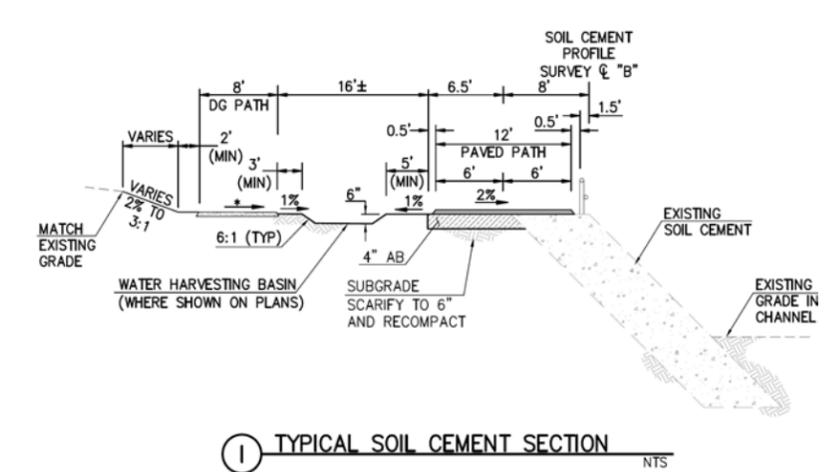
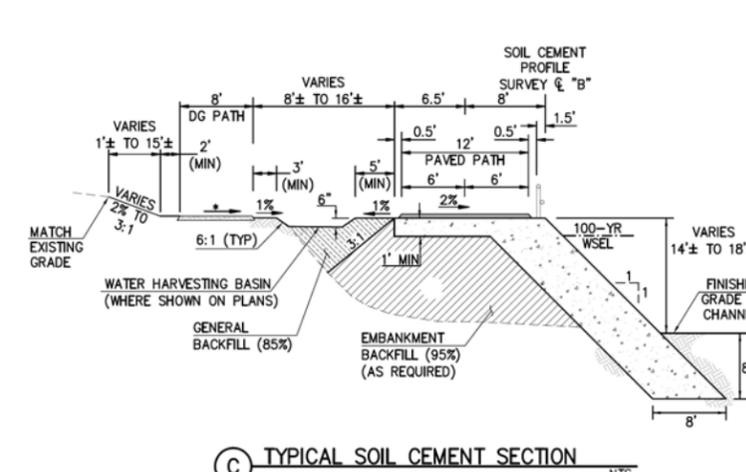
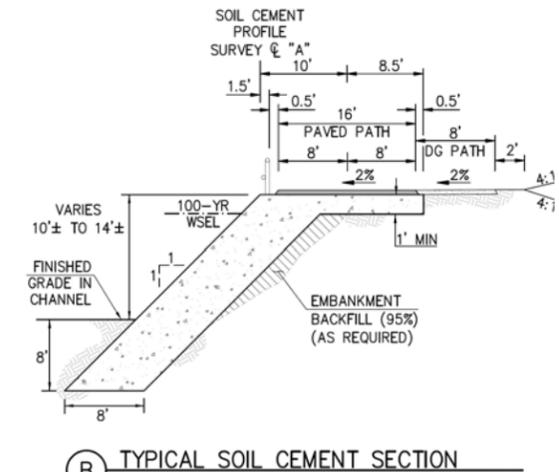
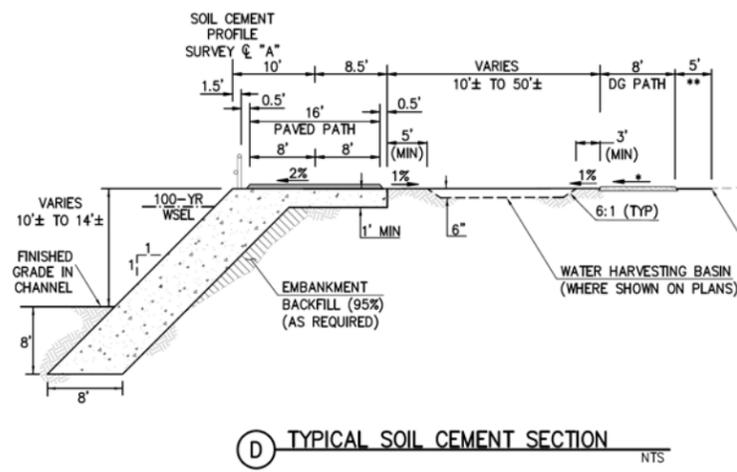
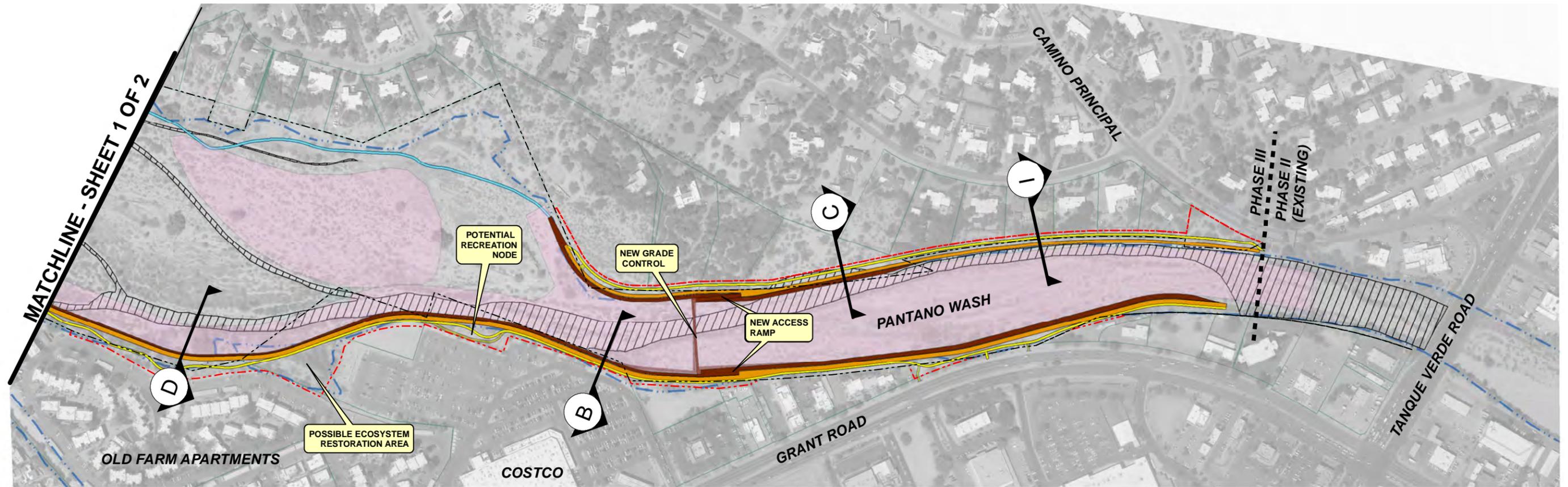
- EXISTING ROW
- - - NEW ROW
- ▨ PROPOSED PJD LIMITS
- PARCEL LINES
- 100-YEAR FLOODPLAIN (FEMA)
- NEW DG PATH OR SHOULDER
- NEW PAVED PATH
- NEW SOIL CEMENT
- NATURAL SURFACE PATH
- ESTIMATED LIMITS OF CHANNEL DISTURBANCE

**NOTES**

**Pantano Wash Bank Protection and River Park - Phase 3 & 4**

**FIGURE 4.1.1  
PREFERRED ALTERNATIVE  
PHASE III & IV  
(SHEET 1 OF 2)**

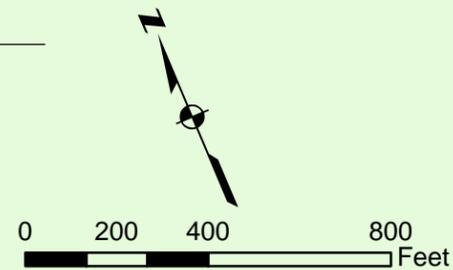
Pima County Regional Flood Control District  
PSOMAS



### LEGEND

- EXISTING ROW
- - - NEW ROW
- ▨ PROPOSED PJD LIMITS
- · - · 100-YEAR FLOODPLAIN (FEMA)
- PARCEL LINES
- NEW DG PATH OR SHOULDER
- NEW PAVED PATH
- NEW SOIL CEMENT
- NATURAL SURFACE PATH
- ESTIMATED LIMITS OF CHANNEL DISTURBANCE

### NOTES



### Pantano Wash Bank Protection and River Park - Phase 3 & 4

#### FIGURE 4.1.1 PREFERRED ALTERNATIVE PHASE III & IV (SHEET 2 OF 2)

Pima County Regional Flood Control District  
PSOMAS

#### **4.2.1.2 Preferred Alternative**

The preferred approach for this reach is to allow the banks to remain in their current state (i.e. no bank protection) and utilize property acquisitions to obtain a 100' foot River Park corridor from the top of existing bank. This width is consistent with new Pima County NRPR minimum requirement for River Parks. The acquisitions would also include the channel portion of any given parcel. The 100' width would allow for adequate setback from the existing bank and for some meandering of the paved and DG pathways. It would also allow for more flexibility in preserving existing biological resources along the top of bank which is beneficial to the overall River Park experience. Disturbance within the adjacent channel would be minimal with little or no impact on the existing high value biological resources, including the important Sonoran Riparian Scrub community discussed in Section 3.6.2. A graphical depiction of this option is shown on Figure 4.2.1 (Sheet 1 of 2). Minimization of impacts to both existing biological and cultural resources is a major goal of the preferred alternative.

#### **4.2.1.3 Alternative Option #1**

This option would include property acquisitions that result in the narrowest width needed to place a paved path with a DG shoulder adjacent to the bank. Acquisitions would also include the channel portion of any given parcel. A minimum offset of 10' from top of bank to the outside edge of the paved or DG path has been assumed, as well as a 5' buffer from the edge of the innermost pathway to the new right-of-way. This results in an overall corridor width of 39' (see Figure 4.2.1). The primary disadvantages of this alternative are the increased risk to the paved path from relatively minor bank migration and the limited ability to meander the paths around some of the more high value vegetation and fully utilize potential shade provided to path users by the larger trees. More bank vegetation will likely need to be removed to accommodate the path than with the preferred alternative. It is also not preferred as it does not meet current Pima County guidelines for a standard width of a River Park. The narrow width will also make it difficult to incorporate any additional River Park amenities or include additional plantings into the design. Impacts to the adjacent channel and associated biological resources, including the high value Sonoran Riparian Scrub community would be minimal to none.

#### **4.2.1.4 Alternative Option #2**

This option would involve the construction of soil cement on both banks to the extents shown on Figure 4.1.3 and assumes property acquisitions are the minimum required to construct soil cement, place a paved path, adjacent DG shoulder, and a 5' buffer to new right-of-way line. The primary advantage to this alternative is that the path can be permanently stabilized. The estimated additional cost of soil cement is \$3.0 million more than the preferred alternative. The main disadvantage to the alternative (beyond the increased cost) is the significant impacts to existing and high value biological resources within the channel and on the banks, including the Sonoran Riparian Scrub community. The estimated extents of impact to the channel are shown on Figure 4.2.2.

An additional issue on the west bank for this alternative is the likely public expectation that the improvements described above would remove adjacent residences from the regulatory floodplain. However, this is not the case, and significantly more money would be required to construct a project that meets this goal. Soil cement constructed to the 100-year flood elevation would essentially "formalize" the levee situation that currently exists along much of the east bank via an existing earthen berm. Removal of properties from the floodplain based on the new soil cement would be subject to FEMA requirements,

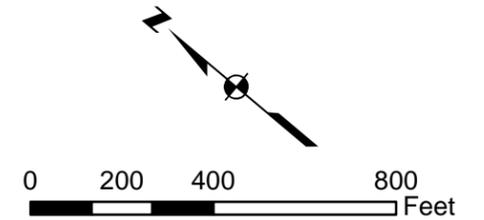
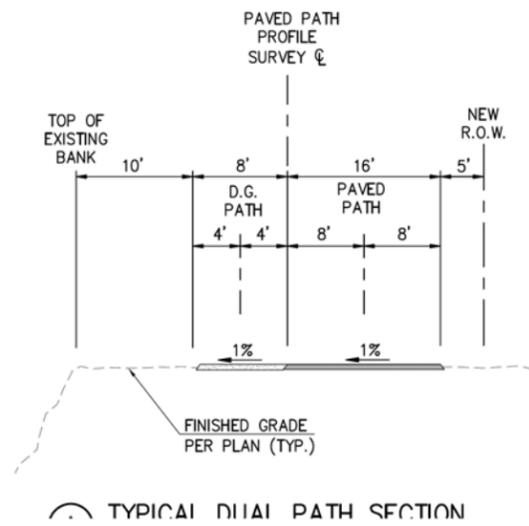
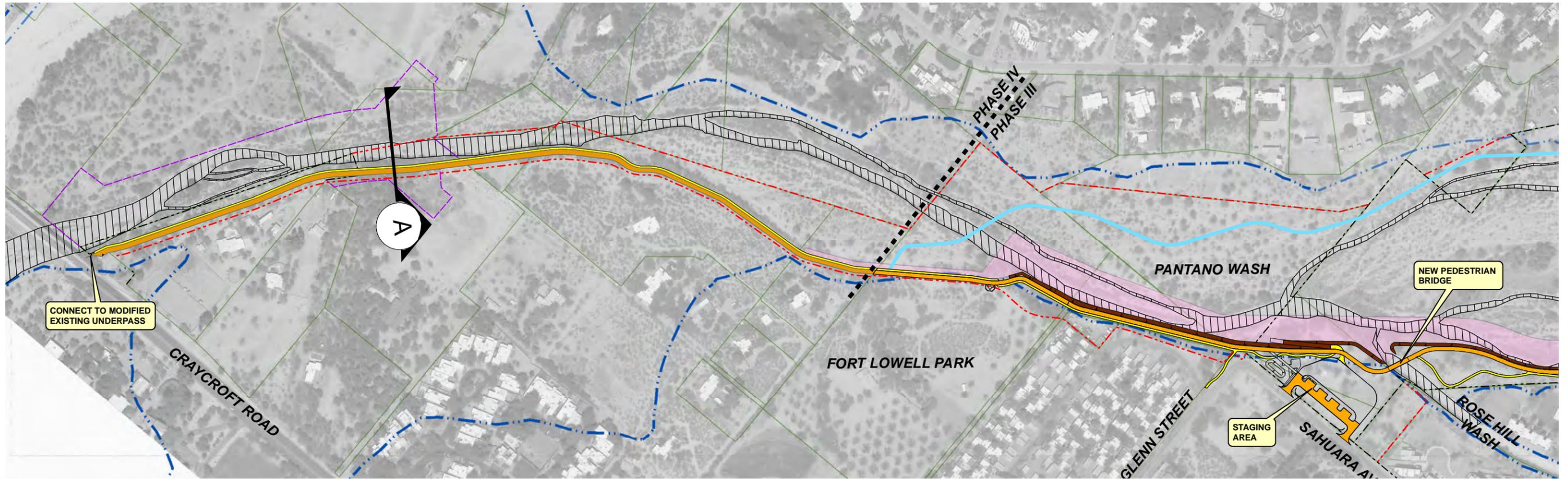
including a minimum of three feet of freeboard above the 100-year WSEL. The soil cement would also need to extend upstream to nearly the north boundary of Fort Lowell Park to prevent all potential breakout into the adjacent floodplain. The estimated additional cost to meet FEMA requirements is \$650K, for a total cost of \$3.65 million dollars. Removal of adjacent properties from the regulatory floodplain via a levee and bank protection system will likely not be considered cost effective given the small number of parcels (8) that would directly benefit from the improvements.

#### **4.2.1.5 Alternative Option #3**

This option involves the use of riprap to stabilize the channel banks as opposed to soil cement. The disadvantages associated with this alternative are similar to those discussed for Phase III with respect to additional channel encroachment, and the potential cost and lack of available materials. The issue of encroachment is even more critical in Phase IV, given the channel is as narrow as 160' feet in some locations. The use of 3:1 slopes to place the riprap would result in a significant loss of conveyance and rise in water surface elevations in an area which is already subject to flooding during the design event. It is recommended that this alternative be given no further consideration.

### **4.2.2 Recreational Amenities**

The nature and extent of recreational amenities along Phase IV from the north side of Fort Lowell Park to Craycroft Road will depend largely on the amount of right-of-way RFGD is able to acquire, but will likely be limited to benches, seatwalls, and possibly some fitness related features along the pathway. The underpass at Craycroft Road will be enhanced to comply with ADA requirements. Ramadas or other more structural features will likely not be included within Phase IV.



**LEGEND**

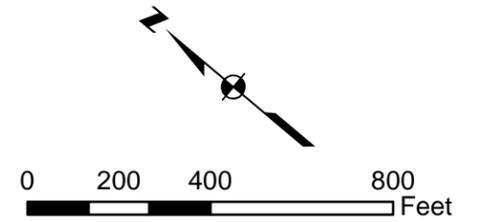
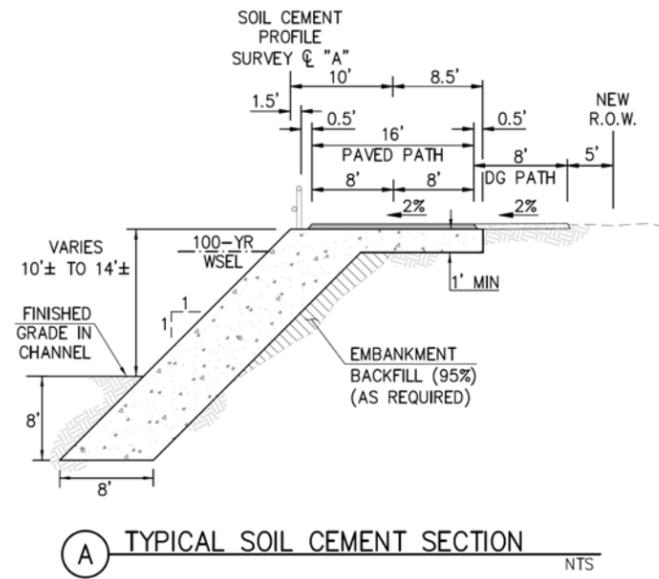
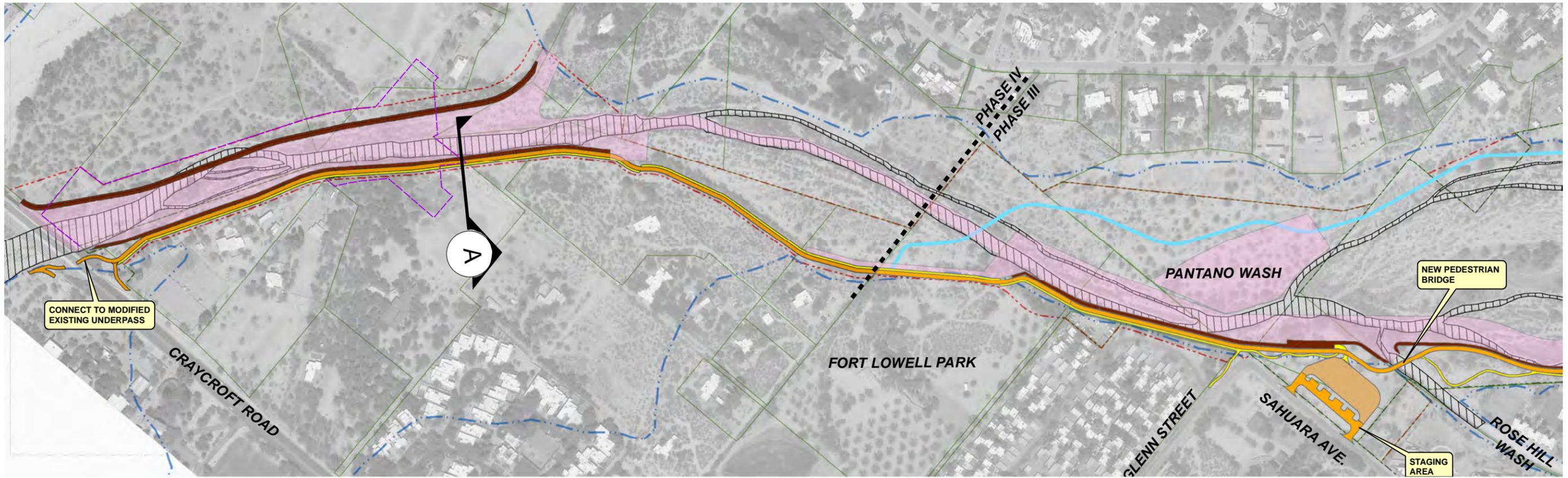
- |                           |   |
|---------------------------|---|
| --- EXST. RFCD EASEMENT   | ▨ PROPOSED PJD LIMITS                     |
| ■ NEW DG PATH OR SHOULDER | ▭ PARCEL LINES                            |
| ■ NEW PAVED PATH          | --- 100-YEAR FLOODPLAIN (FEMA)            |
| ■ NEW SOIL CEMENT         | --- NEW ROW                               |
| ■ NATURAL SURFACE PATH    | --- EXSTING ROW                           |
|                           | ■ ESTIMATED LIMITS OF CHANNEL DISTURBANCE |

**NOTES**

**Pantano Wash Bank Protection and River Park - Phase 3 & 4**

**FIGURE 4.1.2  
ALTERNATIVE OPTION #1  
(PHASE IV)**

Pima County Regional Flood Control District  
PSOMAS



**LEGEND**

- EXST. RFCD EASEMENT
- NEW DG PATH OR SHOULDER
- NEW PAVED PATH
- NEW SOIL CEMENT
- NATURAL SURFACE PATH
- PROPOSED PJD LIMITS
- PARCEL LINES
- 100-YEAR FLOODPLAIN (FEMA)
- NEW ROW
- EXSTING ROW
- ESTIMATED LIMITS OF CHANNEL DISTURBANCE

**NOTES**

**Pantano Wash Bank Protection and River Park - Phase 3 & 4**

**FIGURE 4.1.3  
ALTERNATIVE OPTION #2  
(PHASE IV)**

## 5.0 Opinion of Probable Construction Costs

A preliminary opinion of probable construction cost was developed for the preferred project concept design as well as for the design alternatives discussed in Section 4.0. Accurate estimation of project construction costs is important in assessing the economic feasibility of a project as well as individual elements in a project and assists in developing priorities for the elements. The methods and assumptions used to derive preliminary project costs are provided in the following sections as well as a summarized cost estimate for each alternative. Detailed cost estimates by construction bid item are provided in Appendix G.

### 5.1 Derivation of Unit Costs

Contractor bid tabulations for several recently constructed Projects were utilized in the derivation of unit cost for the proposed Project. A list of reference Projects is provided in the table below. It is important to note that costs can vary significantly over time due to economic conditions and cost of materials.

**Table 5.1.1  
Summary of Unit Cost Reference Projects**

| Project  | Description  | Bid Date | Total Construction Cost |
|--|--|----------|-------------------------|
| <i>Paseo de las Iglesias Phase I</i>                       | Soil Cement Bank Protection, Linear Pathway and Landscaping, Ecosystem Restoration, Staging Area | 9/2013   | \$9.3M                  |
| <i>Pantano Wash Permanent Bank Stabilization, Phase II</i> | Soil Cement Bank Protection, Linear Pathway and Landscaping                                      | 10/2011  | \$3.1M                  |
| <i>Pantano Wash Permanent Bank Stabilization, Phase I</i>  | Soil Cement Bank Protection, Linear Pathway and Landscaping                                      | 10/2009  | \$3.0M                  |

### 5.2 Derivation of Probable Construction Costs

Estimated total construction costs by project phase as well as for Phase IV alternatives is provided in Table 5.2.1. Bid item quantities of were derived from the Concept Design Plans in Appendix B. Quantities for Phase IV project alternatives were derived from a conceptual level design effort for which formal concept design plans were not prepared. A preliminary breakdown of costs by bid item is provided in Appendix G.

#### Flood Control Improvement Assumptions

The preliminary cost estimate for flood control elements was prepared with the following assumptions:

- Soil cement quantities for Phase III were based on preliminary extents, profiles and required toe-down depths discussed in Section 4.0. In most cases the top of soil cement profile was set at 1' above the 100-year water surface elevation. At some locations the profile was set higher to better

match adjacent existing grade, and more specifically, where there is limited space between the back of the soil cement and ultimate right-of-way.

- Soil cement quantities for Phase IV – Alternative 2 were estimated using preliminary profiles and toe-down depth as with Phase III, although no Concept Design Plans were prepared.
- All material required for embankment and general backfill, as well as soil cement production will be obtained from within the project area.
- Tributary drainages will be managed through in-kind pipe extensions, new culverts sized for the Q<sub>100</sub>, scuppers and other appropriate measures.

#### River Park and Recreational Assumptions

The preliminary cost estimate for River Park and recreational features was prepared with the following assumptions:

- Pathways will be designed and constructed in accordance with standards that have been adopted by Pima County for river park development as they relate to pavement type, pathway width, pavement section, etc.
- One principal staging area which includes a lighted parking area will be developed on the west bank at Glenn Street to serve the Project. Additional points of entry and recreational nodes may be located per the Public Facilities Master Plan presented in Section 2.0.
- The plantings and irrigation associated with the recreational element are based on the preliminary landscape plans provided in Appendix B.
- The project will utilize reclaimed water for irrigation and the use of control systems with water management capabilities will be in accordance with policies and procedures established by the RFCD and the Pima County Natural Resources, Parks and Recreation Department.
- The use of post-and-cable barriers, pipe-rails, gates, fences, and screen walls are in accordance with safety and site security standards adopted by Pima County for River Park Development.

#### Ecosystem Protection and Enhancement

- Impacts to high value resources within the channel will be minimal based on the preferred alternative of no soil cement within the Phase IV limits.
- Ecosystem enhancement will include restoration of the area just downstream of the Costco drainage outlet and at a few other discreet locations within the project limits but will not be extensive.

Estimated costs for right-of-way acquisition have been included based on the anticipated acquisitions as reflected on Figure 3.1.2, and adjusted as needed for the other remaining alternatives. The estimate was further broken down based on the portion of each proposed take which was included a breakdown of areas within and outside the regulatory floodplain and floodway limits.

### **5.3 Project Funding**

Funding for both phases is planned to be from the Flood Control Tax Levee fund. The Phase III charter was set at approximately \$6.4M and the Phase IV at \$4.4M. This included the assumption of soil cement in both phases. As shown in Table 5.3.1, the Preliminary Opinion of Probable Cost indicates both phases can be constructed within the project charter limits based on original project assumptions. Phase IV may be significantly less than the charter limit in the event soil cement is not included. This estimate is preliminary and there could be significant unforeseen costs, such as additional ROW acquisitions, which reduce the overall amount available for construction.

**Table 5.3.1  
Summary of Opinion of Probable Costs**

| Priority/Category             | General Description  | Preliminary Cost Estimate |
|-------------------------------|--|---------------------------|
| Phase III – Preferred Concept | <ul style="list-style-type: none"> <li>● West bank soil cement from end of Phase II to south boundary of Fort Lowell Park</li> <li>● East bank soil cement from end of existing soil cement adjacent to Tucson Country Club</li> <li>● Paved pathways along top of soil cement with adjacent DG shoulders or pathway where possible</li> <li>● Limited pathway landscaping and irrigation</li> <li>● Staging Area with parking area and ramada on West Bank at Glenn Street</li> <li>● Miscellaneous recreational amenities per the Public Facilities Master Plan</li> </ul> | \$5,556,000               |
| Phase IV – Preferred Concept  | <ul style="list-style-type: none"> <li>● Acquisition of 100 foot wide recreational corridor on West Bank from just north of Fort Lowell Park to Craycroft Road</li> <li>● No soil cement bank protection</li> <li>● Meandering paved and DG pathways along West Bank with connection to existing underpass at Craycroft Road</li> <li>● Path alignment set to minimize loss of existing high-value vegetation</li> <li>● Pathway Landscaping and Irrigation</li> <li>● Miscellaneous recreational amenities per the Public Facilities Master Plan</li> </ul>                 | \$846,000                 |
| Phase IV –Alternative I       | <ul style="list-style-type: none"> <li>● Acquisition of minimum corridor required on West Bank to accommodate paved pathway and adjacent DG shoulder</li> <li>● No soil cement bank protection</li> <li>● Minimal Pathway landscaping and irrigation</li> <li>● Minimal recreational amenities</li> </ul>  | \$605,000                 |
| Phase IV –Alternative II      | <ul style="list-style-type: none"> <li>● Soil cement bank protection on both banks</li> <li>● Acquisition of minimum corridor required on West Bank to accommodate soil cement, paved pathway and adjacent DG shoulder</li> <li>● Path alignment set with minimum setback from existing bank and without consideration of existing vegetation</li> <li>● Pathway landscaping and irrigation</li> <li>● Extensive impacts to existing vegetation due to soil cement construction</li> <li>● Minimal recreational amenities</li> </ul>   | \$3,010,000               |