

RAINBOW VALLEY

Area Drainage Master Plan

Contract FCD 2006C029

Proposed Alternatives Analysis Report



Submitted to



Submitted by

URS

in cooperation with



June 2011

Proposed Alternatives Analysis Report

for the

Rainbow Valley Area Drainage Master Plan Maricopa County, Arizona

Prepared for the
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Disclaimer

In preparing this report, URS Corporation has used background information that was compiled by prior studies in the project vicinity. URS Corporation has relied on this information as furnished and is neither responsible for nor has confirmed the accuracy of this information.

The Proposed Alternatives Analysis Report is not to be used as the basis for final design, construction, or remedial action; or as a basis for major capital decisions.

June 2011

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Rainbow Valley Area Drainage Master Plan:

Proposed Alternatives Analysis Report

April 2010



BACKGROUND

It was determined that the DDMSW software incorrectly adjusts the XKSAT values for vegetated cover through the course of validating the HEC-1 loss parameters, developed with the DDMSW software. The program failed to adjust XKSAT values of 0.4 or greater corresponding to a classification of sandy loam. The correct procedure includes not adjusting XKSAT values for vegetated cover with values of 1.2 or greater corresponding to a soil texture classification of loamy sand and sand. The vegetated cover adjustment for the XKSAT parameter was revised using a separate spreadsheet and the adjusted XKSAT values were manually entered into the DDMSW program as custom values. Peak discharges calculated for Alternative 5 were updated due to this correction in the XKSAT values. The results of the updated hydrologic analysis for Alternative 5 are provided in Table 4-7.

Section 4.8.3. Replace Table 4-7 on page 4-28 with the following table.

4.8.3 Flood Hazard Protection

Table 4-7 Waterman Wash Flow Summary – Proposed Alternative 5

HEC-1 Location along Waterman Wash	Distance ¹ (miles)	Existing Conditions (cfs)	Future Conditions (cfs)	Alternative 5 (cfs)
F33RIV	25.9	1,332	411	390
E49RIV	24.4	2,762	2,045	1,976
D29RIV	20.7	5,960	4,413	4,286
D40RIV	17.2	5,789	3,915	5,437
B15RIV	15.4	8,876	7,138	7,638
B62RIV	11.0	10,842	8,510	9,233
H86RIV	10.1	10,871	8,490	9,290
A42RIV	8.7	10,953	8,609	9,334
I37RIV	7.1	10,966	8,577	9,283
A51RIV	4.2	11,154	8,694	9259
A62RIV (confluence with Gila River)	0.4	11,290	8,793	9343

Note: All models are the 100-year 24-hour with railroad models

¹ Distance upstream from the Waterman Wash confluence with the Gila River

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LIST OF ACRONYMS AND ABBREVIATIONS

ADMP	Area Drainage Master Plan
ADOT	Arizona Department of Transportation
ADWR	Arizona Department of Water Resources
AGFD	Arizona Game and Fish Department
APS	Arizona Public Service Company
ASLD	Arizona State Land Department
BLM	U.S. Bureau of Land Management
cfs	cubic feet per second
CIP	Capital Improvement Program
CSFHPM	Context Sensitive Flood Hazard Planning Model
District	Flood Control District of Maricopa County
EEC	Engineering and Environmental Consultants
FEMA	Federal Emergency Management Agency
I-8	Interstate 8
IGA	Intergovernmental Agreement
MCDOT	Maricopa County Department of Transportation
NOAA	National Oceanic and Atmospheric Administration
OHV	off-highway vehicle
PIR	Phoenix International Raceway
SR	State Route
UPRR	Union Pacific Railroad
URS	URS Corporation
VA	Value Analysis



1.0 INTRODUCTION

1.1 PURPOSE

This Proposed Alternatives Analysis Report has been prepared for the Flood Control District of Maricopa County (District) as part of the Rainbow Valley Area Drainage Master Plan (ADMP). The Rainbow Valley ADMP study area is shown on Figure 1-1 and described in the following section. The existing conditions and planning influences within the study area, as well as the overall project goals and performance objectives, are presented in the *Data Collection Report* prepared under separate cover. Using the *Data Collection Report*, a family of resource opportunities and constraints maps was developed to aid in the identification of alternative flood control plans to address the identified drainage issues within the study area. The Preliminary Alternatives Formulation Meeting was held with the agency stakeholders on April 29, 2009, to present the results of the data collection effort and to brainstorm flood control alternatives within the study area. A key objective of the process was to identify context sensitive alternatives that would provide added value to the community beyond the basic flood control function. Added value was identified through multipurpose facilities that provide recreation and aesthetics opportunities as well as addressing cultural and biological factors. The purpose of this report is to present the results of the brainstorming meeting and the development and evaluation of six proposed alternatives which are based on the potential alternatives generated at the brainstorming meeting as well as several seed alternatives generated by the District and consultant team. This report further describes the selection of a preferred alternative at the Proposed Alternatives Evaluation Meeting. The preferred alternative was then reviewed in a Value Analysis (VA) process to identify value enhancement opportunities before moving forward with development of the recommended plan. The preferred alternative as modified by the VA recommendations will be further developed in the forthcoming Recommended Design Report.

1.2 STUDY AREA

The Rainbow Valley ADMP study area is comprised of the Waterman Wash watershed, a portion of the Vekol Wash watershed, and adjacent land north and east of the Waterman Wash watershed that has not previously been studied by the District. The study area is bounded to the north by the Gila River, to the south by the North Maricopa Mountains and Interstate 8 (I-8), to the east by the Sierra Estrellas, and to the west by the North Maricopa Mountains. The study area is within the area bounded by approximately Township 1 South to Township 7 South and Range 3 West to Range 2 East. The study area covers approximately 515 square miles and includes unincorporated Maricopa County, City of Goodyear, City of Avondale, City of Maricopa, and Town of Buckeye. Significant portions of the study area are controlled by the U.S. Bureau of Land Management (BLM), Arizona State Land Department (ASLD), Maricopa County, and the Gila River Indian Community.

The Sonoran Desert National Monument is located in the southwestern portion of the study area, and the Union Pacific Railroad (UPRR) divides the southernmost portion of the study area from the north. Waterman Wash flows south to north and confluences with the Gila River in the Town of Buckeye (approximately Section 12/13, Township 1 South, Range 3 West). The Vekol Valley watershed was initially included in the southern portion of the study area to determine whether there was any inter-basin flow to Waterman Wash. Early in the study, it was determined that the flow from the Vekol Valley watershed, if any, does not significantly contribute to the flood flows

of the Waterman Wash and its tributaries during the 100-year storm event. Therefore, ADMP development did not extend to Vekol Valley. The study area, along with jurisdictions and surface management within the study area, are shown on Figure 1-1.

1.3 STAKEHOLDER COORDINATION

Agency stakeholders have been defined as those stakeholders with political or land management jurisdiction within the study area. These stakeholders have regulatory authority and will likely be involved with implementation or enforcement of the recommended plan. Private stakeholders include interested members of the public and large landowners, such as developers, that own 160 acres or more within the study area.

Stakeholder involvement was initiated with the Agency Stakeholder Kickoff Meeting on June 12, 2008. The meeting was conducted in a workshop format and included a presentation of the project scope of work as well as a facilitated discussion of stakeholder issues, concerns, and goals for the project. The input received at the meeting was grouped into project goals with supporting objectives that would guide the plan development throughout the project. Following the kickoff meeting, individual meetings were held with agency and private stakeholders to supplement data collection and further identify issues and concerns.

The *Data Collection Report* was distributed to the agency stakeholders for their review in preparation for the Preliminary Alternatives Formulation Meeting, which was held on April 29, 2009. At this meeting, the stakeholders were invited to brainstorm alternative flood mitigation strategies and solutions to be applied within the study area. The ideas generated in the brainstorming meeting were synthesized by the project team into six preliminary alternatives, which were recommended for more detailed analysis and development as candidates for selection as the preferred alternative for the area. The six preliminary alternatives were documented in the *Preliminary Alternatives Formulation Report* and presented to the agency stakeholders on August 6, 2009, at the Proposed Alternatives Formulation and Selection Meeting. The process used to generate alternatives as well as the results of the proposed alternatives analysis are presented in this report.

1.4 PERFORMANCE CRITERIA

The goals and objectives that were identified in the Agency Stakeholder Kickoff Meeting were restated as performance criteria and incorporated into an evaluation matrix as shown in Table 1-1. These performance criteria were presented in the *Data Collection Report* and are repeated in this section. These four goals of the study comprise the criteria by which the alternative plans will be judged.

1.4.1 Flood Hazard Protection – Flood Context

The project is first and foremost a drainage master plan. The District's mission is "to provide flood hazard identification, regulation, remediation, and education to the people in Maricopa County so that they can reduce their risks of injury, death, and property damage due to flooding while enjoying the natural and beneficial values served by floodplains." This criterion evaluates the effectiveness at reducing the risk of injury, death, and property damage due to flooding, with a preference toward alternatives that preserve natural and beneficial values of floodplains such as preserving natural vegetation and overbank flood storage areas.

1.4.2 Multipurpose Benefits – Land and Resource Context

The District has long recognized the importance of context sensitivity in design of flood control structures and places an emphasis on providing multipurpose benefits to the community in which the project is located. Significant attention is focused, during the data collection process, on identifying opportunities for multipurpose benefits as a way to enhance community pride and to leverage the dollars spent to create greater long-term value as well as bringing in project partners to aid in project implementation and maintenance.

1.4.3 Regional Land Planning Compatibility – Community Context

The Rainbow Valley area, as well as much of the greater West Valley area, has experienced unprecedented growth as demonstrated by the number of new homes built and the number of master-planned communities in some stage of development. Although this has slowed in the past year, the West Valley area is poised for explosive growth in the not-so-distant future. As governmental agencies prepare for this growth, a significant number of regional planning studies have been completed. Coordination and plan compatibility with these other planning efforts has been identified as an important aspect of a successful drainage plan.

1.4.4 Implementation – Community Context

The recommended plan will only become a reality if it can be implemented. Successful implementation is dependent on stakeholder support and participation, particularly the partner cities as well as a phased program that conforms to realistic funding streams. Successfully meeting the preceding three goals should help with implementation because the recommended plan will benefit from synergy with other projects and interests that will help pave the way for implementation.

Table 1-1 Evaluation Matrix

Flood Hazard Protection – Flood Context

1	2	3	4	5
Does not solve existing flood problems				Solves existing flooding problems
Provides low level of flood protection				Eliminates 100-year floodplains
Small benefited area				Maximizes benefited area
Requires human action to function during flooding				Passive system, no intervention required
Requires excessive maintenance to control vegetation				Allows for realistic levels of vegetation in channels
Eliminates natural processes, concentrates flows				Preserves natural hydrologic processes
Flow is diverted away from natural flow paths				Facilities follow existing flow paths

Multi-Purpose Benefits – Land and Resource Context

1	2	3	4	5
No opportunity for regional trail				Implements regional trail
No opportunity for local trails				Implements most local trail systems
No opportunity for recreation facilities				Implements recreation facilities
No east-west connections				Provides multiple east-west connections
No features at Waterman Wash Gila River confluence				Provides multiple features at confluence
Degrades natural resources				Enhances natural resources
Degrades cultural resources				Enhances cultural resources
Truncates wildlife movement				Incorporates wildlife movement
Detracts from desired visual character				Complements desired visual character
Does not extend character of Waterman Wash				Completely extends Waterman Wash character
Obscures or damages sensitive viewsapes				Enhances sensitive viewsapes
Increases degraded landscapes				Restores degraded landscapes
Decreases/damages existing open space value				Enhances existing open space value

Regional Land Planning Compatibility – Community Context

1	2	3	4	5
Requires General Plan Modification				Compatible with projected future land use
Creates conflicts with existing development plans				Compatible with development plans
Requires transportation plan modifications				Supports area transportation plans
No connectivity between local and regional facilities				Optimizes local/regional connectivity
Meets with no other plans				Plan matches other agency plans

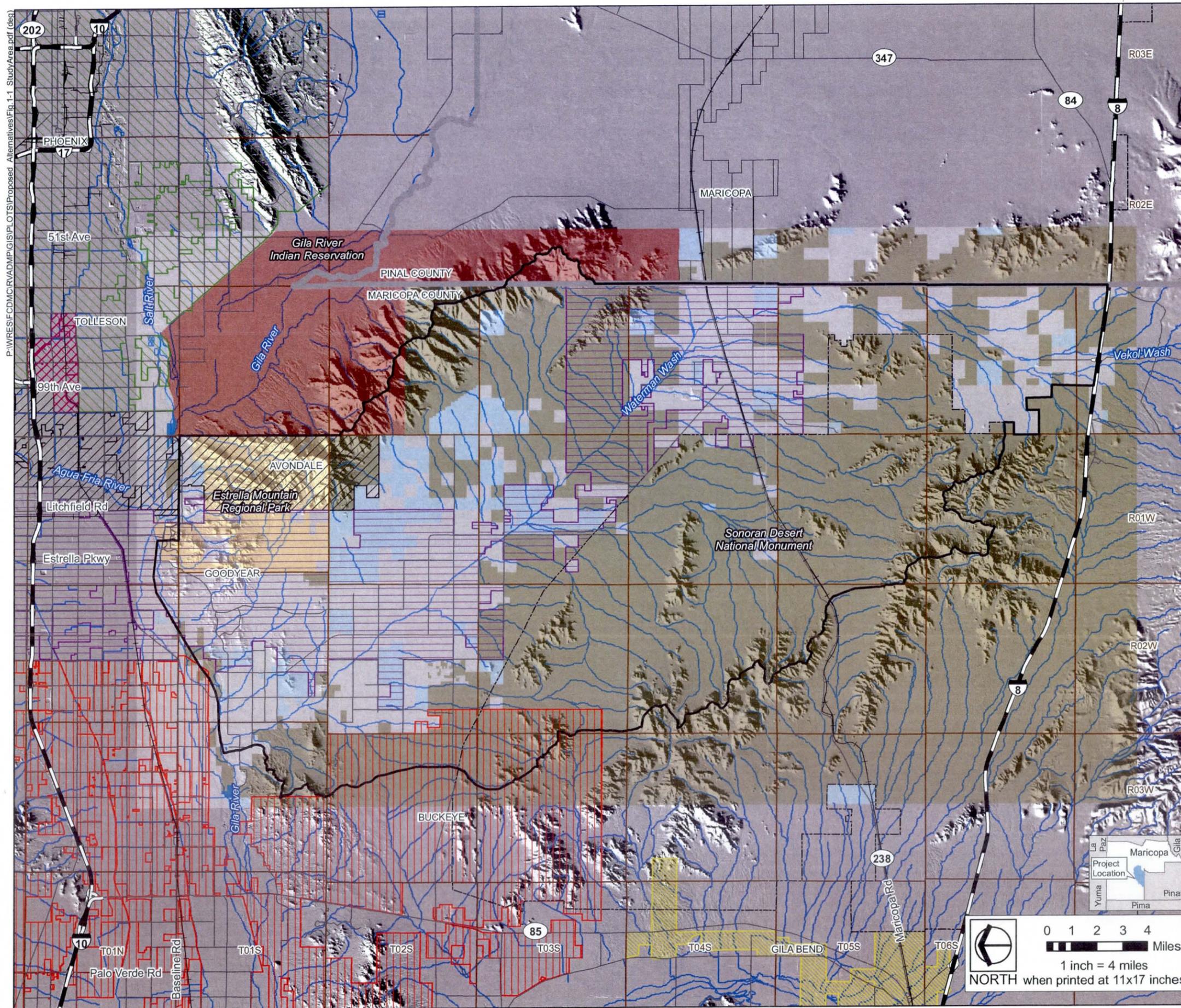
Implementation – Community Context

1	2	3	4	5
Few funding sources available				Significant funding sources available
No partnering opportunities				Multiple partnering opportunities
No phasing opportunity				Many phasing opportunities
Implementation by District				Implementation by others
Requires an individual Section 404 permit				Meets Clean Water Act requirements

Rainbow Valley
Area Drainage Master Plan
Study Area



Figure 1-1



Project Features

☐ Sonoran Desert National Monument

City/Town

▨ Avondale

▨ Buckeye

▨ Gila Bend

▨ Goodyear

▨ Maricopa

▨ Phoenix

▨ Tolleson

☐ Unincorporated Area

Surface Management

■ Bureau of Land Management

■ Gila River Indian Reservation

■ State Trust Land

■ Arizona Game and Fish Department (State Land)

■ County, Park and Outdoor Recreation Area

■ Private Land

Reference Features

— County Boundary

— Interstate Highway/
Freeway

— Rainbow Valley
ADMP Boundary

— Township and Range
Boundary

— Major Road

— River/Stream

— Railroad

Data Sources

Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008



2.0 HYDROLOGY

2.1 INTRODUCTION

An initial hydrology memorandum (URS 2008) was prepared for this project documenting the data and methodologies used in the hydrology model for addressing the concerns and discrepancies in the Waterman Wash Floodplain Delineation Study. Recommendations were made and agreed to by the District and URS Corporation (URS) pertaining to modifying the model. The Floodplain Delineation Study was completed by Engineering and Environmental Consultants (EEC) in 2006 (EEC 2006).

Two hydrologic analyses and models preceded this study for the Waterman Wash watershed. The first model was completed in 1988 (Cella Bar 1988). It was used to determine flows in Waterman Wash for floodplain delineation. The second hydrologic model was completed in 2006. It expanded on the previously completed hydrology for mapping approximately 165 miles of Zone A floodplains contributing to Waterman Wash.

These two previous models were created to determine existing peak discharge conditions in the watershed and were used to delineate floodplains. Neither model accounted for proposed development in the study area. The Rainbow Valley ADMP study used updated information for the study area to revise the existing model and develop a future hydrologic model that can be used as a guide for simulating proposed development.

2.2 HYDROLOGY MODEL UPDATES

The 2006 HEC-1 models developed by EEC were reviewed to determine what information could be used in the new hydrologic models. The EEC 2006 study created three hydrologic models for the watershed. In the first model, the UPRR acts as a levee; the second model ignores the effect of the railroad as a levee, assuming that no flow is diverted along the railroad embankment. The third model evaluated outlying drainage basins that drain directly into the Gila River and not into Waterman Wash. The same three model scenarios were used in the Rainbow Valley ADMP, but the new models have changes that are described in the following sections.

2.2.1 Rainfall

The EEC study used the National Oceanic and Atmospheric Administration (NOAA) 2 Atlas rainfall values. Since that study, NOAA has updated rainfall information in their NOAA 14 Atlas (NOAA 1973; NOAA 2006). The NOAA 2 predicted rainfall is greater than the NOAA 14 amounts. The EEC study used a value of 4.40 inches for the 100-year, 24-hour rainfall in the study area. The new NOAA 14 Atlas shows values ranging from 3.20 inches to 3.70 inches for the 100-year, 24-hour rainfall. The new models used a value of 3.44 inches for the 100-year, 24-hour rainfall.

2.2.2 New Mapping

New 2-foot and 4-foot contour interval mapping was prepared for a large portion of the Rainbow Valley ADMP watershed. The previous study used 10-foot contour mapping for the basin delineations. This new mapping was used to update some of the sub-basin delineations, as well as the routing cross sections.

2.2.3 Split Flow Analysis

The split flow analysis of the watershed (distributing flow characteristics) was updated based on the new topographic map data. There were some areas where the splits changed from the previous models and some areas where splits were removed completely. A FLO-2D analysis using the new topography was done in four separate areas where estimating split flow patterns was due to multiple splits and sheet flow conditions (URS 2009b).

The contributing areas upstream of the split flow locations were updated in the new models. The previous split flow analysis added the entire contributing area upstream of the split flow location to each side of the split. The updated analysis was done based on the percentage of contributing flow each split and that percentage was applied to the contributing area in the new models (URS 2009b).

2.2.4 New Development

New aerial photography was available for this project in addition to the 2-foot contour mapping. The 2-foot contour mapping was generated prior to some recent mass grading in the Estrella Mountain Ranch community, which is shown on the new aerial mapping. The previous hydrologic models did not account for the Estrella Mountain Ranch development. The sub-basin delineations and other hydrologic parameters were updated in the new models to include this development.

2.2.5 Sheet Flow Areas

There are many sheet flow areas within the project limits. These areas are difficult to model in HEC-1 because there is not a well defined wash that can convey the contributing flow. The previous models used vertical walls in the routing cross sections to contain the flow. Cross sections are extended horizontally at the route sections in the new model so that storage volume for the overbanks is increased between cross sections. Extending the cross sections by using gradual slopes better represents the attenuation that occurs in the sheet flow areas.

2.2.6 Union Pacific Railroad Improvements

The UPRR replaced many of the trestle bridge crossings in the project area with culverts made of smooth steel pipe. These culverts were designed so the same conveyance through the railroad would be achieved as with the trestles. New updated stage-storage curves were developed and included in the new models. The UPRR is presently constructing an additional, parallel track just south of the current alignment. The UPRR was modeled as a single embankment with the culvert length based on the total length through combined width of railroad embankment (double track embankments). This information was included in the Rainbow Valley ADMP models.

2.2.7 New Project Boundaries

A new area was added to the original study area as part of the Rainbow Valley ADMP. This area does not drain into Waterman Wash but was included so that a hydrologic model would be available for the area. The new area is on the east side of the Estrella Mountains and includes portions of the City of Avondale near the Phoenix International Raceway (PIR) (URS 2009b).

2.3 DEVELOPED CONDITIONS HYDROLOGY

The developed conditions model used the same information as the existing conditions model with the exception of land use. The future land use was taken from the Maricopa Association of Governments 2020 plan and the Town of Goodyear's future land use plan. The sub-basin infiltration loss parameters were updated using these new data. The sub-basin delineations, routes, soils, split-flow, and FLO-2D data remain the same in the developed conditions model. In addition to updating the land use, future retention was considered for areas that will be developed. The existing and developed conditions models were documented in the *Rainbow Valley ADMP DRAFT – Hydrology Report* (URS 2009b).



3.0 ALTERNATIVES FORMULATION

3.1 INTRODUCTION

This section describes the formulation and screening of flood control alternatives to identify six proposed alternatives recommended for a detailed evaluation in preparation for the Proposed Alternatives Evaluation.

3.2 CONTEXT SENSITIVE FLOOD HAZARD PLANNING

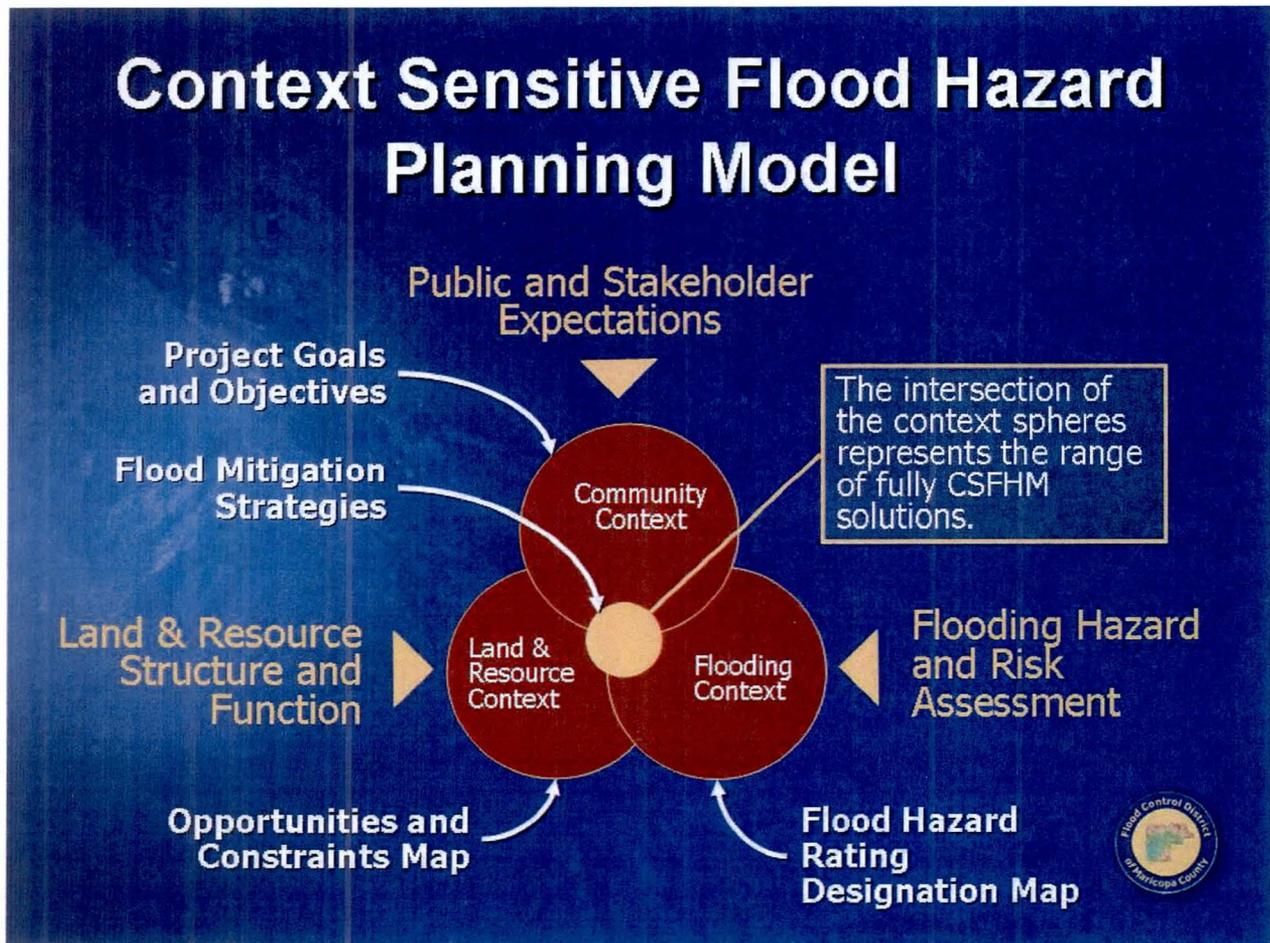
An important part of the ADMP planning process is the consideration of multiple project objectives leading to a recommended plan that is responsive to the particular context of the study area. The essence of this context sensitive planning approach is the integration of opportunities and constraints other than the flood control function of the plan as a means to leverage the flood control projects to provide added value for the community. The District has developed a Context Sensitive Flood Hazard Planning Model (CSFHPM) as a tool to support this process. The model is illustrated on Figure 3-1 and includes an evaluation of the following contexts:

- Flooding Context
- Community Context
- Land and Resource Context

The formulation of flood control alternatives is organized around this model. The formulation of context sensitive solutions involves innovative and inclusive approaches that integrate and balance community, aesthetic, historic, and environmental values with public safety, maintenance, and performance goals. Context sensitive solutions are reached through a collaborative, interdisciplinary approach involving planning team members, stakeholders, and concerned citizens.

The *Data Collection Report* contains extensive data which have been organized and presented as a means to define each of these contexts and form the basis for the formulation of alternatives according to the CSFHPM model. The Flooding Context is described with the Flood Hazard Assessment; the Community Context is described with the project goals and objectives as developed by the agency stakeholders at the project kickoff meeting; and the Land and Resource Context is described with the environmental evaluation and the Landscape Inventory and Analysis which includes a description of scenery, recreation, and open space resources. These resources are illustrated on a family of opportunities and constraints exhibits.

Figure 3-1



Referring to Figure 3-1, the intersection of the three context spheres represents the range of fully context sensitive flood hazard mitigation solutions. Simply stated, solutions that respond to all three contexts are considered to be fully context sensitive. The following process was used to formulate context sensitive flood hazard solutions:

- Identify Potential Flood Hazard Areas
- Select Flood Mitigation Strategies
- Develop Context Sensitive Solutions

Flood hazard areas are identified using the results of the Flood Hazard Assessment, which is illustrated on Figure 3-2, Flood Hazard Rating Designation. A flood mitigation strategy is then selected to be applied to the flood hazard area. The following flood mitigation strategies, described by The Federal Interagency Floodplain Management Task Force, have been identified for application within the study area:

- Modify Susceptibility to Flooding
- Modify Flooding
- Modify the Impact of Flooding
- Protect and Restore Functions and Values of Floodplains

These strategies, as adapted for this study, are illustrated in Table 3-1.

The selected strategy is then used as a basis for developing an alternative that is responsive to all three identified contexts. This process was used first by the project team to develop seed ideas and then by the agency stakeholders in a brainstorming meeting to identify potential alternative flood mitigation solutions. The resulting ideas are described in the following section.

Table 3-1 Floodplain Management Strategies

1. Modify Susceptibility to Flooding
<ul style="list-style-type: none"> • Floodplain management land use regulations • Building codes • Acquisition/relocation • Rules of Development
2. Modify Flooding
<ul style="list-style-type: none"> • Dams, levees, floodwalls • Structural conveyance • Structural detention/retention • Acceptance of risk
3. Modify the Impact of Flooding
<ul style="list-style-type: none"> • Flood insurance • Disaster Assistance • Information and education • Tax adjustment
4. Protect and Restore Functions and Values of Floodplains
<ul style="list-style-type: none"> • Land use planning • Conservation easements • Watershed management • Federal regulations • Multi-use emphasis

3.3 POTENTIAL ALTERNATIVES

The District and the consultant team held a Seed Idea Meeting on April 9, 2009, to brainstorm seed ideas that could be used in the formulation of preliminary alternatives. On April 29, 2009, the seed ideas were presented at the Preliminary Alternatives Formulation Meeting (Stakeholder Meeting). At the Seed Idea Meeting and Preliminary Alternatives Formulation Meeting, the following information was provided to the participants prior to their dividing into smaller groups:

- Project Goals and Objectives
- Project Overview
- Opportunities and Constraints in Watershed (Resource Maps)
- Context Sensitive Methodology
- Discussion on Flood Mitigation Strategies

At the Seed Idea Meeting, participants were then divided into three groups, provided flood hazard maps of the watershed, and were asked to draw their ideas directly on the maps. Each group had a specific mix of people to facilitate obtaining diverse ideas and solutions. The three group types were:

- Engineering Group
- Planner/Environmental Group
- Mixed Group

At the Preliminary Alternatives Formulation Meeting, participants were asked to provide ideas to be used in formulating the preliminary alternatives for the project area (Stakeholder Ideas 1 through 7).

The following sections describe the seed ideas developed by each group and alternatives developed by agency stakeholders. Appendix A includes the drawings prepared by each group. The seed ideas were presented at the end of the Seed Idea Meeting and at the Preliminary Alternatives Formulation Meeting.

3.3.1 Seed Idea 1 – Greenbelt and Reduce Flow Rates (Engineering Group)

The project features include the following (Figure A-1):

- In the medium and high flood hazard areas adjacent to State Route (SR) 238 and the UPRR, a levee is proposed to control and direct flows to upgraded wash crossings. The levee would serve a dual purpose of protecting downstream property from failures of the railroad and road embankments when water ponds upstream and allows for control of the discharge to downstream washes. Basins north of SR 238 are proposed where peak flow attenuation may be needed as a result of concentrating flows downstream where wash capacity is inadequate.
- A flood retarding structure is proposed at the downstream portion of the alluvial fans east of Waterman Wash (Township 2 South, Range 1 East and Range 1 West). The flood retarding structure will divert flows to the south where the outfall to Waterman Wash follows a significant existing wash corridor. Other culverts located along the flood retarding structure will discharge flows to selected washes to maintain their viability.
- A basin is proposed upstream of the utility corridor at the West Prong Waterman Wash with a greenbelt area proposed from the basin to Waterman Wash and then extending downstream to the Gila River.

3.3.2 Seed Idea 2 – Backbone Drainage System (Engineering Group)

The project features include (Figure A-2):

- Amaranth Development (original development name) will develop the backbone drainage system for the development in the southeast portion of the study area.
- Designate drainage corridors in both the east and west medium flood hazard development areas north of the confluence of the West Prong Waterman Wash and Waterman Wash. The sizing of conveyance crossings for proposed significant roads will depend on whether it is a multi-use corridor. Multi-use options for any of the corridors would determine how the context sensitive approach to its design would be implemented.

3.3.3 Seed Idea 3 – Linear Basin/Transportation Corridor Approach (Engineering Group)

The project features include the following (Figure A-3):

- This alternative focuses on capturing flows from upstream of proposed road alignments in linear basins and providing planned culvert/bridge crossings at significant washes to reduce the number of road crossings, identifying the locations of the crossing and coordinating proposed conveyance requirements with downstream development, while providing opportunities for context sensitive multi-use wash corridors.
- Linear basins are proposed between the utility corridor adjacent to the Sonoran Desert National Monument and the proposed Hassayampa Freeway that will capture flows upstream of the parkway and strategically discharge the flows downstream to Waterman Wash. The northern extent of the basins is in the southern portion of Township 2 South and extends through Township 3 South.
- A basin is proposed at the apex of the alluvial fans that contribute flow to both Corgett Wash and Lum Wash. The basin will have an outlet channel directing flows to Lum Wash. Lum Wash discharges to the Gila River in the northern portion of the study area. There is a proposed transit corridor that will cross Lum Wash in the future.
- Linear basins are proposed along the east side of the proposed Loop 303 Extension in Township 2 South and Range 1 West. Wash channels will convey flows from the Estrella Mountains to the east and convey runoff to the basins. Basin outfall wash locations to Waterman Wash will be coordinated with Maricopa County Department of Transportation (MCDOT), City of Goodyear, and developers. The outfall channels will also cross the proposed transit corridor.

3.3.4 Seed Idea 4 – Waterman Wash Restoration (Engineering Group)

The project features include the following (Figure A-4):

- A two-phase restoration of the Waterman Wash corridor is proposed from Arizona Public Service Company (APS) alignment (northern extent) through to Rod-Nell Road (South Road), the Township 3 South and Township 4 South boundary (southern extent).

- Trails are proposed connecting the restoration corridors northern limit with the Gila River and southern limit with I-8.

3.3.5 Seed Idea 5 – Alternative I (Planner/Environmental Group)

The project features include the following (Figure A-5):

- On-line basins are proposed at the apexes of the alluvial fans in Township 2 South and Range 1 West. The detained flows will be conveyed to Waterman Wash through channel facilities that preserve the natural character and function of the area and provide multi-use opportunities.
- There are a number of the larger washes that convey flows from the east and west that if used for flood conveyance should be designed to preserve natural character and function and provide multi-use opportunities.
- Off-line basins are shown along the east side of the Waterman Wash flood fringe that should be used to balance flows.
- In the low flood hazard area being considered for a wildlife corridor, approximate floodplain delineations (AO Zones) should be designated and any flood hazard mitigation should be non-structural. In the wildlife corridor, future regional roads (e.g., proposed Hassayampa Freeway) should provide wildlife crossings with culverts.
- Any flood hazard mitigation projects in the vicinity of Mobile should have a theme that preserves Mobile's history.
- The group divided the watershed into two planning areas—north and south—with the boundary occurring approximately one mile north of the SR 238 and UPRR corridor.
- A linear basin is proposed south of the UPRR and west the APS corridor. The basin should have a park and recreation focus and multi-use function. Multiple wash outfall corridors are proposed to convey flow north to Waterman Wash.
- A linear basin is proposed east of the APS corridor with outlets at the two main washes in the area (delineated floodplains). One of these outlets is Waterman Wash. The basin and flow corridors should have a wildlife focus and provide wildlife crossings under roads and the railroad.

3.3.6 Seed Idea 6 – Alternative II (Planner/Environmental Group)

The project features include the following (Figure A-6):

- There is a property in the Sonoran Desert National Monument that is owned by the State of Arizona Department of Health Services (used tire storage facility). A proposed collector system and basin is proposed for this site with the flows from the basin conveyed to Waterman Wash by the West Prong Waterman Wash.
- In Township 2 South and Range 1 West, there is an opportunity for a land swap for some high hazard privately owned land with Arizona State Trust Land to the west that is not in an alluvial fan.

- The same alluvial fans as described in the land swap could instead include a diversion levee at the toe of the fan and provide an outlet that conveys flows downstream to Waterman Wash.

3.3.7 Seed Idea 7 – Alternative I (Mixed Group)

The mixed group formulated alternatives by considering the floodplain management strategies described in Table 3-1. Potential project areas were described as to which strategies were to be used. This means of presentation was used for both Seed Ideas 7 and 8. The numbering system used on the figures denotes the strategy as listed:

1. Modify Susceptibility to Flooding
2. Modify Flooding
3. Modify the Impacts of Flooding
4. Protect and Restore Functions and Values of Floodplains

The project features include the following (Figure A-7):

- All alluvial fans need strategy 2.
- The area west of Waterman Wash and south of the Sonoran Desert National Monument will require strategy 4 along the major washes and delineated floodplains and strategies 1 and 2 in other areas.
- Lum and Corgett washes should be managed by strategy 4. So should the major unnamed wash entering Waterman Wash just upstream of the northern APS corridor.
- The private and public land east of Waterman Wash in the northern portion of the study area should be managed by a modification to strategy 2.
- The UPRR should be protected using strategy 2.
- Private land south of the UPRR should implement strategies 1, 2, and 4.
- Private land north of the UPRR should implement strategies 1 and 2.
- The wildlife corridor should implement strategy 4.
- The Waterman Wash corridor should implement strategy 4.
- Private land in the area toward Vekol Wash and Cimarron Development could use strategies 1 and 2 and include a water/natural theme.
- Floodplains should provide non-structural flood protection.
- The strategy 4 land use option should be used in some areas to keep people out and add resource value.
- In the City of Goodyear rules of development should be considered to mitigate flood hazard impacts.

3.3.8 Seed Idea 8 – Alternative II (Mixed Group)

The project features include the following (Figure A-8):

- In the riverine areas, strategy 4 could be implemented. Non-structural solutions are favored. These are high flood hazard areas that also have high resource value.
- The alluvial fans are a high hazard cultural setting. Strategy 2 should be implemented using linear basins and channels conveying flow to Waterman Wash or connecting and diverting the flows to the northeast and the Gila River. The basin would be located at the apex of the fan. A somewhat similar solution would be placing a levee structure at the base of the fan to collect runoff and then use similar conveyance as described above. These concepts are proposed for the fans in Township 2 South and Range 1 West.
- Suburban/urban/industrial cultural setting would implement strategy 2 and context sensitive guidelines.
- The open space cultural setting could include biological enhancement and restoration. Strategy 4 would be implemented in these areas.
- Low flood hazard risk areas could utilize strategy 4 and context sensitive guidelines.
- The UPRR should be protected from flood hazards utilizing strategy 2 with flow diverted to Waterman Wash.

3.3.9 Stakeholder Idea 1

The project features include the following (Figure A-9):

- Maintain surface flows in Sonoran Desert National Monument.
- Preserve the natural channel for the West Prong Waterman Wash.
- Preserve natural floodways and maximize floodplain limits along Waterman Wash.
- Provide density zoning regulation in private development lands in Goodyear east of Waterman Wash.
- Preserve alluvial fans in Township 2 South and Range 1 West or dam flows at apex and convey to the southeast increasing flows to wildlife corridor. Maintain present surface flow patterns in wildlife corridor.
- In areas south of the wildlife corridor along Waterman Wash, create mesquite bosques in the basins. In these reaches of Waterman Wash, use soft structural or natural vegetation in the designs.
- Water quality protection from tire dump.
- Provide wildlife friendly culvert openings along UPRR and SR 238.

3.3.10 Stakeholder Idea 2

The project features include the following (Figure A-10):

- Create a passive recreation corridor along Waterman Wash.
- Create a chain of developer-financed parks along Waterman Wash floodplain fringe, including a trail along the wash to provide connectivity.
- Include a trail along the unnamed wash corridor in Township 1 South and Range 2 West from Waterman Wash to the Estrella Mountain Regional Park.
- Provide a flow diversion at alluvial fans in Township 2 South and Range 1 West that provides conveyance of flow to the southeast and the wildlife corridor. Include trail connectivity from the Estrella Mountains to Waterman Wash in the wildlife corridor along major washes.
- Provide basins upstream of UPRR along Waterman Wash and its major tributary.

3.3.11 Stakeholder Idea 3

The project features include the following (Figure A-11):

- Share right-of-way between stakeholders in the corridor adjacent to and including the wildlife corridor where transportation, utilities, and potential flood control structures are needed to convey flood flows when the transportation projects are constructed and functioning.

3.3.12 Stakeholder Idea 4

The project features include the following (Figure A-12):

- Create a buffer for natural areas in the Estrella Mountains prior to formulating concepts.
- Provide a flood retarding structure or basins at the apexes of alluvial fans in Township 2 South and Range 1 West. Meter flows from structures to the wildness area, through fans to Waterman Wash and/or to the north and into Lum and Corgett washes.
- Reestablish historic flow paths in agricultural lands adjacent to Waterman Wash.
- Provide a flood retarding structure along the upstream side (east) of the proposed Loop 303 Extension to facilitate reestablishment of flow in agriculture lands above.

3.3.13 Stakeholder Idea 5

The project features include the following (Figure A-13):

- Provide protection of the Sonoran Desert National Monument, although there may be some opportunities for projects that are regional solutions.

- Utilize the Loop 303 Extension as a channel/levee to capture flows and direct them to more desired areas.
- Use on-line and off-line retention basins within the existing Waterman Wash floodplain to maintain existing flows and volumes within floodways. Use for mitigation of impacts to the wash.
- Keep flows within Section 404 washes.
- Combine District planning proposals/application with MCDOT and Arizona Department of Transportation (ADOT) when submitting to the federal government including the BLM.
- Utilize Natural Resource Conservation Service easement strategy for floodways.

3.3.14 Stakeholder Idea 6

The project features include the following (Figure A-14):

- Preserve the West Prong Waterman Wash and tributaries from the Sonoran Desert National Monument to Waterman Wash.
- Maintain and preserve the biological values of the wildlife corridor that divides the study area.
- Preserve the floodplain and floodway of Waterman Wash from its confluence with the Gila River to the mainstem headwaters south of the UPRR. Maintain the floodplain of the main tributary of Waterman Wash from where it confluences about 1 mile north of the UPRR to its headwaters.

3.3.15 Stakeholder Idea 7

The project features include the following (Figure A-15):

- There is a concern that future development will look for gravel sources in the study area.
- Waterman Wash from the Gila River confluence to SR 238 should remain natural with passive recreation. Active recreation facilities can be located outside and adjacent to the wash.
- The BLM should perform land use studies to determine where land swaps would be advantageous to all. Township 2 South and Range 1 West is an area where this strategy could be a beneficial use of land.
- There is a potential for trails on the north boundary of the wildlife area.

3.4 PRELIMINARY ALTERNATIVES

This section describes the preliminary alternatives that are recommended for further evaluation in the proposed alternatives analysis.

3.4.1 Formulation of Alternatives

The consultant team reviewed the ideas generated during the Seed Idea Meeting and Preliminary Alternatives Formulation Meeting and synthesized them into six preliminary alternatives based on different flood control strategies applied to the entire planning area. The planning area is smaller than the study area and is based on the assumption that secured open space such as the Sonoran Desert National Monument and the Sierra Estrella Wilderness will remain natural and will not be subject to flood mitigation strategies. During the review it was recognized that a single strategy would not likely be ultimately selected for the entire area. As a result, the planning area was divided into several planning units that were considered to be reasonably uniform in character and would be appropriate for a single strategy to be applied throughout the planning unit. The identified planning units are shown on Figure 3-3. The preliminary alternatives described in the following sections are based on the application of a single strategy to the entire planning area. However, it is anticipated that during the proposed alternatives evaluation, alternatives will be independently selected for each planning unit, providing a collective solution. In addition to specific flood mitigation strategies, several value added ideas were generated which could be applied to several strategies as an overlay. These value added opportunities also are described.

3.4.2 Preliminary Alternative 1 – No New Action

Description: Flood hazard mitigation planning and development will occur according to the existing regulatory requirements and review (Figure 3-3). Flood protection will be the responsibility of local municipalities and developers to enforce and/or follow local and federal floodplain regulations and ordinances.

Relative Cost: Low

Flood Hazard Mitigation Strategy: Modify Susceptibility to Flooding (strategy 1).

Context Sensitive Flood Hazard Planning: The No New Action alternative will result in a continuation of current planning and development methods and patterns. The accomplishment of context sensitive solutions to mitigate flooding hazards will be largely dependent on individual developers or underlying municipal oversight, resulting in a variety of solutions. These solutions will likely range from being highly context sensitive to solutions that focus only on meeting the flooding context requirements but do not address the land resource or community context. This may result in areas that do not accomplish the community or land and resource context goals identified during the data collection process while passing flooding hazards on to adjacent owners. Compatibility of flood protection methods, structure types, or design themes will be the result of individual owners' discretions and local municipal requirements, which will increase the probability that incompatible flood hazard mitigation methods will be used. Visually discordant, single-use projects that may also lower the biological or cultural resource value of a given area will likely result causing the loss of beneficial floodplain functions and the value-added opportunities that could have been provided by these facilities.

Flooding Context: Existing floodplain regulations and ordinances have been largely effective in mitigating flooding in the study area at current levels of development. In areas where future flood hazard risks have been identified as being low, for example in areas protected from development such as the Sonoran Desert National Monument, existing floodplain regulations and ordinances may represent appropriate solutions that respond to both the existing and future flooding context. However, as development in the area continues to expand, flood hazard mitigation may become more difficult through existing regulations and result in impacts to adjacent and downstream landowners. This alternative does not respond adequately to the high flood hazard risk represented by alluvial fans or in future developed areas with distributary flows (Lum Wash, Estrella, Sonora, Sevenmile Mountain, and Mobile Planning Units).

Community Context: The accomplishment of the goals and objectives identified by the project stakeholders and the public will be decoupled from flood hazard mitigation under this alternative. The planning for multi-use facilities will require the coordination of the various stakeholders on a project-by-project basis, increasing the likelihood that these goals will not be accomplished. Regional goals and objectives will require the City of Goodyear, Town of Buckeye, City of Avondale, and county and state agencies to be more heavily involved and actively coordinating for implementation.

Land and Resource Context: Current floodplain regulations allow for development within the flood fringe under Federal Emergency Management Agency (FEMA) guidelines. Development under these regulations will result in a decrease in the beneficial functions served by these floodplains. The *Waterman Wash City of Goodyear Conceptual Corridor Study* (Preliminary Final Draft, February 25, 2008) will serve to mitigate some of these impacts within Waterman Wash, although the opportunity for the District and the City of Goodyear to work together to accomplish the goals identified within the study will not be realized in this alternative. Open space preservation, regional trail development, and other active recreation development, biological diversity preservation and enhancement, as well as other resource goals may require local municipalities and county and state agencies to act as the lone facilitator. This may result in fewer multi-use goals being accomplished and/or the loss of resources in some areas.

Opportunities: None

Constraints:

- Limitations on regulation of flooding.
- Development constrained by hazards in alluvial fan, sheet flow, and distributary flow areas.
- Municipalities may not have the opportunity to partner in development of open space goals.
- No assurance of a positive outfall outside of development.
- Current flood/flow levels may degrade vegetation and habitat in some areas.

Strengths:

- No new regulations are needed.
- No Capital Improvement Program (CIP) costs would be incurred.
- Uses existing, familiar, regulation framework.
- Developers/landowners can anticipate what will be required to develop.
- Effective in areas that are secured open space or will not be developed and areas that do not have unusual flood hazards that would not be addressed by existing regulations.
- Flood control structures will not be placed in sensitive habitats, and likely will be limited to areas near development.
- Maintains natural flood/flow cycles to which wildlife and plants are adapted.
- Cultural resources would continue to be managed pursuant to applicable state and federal laws.

Weaknesses:

- Development practices may not adequately address flooding hazards.
- Higher potential for adverse cumulative impacts to downstream landowners.
- No additional protection of native habitats outside of federal lands and other protected areas.
- Limits opportunities to enhance degraded habitats and landscapes such as parts of Waterman Wash.
- Low likelihood of achieving a context sensitive plan.
- Difficult to implement effectively with individual lot development or lot splits.
- District would not be a facilitator of regional recreation and multi-use functions.
- If development reduces flows in Waterman Wash due to the 100-year, 6-hour retention requirement, the result could be harmful to wildlife and vegetation.

3.4.3 Preliminary Alternative 2 – New Regulations

Description: Flood hazard mitigation planning and development will be guided by new regulations and/or rules of development (Figure 3-4). These regulations/rules of development will focus on reducing flood hazard risk through modifications to land-use plans (changing the underlying cultural setting), using FLO-2D (two-dimensional hydraulic model) to assist in developing guidelines for areas with distributary flows, and coordinating planned road development to be responsive to flooding characteristics in a manner that minimizes structural flooding mitigation requirements and their associated costs. Other measures would include working with the City of Goodyear to develop additional implementation strategies for the *Waterman Wash City of Goodyear Conceptual Corridor Study* that accomplish project goals and objectives; working with local municipalities and agencies to develop guidelines for development in other floodplains to preserve or enhance the beneficial functions served by these floodplains; and developing Section 404 mitigation banking strategies for the project area that allow developers to work with local and regional agencies to focus floodplain restoration or enhancement measures where they will have a greater cumulative beneficial impact than may be accomplished by individual, project-by-project mitigation.

Relative Cost: Low

Flood Hazard Mitigation Strategy: Modify Susceptibility to Flooding (strategy 1), Protect and Restore Functions and Benefits Served by Floodplains (strategy 4).

Context Sensitive Flood Hazard Planning: This alternative seeks to respond to the flooding context of the study area by focusing flood hazard mitigation efforts on preventative measures. The process of planning and instituting revised regional regulations/rules of development allows for opportunities to accomplish the goals and objectives identified by the project stakeholders while responding to the natural and potential land resources present in the Rainbow Valley ADMP study area. No regional structures are proposed under this alternative. Local structures can be regulated to have a naturalistic character, resulting in highly compatible non-structural, soft structural, or semi-soft structural flood protection methods and structure types to accomplish the regional flood hazard mitigation strategy. As the dominant character of the existing drainages is natural, design themes for the local flood protection structures will be primarily natural riparian themes that respond to the adjacent topographic form. These include the Natural Sonoran Desert Uplands theme and the Natural Lower Sonoran Desert Riparian theme.

Flooding Context: As stated in the No New Action alternative, the existing floodplain regulations and ordinances have been largely effective in mitigating flooding in the study area at current levels of development. This alternative should be effective in responding to the future flooding context by addressing the potential impacts caused by future development in areas with flow characteristics that would result in a high flooding hazard risk level.

Community Context: It would be reasonably simple to plan for the inclusion of identified stakeholder goals and objectives while developing the rules of development, regulations, and guidelines. However, the effective implementation of these goals will be dependent on stakeholder buy-in during the adoption phase of this alternative.

Land and Resource Context: This alternative could potentially protect significant resource areas, depending on the level of acceptance generated within the local stakeholder and developer community. Varying levels of resource protection and enhancement could be accomplished depending on the types of regulations ultimately adopted. Section 404 wash mitigation banking may result in the ability to restore disturbed landscapes, although there would be little or no opportunity to introduce water in areas that could benefit from additional precipitation such as in Waterman Wash south of the confluence with the West Prong. Although wildlife corridor protection under this alternative would not be aided through the implementation of flood hazard mitigation projects, establishing mitigation banking within the identified corridor could serve this purpose to some extent.

Opportunities:

- Mitigation banking can help enhance existing cultural, biological, or open space resource areas and provide connectivity/continuity between them.
- Protect natural resources.

- Creative transportation planning could be integrated with natural drainage patterns to prevent drainage damage and reduce drainage infrastructure costs (e.g., fewer culverts).
- Protect existing drainage corridors.
- Create drainage development districts for coordinated retention/recharge planning and construction in lieu of individual 100-year, 6-hour on-site retention.
- Allow base flow up to natural channel capacity into channels, then retention for flows above channel capacity. This would help protect vegetation along washes. Developers would still need to provide first flush retention.
- Retention sites could create additional riparian or wetland habitat.
- Land swaps can help retain or preserve areas with higher quality biological resources.

Constraints:

- Limits on regulation to prevent a “taking.”
- Possible lack of political will for adoption.
- Potential conflicts with existing regulation.
- Jurisdictional constraints on regulation. Required agencies may not support or have enforcement authority.
- Limitation on ability to enhance degraded habitats and landscapes.

Strengths:

- Allows for coordinated regional planning of regulations.
- Higher potential for protection of existing drainageways and other beneficial resources and hydrologic processes.
- Few additional flood control structures that could modify vegetation and wildlife habitat.
- New regulations and development rules could incorporate biological values as part of the flood protection plans (e.g., retention of open space).
- Section 404 mitigation banking could result in coincidental preservation of cultural resources, as could any associated land exchanges that preserve undeveloped alluvial fans for areas that might have fewer and less sensitive cultural resources.

Weaknesses:

- Multiple regulatory strategies may be difficult to implement and/or oversee, especially if different regulations apply to different planning units.
- Requires adoption and potentially enforcement by multiple agencies/municipalities; this could be a challenge.
- Developers may resist additional regulations.
- More difficult to implement regional trail facilities as compared to structural approaches due to long-term political oversight of implementation.
- A lack of cohesive regulatory strategies could inhibit regional planning for biological resources.

3.4.4 Preliminary Alternative 3 – Structural Conveyance

Description: This alternative provides flood protection through the construction of floodwater interception and conveyance structures (Figure 3-5). Proposed structures include (1) a series of training berms-levees within the alluvial fan in the planned development areas that funnel flows to multiple channels that convey the flows southwest to Waterman Wash; (2) a single diversion channel along the apex of the alluvial fans in the Estrella Planning Unit that routes flows (5-year flood event) around proposed developed areas and through one or two outlets into Waterman Wash or the Gila River (Estrella Planning Unit); (3) a proposed channel, downstream of the proposed Hassayampa Freeway adjacent to the Sonoran Desert National Monument in the Sonora Planning Unit, directing flows into an existing wash that then flows into Waterman Wash; (4) a channel-levee upstream of the UPRR within the limits of proposed development in the Mobile Planning Unit that would then outlet flows into a newly channelized reach of Waterman Wash; and (5) additional alluvial fan apex basins in the Waterman-South Planning Unit that would outlet into channels that flow into the Waterman Wash head waters. Waterman Wash would be managed in accordance with the *Waterman Wash City of Goodyear Conceptual Corridor Study*.

Relative Cost: High

Flood Hazard Mitigation Strategy: Modify Flooding (strategy 2).

Context Sensitive Flood Hazard Planning: This alternative responds to the study area flooding context through the use of structural methods, which are generally very effective for mitigating flooding risks. Co-locating various multi-use opportunities with these structures will provide opportunity to accomplish many or all of the goals and objectives identified by the project stakeholders. Conveyance structures such as channel-levees and channels are proposed in a number of different physical settings, including the upper and lower bajadas of the Sierra Estrellas, and within the valley plain. These structures have been determined to be compatible with the scenic, recreation, open space, biological, and cultural resources in this area based on the compatibility mapping for the study area, provided that proposed structures meet the criteria for a medium or small channel and are configured to remain in largely suburban-developed areas. Structures should generally be designed using a semi-soft method with some apex basins and channel segments lying in areas where a soft-structural method would be required. Small channel reaches located in future urban areas may also be designed as enhanced hard structures if further stakeholder input shows this is desirable to the community. The predominant landscape design themes will be the Natural Sonoran Desert Uplands Riparian and Natural Lower Sonoran Desert Riparian for the channels, with some reaches potentially being designed with a Semi-Natural Sonoran Desert theme in developed areas.

Flooding Context: This alternative responds to the existing flooding context by mitigating the areas of known flooding near SR 238. Future flooding risk also will be effectively mitigated through this alternative, although the structural solutions proposed will be costly to implement.

Community Context: Structural solutions create strong opportunities to both implement and maintain multi-use purposes as part of flood hazard mitigation projects. Project multi-use goals and objectives should be implementable in conjunction with these structural solutions.

Land and Resource Context: This alternative would have a varied impact on the land and resource context within the study area and requires sensitive structural design to achieve success. Reducing or channelizing flows may reduce water available to existing washes, resulting in a decrease in vegetation in these washes and an increase in the types and densities of vegetation in channelized areas. Wildlife corridor protection may be aided through the implementation of flood hazard mitigation projects such as a drainage channel that routes flows from the alluvial fan basins through a natural wash alignment within the protected area.

Opportunities:

- East-west wildlife and recreation connectivity within study area.
- Enhancement of degraded areas in wildlife corridor.
- Provide outfalls for Hassayampa, Loop 303, and Sonoran Parkway roadway projects.
- Remove private land from the floodplains.
- Facilitate wildlife corridor protection and creation.
- Enhance vegetation in washes by concentrating flows.

Constraints:

- Coordination with developments and acquisition of right-of-way.
- Construction in protected areas, such as wilderness, National Monument, etc.
- Levees would be constrained by potential FEMA and Arizona Department of Water Resources (ADWR) dam requirements.
- Concentrating flows may increase erosion in channels and degrade vegetation.
- Conveyances may inhibit north-south connectivity of wildlife in study area.

Strengths:

- Effectively controls flooding (especially alluvial fans).
- Provides positive drainage for developments and ensures connectivity.
- Allows for development in alluvial fan areas.
- Reduces some wildlife-urban interface conflicts.
- Enhances the value of certain properties.

Weaknesses:

- Requires costly CIP programs to implement.
- Possible limited implementation partners.
- High maintenance costs, especially with diversion channel at apex of fans.
- De-values certain properties.

- Sediment issues.
- Decreasing groundwater recharge and infiltration in sheet flooding areas.
- Phasing of implementation could be challenging.
- Vegetation and wildlife habitats may change where flows have been diverted or channels intercept sediment in apex areas.
- Diverting water into wildlife corridor washes may degrade or change wash habitats there.
- No conflicts with high sensitivity cultural resources, but upper bajada setting has highest density of archaeological sites (many with petroglyphs) and extensive construction could disturb numerous sites.

3.4.5 Preliminary Alternative 4 – Structural Storage, Transportation Corridors

Description: This alternative provides flood protection through the construction of floodwater interception and storage structures that would be shared with the large planned transportation facilities such as the Loop 303 and the proposed Hassayampa Freeway (Figure 3-6). Flood storage basins would be located upstream of these roads with the opportunity to partner with MCDOT or ADOT sharing the use of these basins to concentrate floodwaters in a single series of facilities rather than using two separate flood protection systems. These basins would be configured so that they are not directly adjacent to the roadways, allowing for development of the highly desirable land immediately adjacent to the roads. Instead, these basins would be configured at a determined distance upstream of the road where they would be able to form a “greenbelt” of passive-use open spaces and active-use recreation areas. This also would allow the facilities to be flexible in their ultimate configuration if acquiring a property planned for flood control use proves difficult. Other structures proposed in this alternative include a storage basin upstream of the UPRR within the Mobile Planning Unit and small apex storage basins on the alluvial fans. Apex basins will be located in the Estrella Planning Unit. Channels will convey flows from the apex basins to the Loop 303 Extension linear basins. Waterman Wash would be managed in accordance with the *Waterman Wash City of Goodyear Conceptual Corridor Study*, with the basin at the UPRR providing an opportunity to enhance the southern reach of Waterman Wash.

Relative Cost: High

Flood Hazard Mitigation Strategy: Modify Flooding (strategy 2).

Context Sensitive Flood Hazard Planning: This alternative responds to the study area flooding context through the use of structural methods, which are generally very effective for mitigating flooding risks. Opportunities for multiple uses in conjunction with flood protection will be high, as will the opportunity to form groups with multiple cost-share partners and stakeholders for project implementation. The storage basins associated with the roads are primarily proposed in either the lower bajada or valley plain physical setting. As the roads will naturally attract development, the predominant future cultural setting in these areas will be suburban. Basin configuration would need to be either small or medium in size and respond to the adjacent land use to be context sensitive with the scenic, recreation, open space, biological, and cultural resources in this area. As with the previous alternative, the apex basins also would be considered context sensitive provided they meet the requirements for small basins. Structures should

generally be designed using a semi-soft method with some apex basins lying in areas where a soft-structural method would be required. The predominant landscape design themes will be the Natural Sonoran Desert Uplands and Natural Lower Sonoran Desert for basins with a passive open-space multi-use function and a Semi-Natural or Desert Park theme for basins that would include active recreation uses. The small apex basins would primarily use the Natural Sonoran Desert Uplands. The basin upstream of the UPRR would be designed with a Natural Lower Sonoran Desert theme and could also serve as open space, allowing wildlife to move across the railroad and into the enhanced portion of Waterman Wash. A Desert Park theme could provide opportunities for active recreation associated with the Amaranth Development. Conveyance channels are proposed in the upper and lower bajadas of the Sierra Estrellas. Based on the compatibility mapping for the study area, these structures have been determined to be compatible with the scenic, recreation, open space, biological, and cultural resources in this area, provided that proposed structures meet the criteria for a medium or small channel and are configured to remain in largely suburban-developed areas.

Flooding Context: This alternative responds to the existing flooding context by mitigating the areas of known flooding near SR 238. Future flooding risk also will be effectively mitigated through this alternative. Structural costs may be offset through cost-share partnering.

Community Context: Structural solutions provide a good opportunity to both implement and maintain multi-use functions as part of flood hazard mitigation projects. Project goals and objectives should be implementable in conjunction with these structural solutions.

Land and Resource Context: This alternative would have a varied impact on the land and resource context within the study area and requires sensitive structural design to achieve success. Reducing or channelizing flows may result in less water being available to existing washes, causing a decrease in vegetation. Basins would require designs that effectively mitigate flooding hazards while providing sufficient water to maintain biological and scenery resources within preserved washes.

Opportunities:

- Partnering opportunities with ADOT, MCDOT, and Goodyear for transportation projects.
- Reduces the number of culvert crossings under roads.
- Context sensitive development in commercial areas.
- Urban greenbelt system.
- Wildlife crossings through roadways/railroad integrated with green-space basin corridors.
- Use West Prong for wildlife crossing.
- Grind up tires for rubberized asphalt on roadways – environmental benefits from quieter roads.
- Limits disturbance of vegetation and habitats for roads and flood control structures by creating multipurpose areas, which reduces overall impact to biological resources.

Constraints:

- Desire for development next to transportation corridors. Need to be flexible in siting.
- Getting water to basins through developed land upstream of basins, especially commercial areas adjacent to roadways between road and basin, may be difficult.
- Wildlife may be averse to using artificial habitats and crossings next to heavily used transportation corridors.
- Wildlife crossings may convey some but not all species.
- Apex basins may not be implementable, especially if an apex is in a wilderness area.
- Linear basin may not be hydraulically efficient.

Strengths:

- Partnering opportunities for implementation.
- Levees would not be required because the basins are located in a cut section. No ADWR or FEMA problems with levees/dams.
- Some potential to publicly interpret Juan Bautista de Anza Trail (Gila Trail)/Butterfield Overland Mail Road, and historic Mobile African-American community in conjunction with any recreational facilities at basins along railroad.

Weaknesses:

- Water next to transportation corridors can increase the risk of wildlife-vehicular conflicts for some species.
- High maintenance cost, especially with apex basins.

3.4.6 Preliminary Alternative 5 – Protect Significant Wash Corridors

Description: This alternative recognizes that development will occur in the Rainbow Valley area and seeks to establish opportunities to include the preservation of open spaces and the beneficial functions served by floodplains with development planning (Figure 3-7). Flood protection is provided through the identification of significant drainage corridors ($Q > 500$ cubic feet per second [cfs]) that would be protected and give more flexibility to developers for impacting smaller washes. This likely would require that flows be diverted to the identified corridors, which could result in higher flows and larger flooding area within these drainage corridors. The need to increase the floodplain in these significant washes may be offset by reductions in current floodplains using the NOAA-14 precipitation predictions. Waterman Wash would be managed in accordance with the *Waterman Wash City of Goodyear Conceptual Corridor Study*.

Relative Cost: Medium

Flood Hazard Mitigation Strategy: Protect and Restore Functions and Benefits Served by Floodplains (strategy 4).

Context Sensitive Flood Hazard Planning: This alternative responds to the study area flooding context through the use of nonstructural methods for the regional flood conveyance. This provides a significant opportunity to include the protection of resource protection and enhancement within the identified corridors as well as other multi-use opportunities. These regional flood

hazard mitigation solutions would be nonstructural, or compatible with all areas, and have either a Natural Lower Sonoran Desert Riparian or Natural Sonoran Desert Uplands Riparian landscape design theme. The alternative also would require rules of development for drainages that flow to these washes to ensure they also achieve a context sensitive solution. In most cases, this would mean that proposed developed channels should be semi-soft structures with either a natural or semi-natural design theme based on the planned multi-use and physical setting.

Flooding Context: The mitigation of future flooding risk will be dependent on the capacity of the identified washes to carry the required flows and the implementation of flood conveyance facilities by individual landowners and developers in areas between the major washes. This alternative would not be effective in areas that do not have major existing washes, such as the Estrella Planning Unit. This alternative does not address the flooding risk associated with the alluvial fans within the Estrella Planning Unit.

Community Context: The preservation of large areas of open space within the significant wash corridors provides opportunity to accomplish many stakeholder goals and objectives. As with the flooding context, this alternative is only effective for achieving these goals in areas with existing major washes.

Land and Resource Context: This alternative would have a varied impact on the land and resource context within the study area. By recognizing that development will occur within the study area, planning for major wash preservation will provide opportunities to protect and enhance these areas along with their associated resource value. Smaller washes and large expanses of open space may be replaced with development through this alternative, resulting in a concentration of resources within these corridors.

Opportunities:

- Implement context sensitive solutions.
- Protect, enhance, and/or restore existing major wash corridors.
- Preserve or enhance the most important wash habitats that can function as wildlife movement areas.
- Enhance east-west connectivity of vegetation and wildlife movement areas.

Constraints:

- Geomorphology of channel change resulting from increased frequency and magnitude of flows.
- Erosion setback requirements.
- There could be a possible delta formation at Waterman Wash.
- Erosion of channels could degrade wildlife habitat and vegetation along the major washes.
- Diverting water could alter vegetation and habitat where water is removed.

Strengths:

- More flexibility for developers in areas outside major wash corridors.
- Builds on natural systems that already exist in the area, providing a context sensitive solution.
- Solution can adapt to the needs of biological resources by utilizing natural channels.
- Protection of wash corridors could result in coincidental preservation of cultural resources.

Weaknesses:

- Some areas do not have wash corridors.
- The increased flows will result in the need to acquire or protect corridors.
- No east-west recreation connectivity of trails between population centers.
- Anticipated development areas are not located where the major washes are. Development is expected in sheet flow and distributary flow areas.
- Does not enhance south Waterman Wash, an area that would benefit from more and concentrated flows to give it better definition.
- Altered washes may not provide the same resources to support current vegetation and wildlife.

3.4.7 Preliminary Alternative 6 – Pocket Basins

Description: This alternative also recognizes that development will occur in the Rainbow Valley area and seeks to establish opportunities to include the preservation of open spaces and the beneficial functions served by floodplains with development planning (Figure 3-8). Flood protection is provided through off-line basins in the floodway fringe of the existing washes outside of the incised channel. These basins would serve to store high flood flows without eliminating low flows and give more flexibility to developers for developing within other areas of the floodway fringe. These basins would be designed to perform the same functions and provide the benefits associated with overbank flows within floodplains. Other design guidelines would include the protection of the multistoried vegetative communities associated with the floodways and near-fringe while enhancing the pocket basins through mitigation banking and other cooperative measures.

Relative Cost: Medium to High

Flood Hazard Mitigation Strategy: Modify Flooding (strategy 2), Protect and Restore Functions and Benefits Served by Floodplains (strategy 4).

Context Sensitive Flood Hazard Planning: This alternative responds to the study area flooding context through the use of nonstructural methods for the regional flood conveyance and implementing structural methods that control flows within the floodways. This provides an opportunity to include resource protection and enhancement within the existing drainage corridors as well as within the proposed off-line basins. Opportunities for open space preservation and recreation implementation allow many goals and objectives to be accomplished through this alternative. Washes would be managed as nonstructural features, or compatible with

all areas, and the adjacent basins would be designed as soft or semi-soft structures to assist in creating flood protection projects that respond to the land and resource context of the area. Appropriate landscape design themes include the Natural Lower Sonoran Desert Riparian or Natural Sonoran Desert Uplands Riparian themes for conveyance features and Natural Lower Sonoran Desert or Natural Sonoran Desert Uplands themes for the pocket basins. The Desert Park theme could also be applied to the pocket basins in key locations where they coincide with the park and recreation facility needs of the community. The alternative also would require rules of development for drainages that convey to these washes that ensure they also achieve a context sensitive solution. In most cases, this would mean that proposed developed channels should be semi-soft structures with either a natural or semi-natural design theme based on the planned multi-use and physical setting.

Flooding Context: The future flooding context will be effectively mitigated through this alternative using proper hydrologic design to ensure the basins effectively control overbank flows. This is particularly effective for addressing issues with Waterman Wash and any increases to the flows or timing of flooding within the wash. This alternative would not be effective in areas that do not have major existing washes, such as the Estrella Planning Unit. This alternative does not address the flooding risk associated with the alluvial fans within the Estrella Planning Unit.

Community Context: The preservation of open space within the wash corridors and the enhancement of the pocket basins to serve desirable functions provide opportunity to accomplish many stakeholder goals and objectives. As with the flooding context, this alternative is only effective for achieving these goals in areas with existing major washes.

Land and Resource Context: This alternative would have a varied impact on the land and resource context within the study area. By recognizing that development will occur within the study area, planning for wash preservation will provide opportunities to protect and enhance these areas along with their associated resource value. Depending on the number of washes where this solution is deemed effective, some smaller washes and large expanses of open space may be replaced with development through this alternative, resulting in a concentration of resources within the remaining corridors.

Opportunities:

- Artificially restore functions of floodplains for flow attenuation and flood storage.
- Provides opportunity for creating open space and some types of riparian/wetland habitat.
- Mitigation banking.
- Multiple uses – probably more passive uses.
- Groundwater recharge by directing local runoff into basins.
- Density transfers and land swapping.
- Meets open space requirements.
- Cascading basins for alluvial fan solutions.

Constraints:

- Small parks subject to flooding are not as desirable for parks departments.
- Multiple uses must be compatible with occasional deep flooding.
- Overall design may impede movement of terrestrial wildlife species upstream and downstream.
- Could adversely modify the environment for species adapted to flood fringe areas.

Strengths:

- Habitat development for some aquatic and riparian species that use a modified environment.
- Reclaims flood fringe areas for development by concentrating floodplain functions into a smaller area.
- The pocket basins could be developed in many different ways.
- Potential to publicly interpret historic Mobile African-American community at one or more pocket basins in conjunction with any associated recreational facilities.

Weaknesses:

- Finding appropriate sites could be difficult.
- Coordination of mitigation banking could be difficult to implement.
- Maintenance to ensure capacity and remove weeds and trash.
- This is not a complete solution because it does not address flooding upstream of pocket basins.
- Standing water in basins could breed mosquitoes and serve as a reservoir for the West Nile Virus (only if basins do not drain within 36 hours).
- Artificial habitats may not be utilized by some species.
- Paternoster-like environments may not be ecologically viable in a desert environment.

3.4.8 Value Added Features/Opportunities to be Added to any Preliminary Alternatives

These additional features represent opportunities that could be added to any of the preliminary alternatives to assist in achieving context sensitive solutions.

Mitigation Banking: Mitigation banking refers to the practice of establishing credits through creation, enhancement, and restoration of wetland/upland areas. Developers can purchase mitigation credits that are used to mitigate for on-site disturbance in lieu of compensating with on-site mitigation. The location of the mitigation banks would be determined on an alternative-by-alternative basis, but should focus on improving the resource values in areas that have been previously disturbed, such as in Waterman Wash, and in areas where mitigation could assist in achieving project goals and objectives. The benefit of mitigation banking is that mitigation measures required of individual developers can be “pooled,” creating larger contiguous areas of quality habitat. Possible locations for mitigation banks include:

- BLM lands/wildlife corridor
- Major washes
- Pocket basins
- Flood pool areas associated with flood control projects

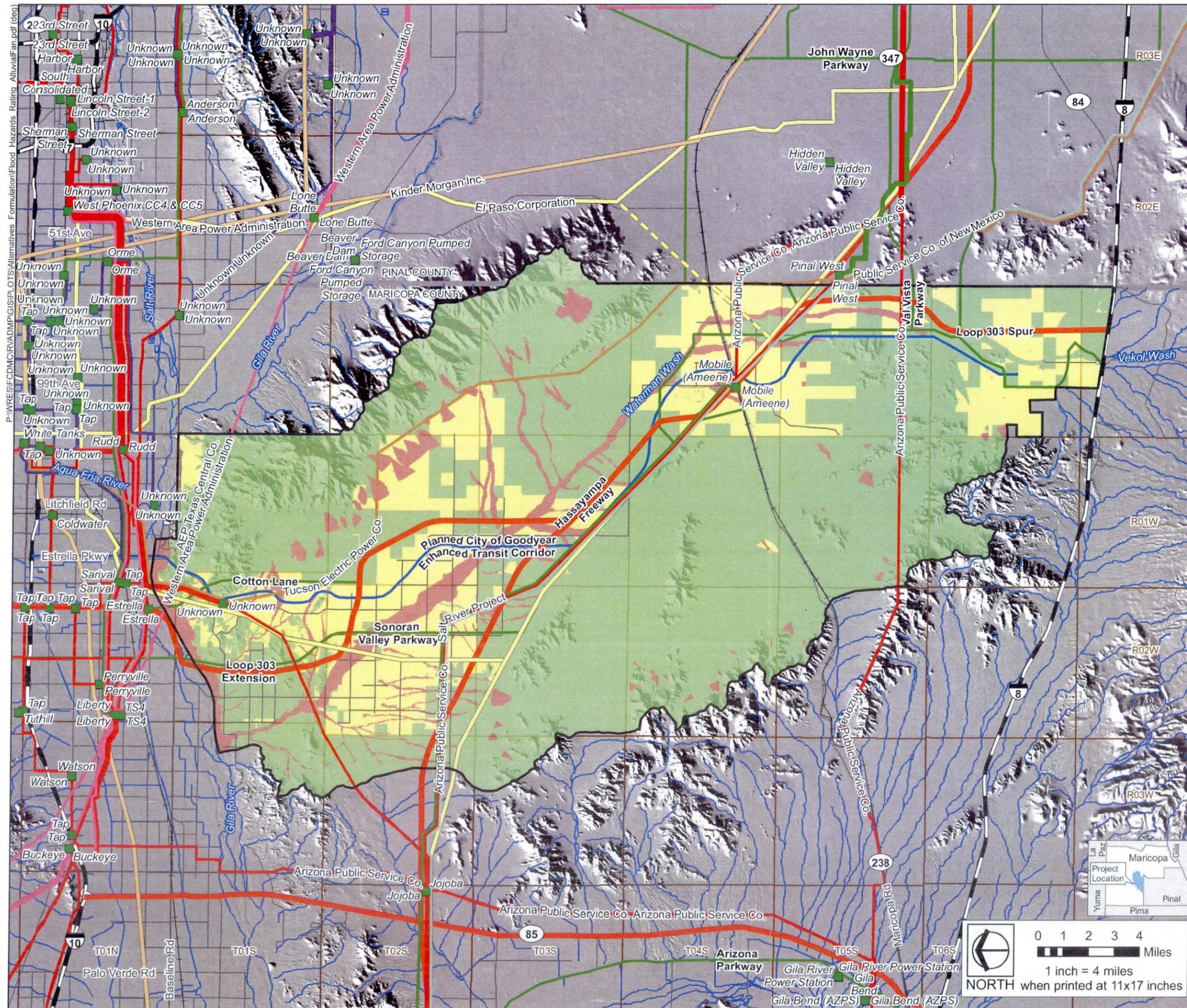
'First Flush' Rules of Development: On-site water retention may decrease the water available in existing washes, resulting in a loss of biological value within the drainage area. The development of appropriate 'first flush' rules that only capture run-off from high-pollutant surfaces such as parking areas, turf, and drives should be developed for alternatives where wash preservation or enhancement is a feature. Rules for run-off from highly polluting surfaces also may include the development of biological treatment basins that would allow for the eventual reintroduction of the water back into the existing drainage systems.

City of Goodyear Waterman Wash Implementation: The City of Goodyear is currently developing implementation measures for the *Waterman Wash City of Goodyear Conceptual Corridor Study*. Opportunities may exist to include rules of development within the ADMP that would assist Goodyear in implementing the *Waterman Wash City of Goodyear Conceptual Corridor Study* and accomplishing the project goals and objectives associated with Waterman Wash.

Rainbow Valley Area Drainage Master Plan Flood Hazard Rating Designation



Figure 3-2



Project Features

Flood Hazard Rating

- Low
- Medium
- High

Future Corridor Type

- Freeway
- Parkway
- Transit Corridor

Gas Pipeline Owner and Status

- El Paso Corporation, Active
- El Paso Corporation, Abandoned
- Kinder Morgan Inc., Active

Transmission Line Owner and Location

- Arizona Public Service Co., Overhead
- Arizona Public Service Co., Underground
- Public Service Co. of New Mexico, Overhead
- Salt River Project, Overhead
- Tucson Electric Power Co., Overhead
- Western Area Power Administration, Overhead
- Unknown, Overhead
- Substation and Name

Flood Hazard Rank	Range
Low	0-3
Medium	4-10
High	11-15

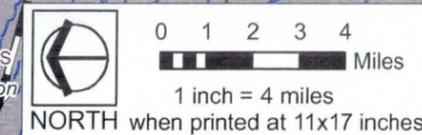
Note: Flood Hazard Designations subject to change. Rankings were determined from values in Appendix D with exception to Special Flood Hazard Areas and Alluvial Fans, which are ranked as High.

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/Freeway
- Major Road
- River/Stream
- Railroad

Data Sources

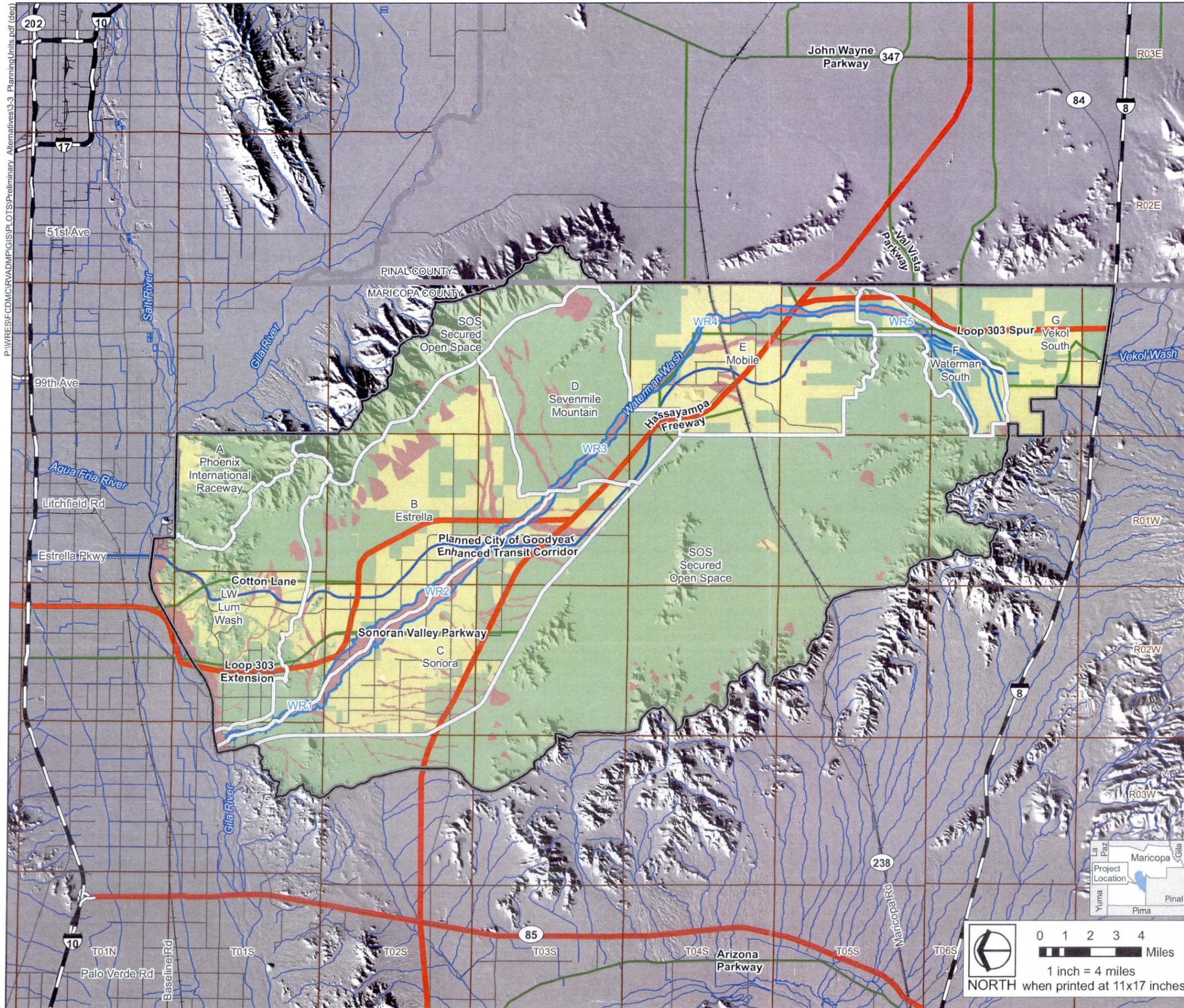
Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008



Rainbow Valley
Area Drainage Master Plan
Preliminary Alternatives - Planning Units



Figure 3-3



Project Features

- Planning Unit Boundary
 - Waterman Wash Reach (with ID)
- Flood Hazard Rating**
- Low
 - Medium
 - High
- Future Corridor Type**
- Freeway
 - Parkway
 - Transit Corridor

Label	Planning Unit
A	Phoenix International Raceway
B	Estrella
C	Sonora
D	Sevenmile Mountain
E	Mobile
F	Waterman South
G	Vekol South
LW	Lum Wash
SOS	Secured Open Space
WR1 to WR5	Waterman Wash Reaches

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/Freeway
- Major Road
- Railroad
- River/Stream

Data Sources

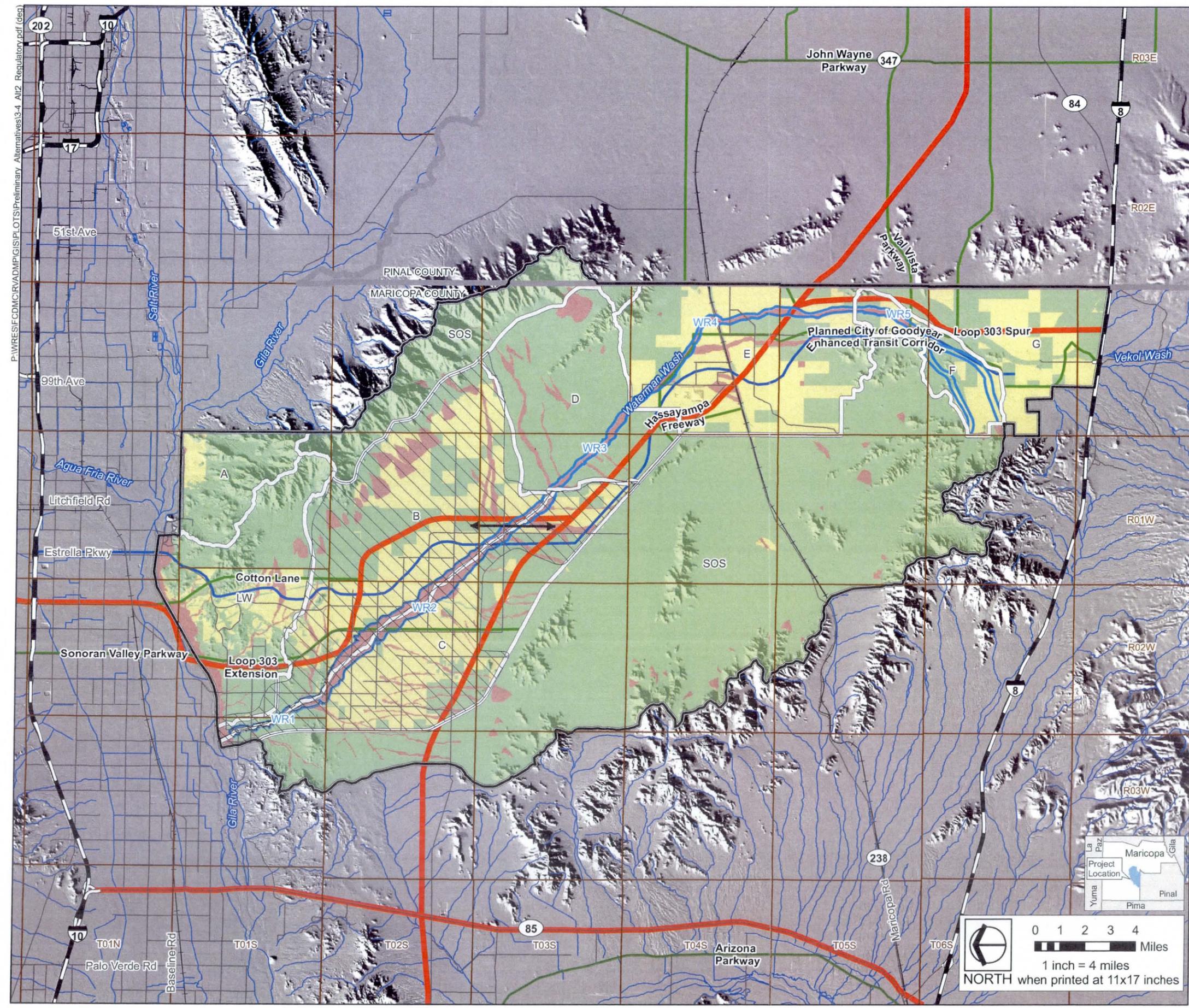
Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
URS Corporation
Flood Hazard Rating and Alternative Data 2009

0 1 2 3 4 Miles
1 inch = 4 miles
NORTH when printed at 11x17 inches

Rainbow Valley
Area Drainage Master Plan
Preliminary Alternative 2 - Regulatory



Figure 3-4



Project Features

- Planning Unit Boundary
 - Waterman Wash Reach (with ID)
 - Regulatory Area
 - Land Swap to Mitigate Fan, Floodplain, and/or Resource Impacts
- Flood Hazard Rating**
- Low
 - Medium
 - High
- Future Corridor Type**
- Freeway
 - Parkway
 - Transit Corridor

Label	Planning Unit
A	Phoenix International Raceway
B	Estrella
C	Sonora
D	Sevenmile Mountain
E	Mobile
F	Waterman South
G	Vekol South
LW	Lum Wash
SOS	Secured Open Space
WR1 to WR5	Waterman Wash Reaches

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/Freeway
- Major Road
- Railroad
- River/Stream

Data Sources

Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
URS Corporation
Flood Hazard Rating and Alternative Data 2009

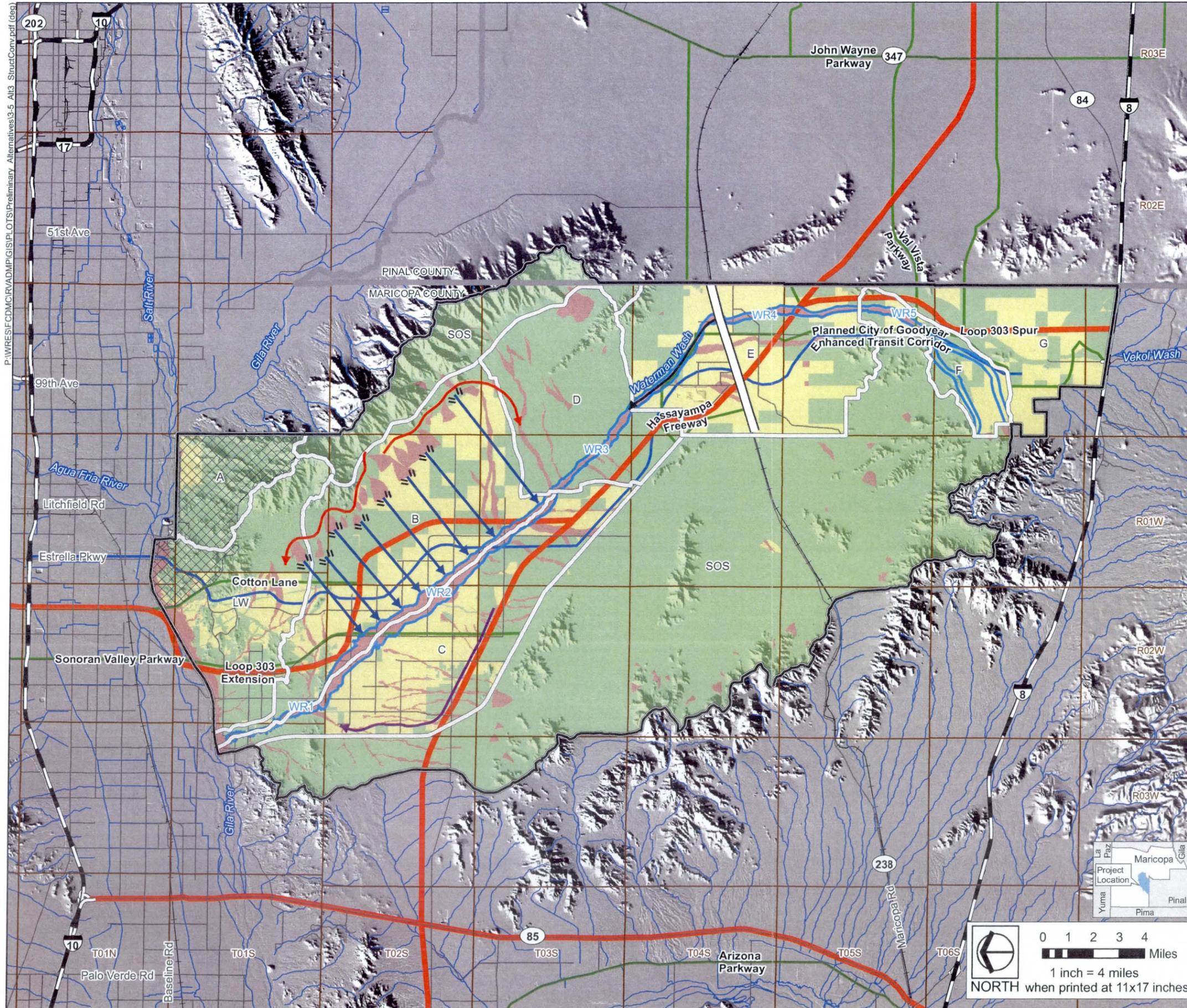
0 1 2 3 4 Miles
1 inch = 4 miles
NORTH when printed at 11x17 inches

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Rainbow Valley
Area Drainage Master Plan
Preliminary Alternative 3 - Structural Conveyance



Figure 3-5



Project Features

- Planning Unit Boundary
- Waterman Wash Reach (with ID)

Structural Conveyance

- Phoenix International Raceway (PIR) Conveyance (Should All Go to Gila River)
- Levee to protect UPRR
- Channelize Waterman Wash to a Soft or Semi-Soft Wash
- Channel to Waterman Wash (Typical)
- Channel to Waterman Wash or Gila River (5-Year Flood)
- Use Road Interceptor Channel Across Distributary Flow
- Berm Structures in Alluvial Fan

Future Corridor Type Flood Hazard Rating

- | | |
|------------------|--------|
| Freeway | Low |
| Parkway | Medium |
| Transit Corridor | High |

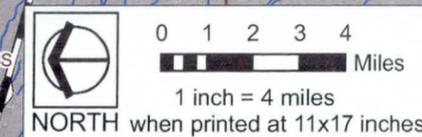
Label	Planning Unit
A	Phoenix International Raceway
B	Estrella
C	Sonora
D	Sevenmile Mountain
E	Mobile
F	Waterman South
G	Vekol South
LW	Lum Wash
SOS	Secured Open Space
WR1 to WR5	Waterman Wash Reaches

Reference Features

- | | |
|------------------------------|-----------------------------|
| County Boundary | Interstate Highway/ Freeway |
| Rainbow Valley ADMP Boundary | Major Road |
| Township and Range Boundary | Railroad |
| | River/Stream |

Data Sources

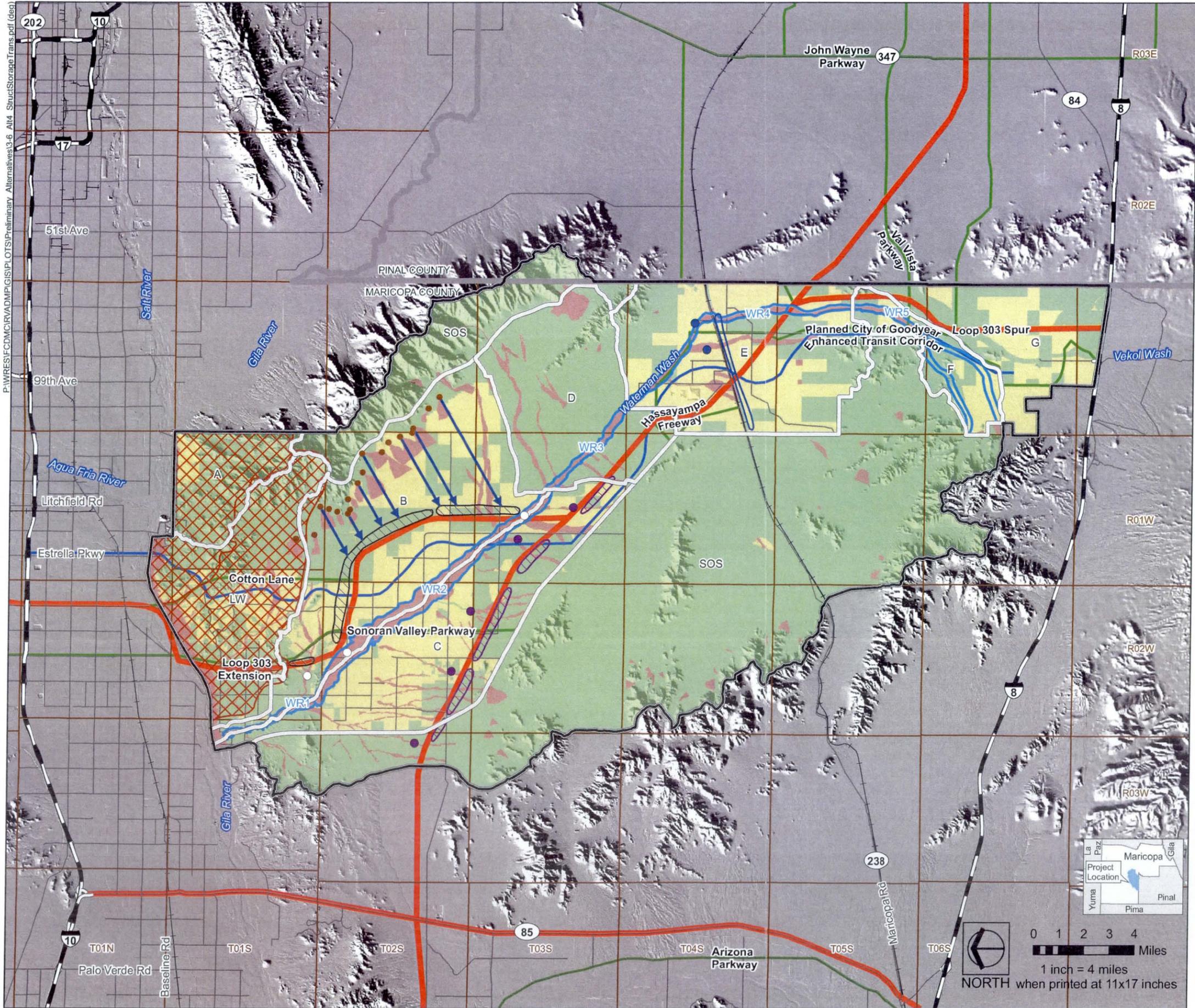
Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
URS Corporation
Flood Hazard Rating and Alternative Data 2009



Rainbow Valley
Area Drainage Master Plan
Preliminary Alternative 4 -
Structural Storage, Transportation Corridors



Figure 3-6



- Project Features**
- Planning Unit Boundary
 - Waterman Wash Reach (with ID)
 - Local Basins to Outfall in Major Washes on Estrella
 - Local Basins to Outfall in Major Washes on Sonora
 - Regional Basin Upstream of Roads and Union Pacific Railroad
 - Not Viable or Highly Effective
 - Apex of Alluvial Fan
 - Local Basins to Outfall in Major Washes on Estrella
 - Local Basins to Outfall in Major Washes on Sonora
 - Regional Basin Upstream of Roads and Union Pacific Railroad
 - Channel to Waterman Wash

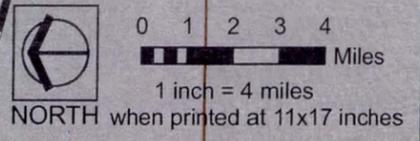
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|----------------------------|-----------------------------|
| Flood Hazard Rating | Future Corridor Type |
| Low | Freeway |
| Medium | Parkway |
| High | Transit Corridor |

- | | |
|--------------|-------------------------------|
| Label | Planning Unit |
| A | Phoenix International Raceway |
| B | Estrella |
| C | Sonora |
| D | Sevenmile Mountain |
| E | Mobile |
| F | Waterman South |
| G | Vekol South |
| LW | Lum Wash |
| SOS | Secured Open Space |
| WR1 to WR5 | Waterman Wash Reach |

- Reference Features**
- | | |
|---------------------------------|--------------------------------|
| County Boundary | Interstate Highway/
Freeway |
| Rainbow Valley
ADMP Boundary | Major Road |
| Township and Range
Boundary | Railroad |
| | River/Stream |

Data Sources

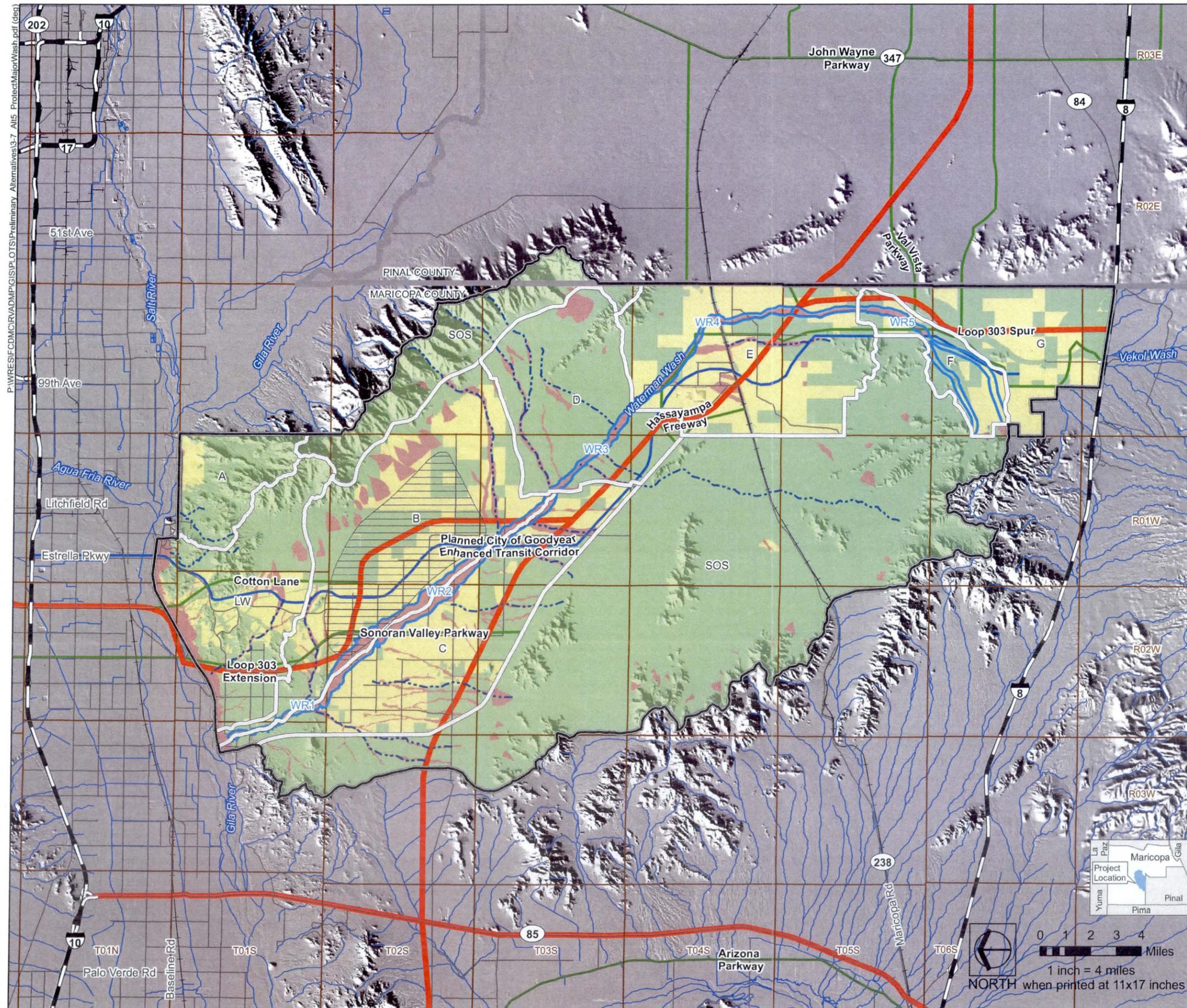
Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
URS Corporation
Flood Hazard Rating and Alternative Data 2009



Rainbow Valley
Area Drainage Master Plan
Preliminary Alternative 5 -
Protect Significant Wash Corridors



Figure 3-7



Project Features

- Planning Unit Boundary
 - Waterman Wash Reach (with ID)
 - No Major Wash Corridors
 - 500 Cubic Feet per Second (cfs) Wash
- Flood Hazard Rating**
- Low
 - Medium
 - High
- Future Corridor Type**
- Freeway
 - Parkway
 - Transit Corridor

Label	Planning Unit
A	Phoenix International Raceway
B	Estrella
C	Sonora
D	Sevenmile Mountain
E	Mobile
F	Waterman South
G	Vekol South
LW	Lum Wash
SOS	Secured Open Space
WR1 to WR5	Waterman Wash Reach

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/Freeway
- Major Road
- Railroad
- River/Stream

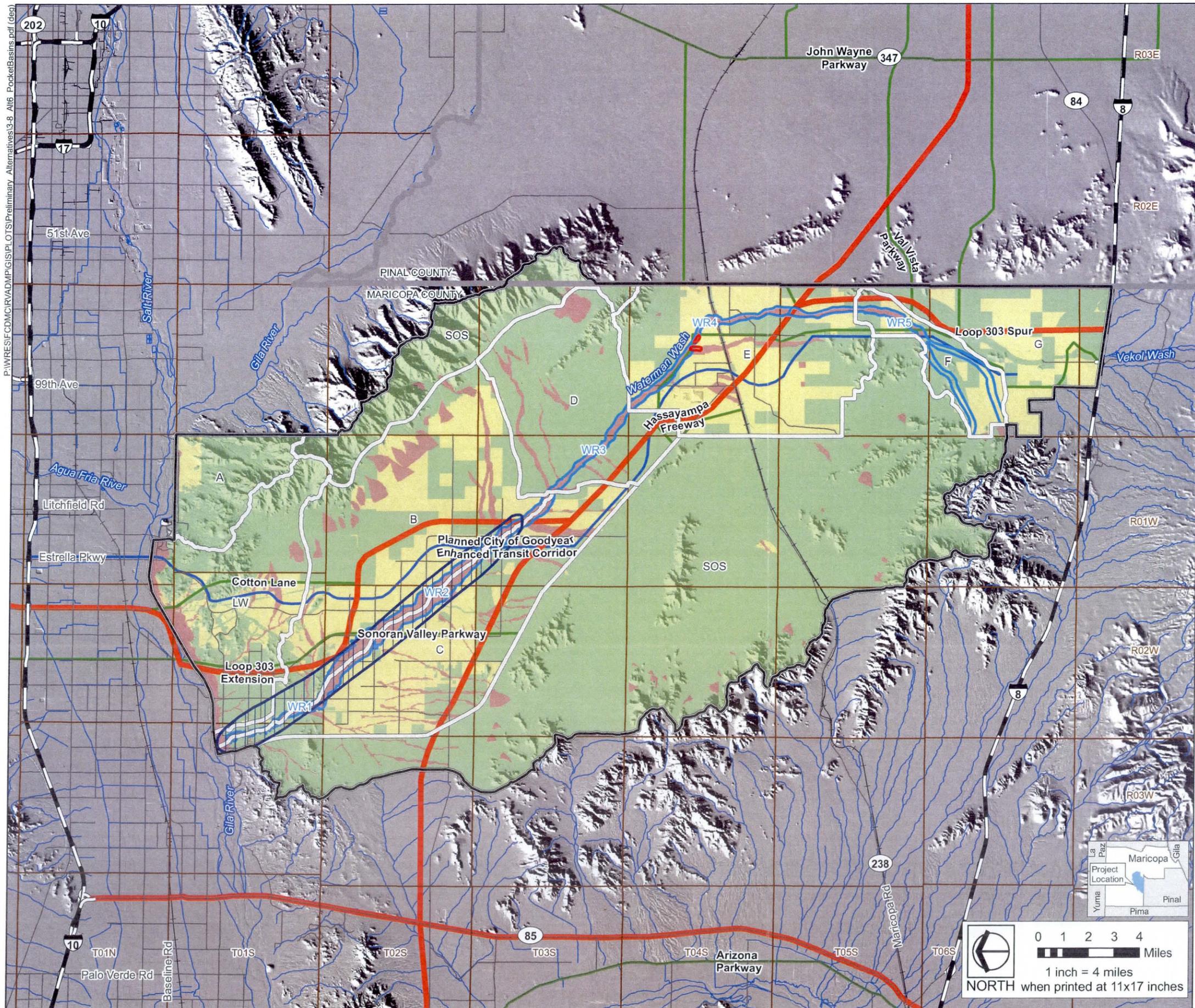
Data Sources

Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
URS Corporation
Flood Hazard Rating and Alternative Data 2009

Rainbow Valley
Area Drainage Master Plan
Preliminary Alternative 6 - Pocket Basins



Figure 3-8



- Project Features**
- Planning Unit Boundary
 - Waterman Wash Reach (with ID)
 - General Location of Pocket Basins in Flood Fringe
 - Pocket Basin
- Flood Hazard Rating**
- Low
 - Medium
 - High
- Future Corridor Type**
- Freeway
 - Parkway
 - Transit Corridor

Label	Planning Unit
A	Phoenix International Raceway
B	Estrella
C	Sonora
D	Sevenmile Mountain
E	Mobile
F	Waterman South
G	Vekol South
LW	Lum Wash
SOS	Secured Open Space
WR1 to WR5	Waterman Wash Reach

- Reference Features**
- County Boundary
 - Rainbow Valley ADMP Boundary
 - Township and Range Boundary
 - Interstate Highway/Freeway
 - Major Road
 - Railroad
 - River/Stream

Data Sources

Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
URS Corporation
Flood Hazard Rating and Alternative Data 2009

NORTH when printed at 11x17 inches

0 1 2 3 4 Miles

1 inch = 4 miles

P:\WRES\FCD\CMC\R\AD\MP\GIS\PILOTS\Preliminary Alternatives\3-8_Alt6_PocketBasins.pdf (dgn)



4.0 ALTERNATIVE EVALUATION

4.1 INTRODUCTION

The six alternatives described in the previous sections were presented to the agency stakeholders for discussion and approval at the Proposed Alternatives Selection Meeting on August 6, 2009. Upon approval of the proposed alternatives, the consultant team further developed and evaluated the proposed alternatives. The results of the evaluation are documented in this report section.

4.2 ALTERNATIVES DEVELOPMENT

As previously described, the study area was divided into 14 planning units that were considered to be reasonably uniform in character and would be appropriate for a single flood mitigation strategy to be applied throughout the planning unit. A key aspect of this approach is the need to respond to a wide range of flooding characteristics that are exhibited within the study area. Areas with various flow characteristics are delineated on the Flow Characteristics Map contained within the *Data Collection Report* and included here as Figure 4-1. Nine different flow characteristics are identified, ranging from riverine conditions typical of washes and rivers to unconfined sheet flow and uncertain flow path alluvial fan flooding. A suite of six flood management tools are identified for application within the study area; however, different tools will be effective within each of the flow characteristic areas just described. It was determined that each flood management tool would only be considered in areas where it would be effective. As a result, each of the six alternatives to be evaluated is only applied within the planning units where they are deemed to be effective. Table 4-1 shows each of the planning unit alternatives in a matrix format. Planning units where an alternative is deemed to be feasible or effective are highlighted in green. Planning units where an alternative is deemed infeasible or ineffective are highlighted in red. The alternative evaluation presented within this section is applied only to the planning units with effective alternatives as indicated by green shading (Table 4-1).

The development of the alternatives within the planning units where they are deemed effective is described in the following sections.

Table 4-1 Planning Unit Alternatives Matrix

PLANNING UNIT	PRELIMINARY ALTERNATIVE					
	1 – No New Action	2 – New Regulations	3 – Structural Conveyance	4 – Structural Storage, Transportation	5 – Protect Significant Wash Corridors	6 – Pocket Basins
A – Phoenix International Raceway (PIR)	Green	Red	Red	Red	Red	Red
B – Estrella	Red	Green	Green	Green	Green	Red
C – Sonora	Red	Green	Green	Green	Green	Red
D – Sevenmile Mountain	Green	Red	Red	Red	Red	Red
E – Mobile	Red	Red	Green	Green	Green	Red
F – Waterman South	Green	Green	Red	Red	Red	Red
G – Vekol South	Green	Red	Red	Red	Red	Red
LW – Lum Wash	Green	Red	Green	Red	Green	Red
SOS – Secured Open Space	Green	Red	Red	Red	Red	Red
WR1, WR2, WR3	Red	Green	Red	Red	Red	Green
WR4, WR5	Green	Green	Red	Red	Red	Green

WR1 to WR5 – Waterman Wash City of Goodyear – Conceptual Corridor Plan

WR1 to WR5 – Alternatives 3 and 4 based on compatibility mapping

Estrella – No New Action (Alluvial Fans and Sheet Flow Area will require flood hazard mitigation)

Sonora – No New Action (Distributary Flow and Uncertain Flow Paths will require flood hazard mitigation)

Alternative considered feasible in the Planning Unit



Alternative not feasible in the Planning Unit

4.3 HYDROLOGY FOR PROPOSED ALTERNATIVES

The following sections describe development of the hydrology for the six alternatives being analyzed for each planning unit. The hydrology is based on the future (developed) condition HEC-1 model for the Rainbow Valley ADMP study area.

4.3.1 Alternative 1

The first alternative is the “No New Action” alternative and applies to all the planning units. This alternative would use the current regulations of Maricopa County, City of Goodyear, City of Avondale, and Town of Buckeye for new developments in the project area. No modifications were done to the hydrology for this alternative.

4.3.2 Alternative 2

Alternative 2 would impose new drainage regulations on the Estrella and Sonora Planning Units with areas located in the City of Goodyear. The current drainage regulation for City of Goodyear requires new development to retain the 100-year, 6-hour rainfall event. The Estrella and Sonora Planning Units drain directly to Waterman Wash. This alternative proposes reducing the rainfall volume retained to a smaller storm, the 100-year, 2-hour storm. The diversions in the HEC-1 model have been modified so that the volume attributed to the smaller rainfall event has been diverted out of the model for this alternative.

In the Waterman Wash Planning Units, this alternative would allow encroachment in the floodplain fringe to floodway boundary (where applicable) without any compensating storage or conveyance. The routing sections in Waterman Wash were modified to increase the developable area in reaches that have existing floodways.

4.3.3 Alternative 3

The third alternative proposes structural conveyance in four planning units: Estrella, Sonora, Mobile, and Lum Wash (Figures 4-2 to 4-4). The channel dimensions that were used for the route reaches consisted of a trapezoidal channel section with 6-horizontal to 1-vertical side slopes (6H:1V), a depth of 5 feet, an average Manning’s N-value of 0.045, and a minimum bottom width of 20 feet.

4.3.3.1 Estrella Planning Unit

The Estrella Planning Unit proposes three options to collect and convey flows to Waterman Wash. The first drainage option is a channel that will collect flows from the alluvial fan apex and will convey these flows toward Waterman Wash. The first apex channel begins at basin H05 and flows northwesterly to basin I53, where it will flow west and flow into the wash at the concentration point of basin I65. The second apex channel begins at basin H17 and flows south through basin H22, where it is redirected west and flows into Waterman Wash at basin H74. The two apex channels will have 100-year capacity.

The second option proposed in the Estrella Planning Unit is diversion berms that will funnel flow from the alluvial fans and direct them to a main channel, which will carry the flows to Waterman Wash. There are five main channels carrying flow to Waterman Wash in this option. The third option for this alternative is a combination of the first two options. The apex channel in the third

option will have 5-year capacity; the excess flow will be directed to the bottom of the fans and conveyed through the five main channels proposed in the second option. The size of this conveyance channel will increase as it continues downstream and other sub-basins drain into the channel. In the third option, where the apex channel will be sized for the 5-year flow, the excess flow will be diverted to the downstream channels that flow to Waterman Wash. The apex channels will be designed to convey the 5-year flow from the alluvial fan apexes as well as the 100-year flow from adjacent sub-basins that drain into the channel. There are some downstream sub-basins that will be disconnected from upstream flow resulting from these proposed diversions.

4.3.3.2 Sonora Planning Unit

The Sonora Planning Unit proposes two conveyance channels that will collect flow from the alluvial fans and direct them to Waterman Wash. Each conveyance channel will cross the Hassayampa Freeway where a bridge/culvert conveys the water under the roadway. The first channel begins on the downstream end of sub-basin A11 and follows the Hassayampa Freeway alignment to the northwest, where it will cross the roadway through sub-basin A21. The channel continues through this sheet flow area through sub-basins A20, A32, and A52, eventually draining into an existing wash at the concentration point of sub-basin A52. This existing wash drains into Waterman Wash through sub-basin A56.

The second conveyance channel has two tributaries upstream of the Hassayampa Freeway. The first tributary begins at sub-basin B50 and flows northwest where it combines with the second tributary at sub-basin B26 and is conveyed under the Hassayampa Freeway. The second tributary begins at sub-basin A13 and flows southeast to sub-basin B26. This combined flow is routed through sub-basins in an improved channel to Waterman Wash.

The routed flow from upstream contiguous basins was collected and diverted in the HEC-1 model to the two crossings of the Hassayampa Freeway. This flow was routed to Waterman Wash in an improved channel, which collected flow from adjacent basins along its alignment. The channel dimensions in the affected route reaches increased as it collected this additional flow.

4.3.3.3 Mobile Planning Unit

The Mobile Planning Unit proposes a main conveyance channel that will collect flow upstream of the UPRR and will convey it to a main crossing at sub-basin F27. The channel begins at sub-basin E32 and flows to the northeast along the UPRR alignment to the crossing at sub-basin F27. An additional channel collects flow from sub-basin F28 and flows southwest to this crossing. Two smaller channels collect flow upstream of the UPRR and direct them into the Waterman Wash crossing at sub-basin F29. The main conveyance channel will be routed to Waterman Wash through basin F34 in an improved channel section.

Many of the existing diversions in the HEC-1 model will be removed for this alternative as flow is routed to the two proposed crossings. The improved channel will be sized to convey the 100-year storm event.

4.3.3.4 Lum Wash Planning Unit

The Lum Wash Planning Unit proposes a conveyance channel that will collect flow upstream at the alluvial fan apex at sub-basin J04 and convey this flow in an improved channel through sub-basin J07 to a Lum Wash tributary at the concentration point of sub-basin J16.

The diversion downstream of sub-basin J04 will be removed from the HEC-1 model, and this flow will be routed in an improved channel through sub-basins J07, J11, and J16. The improved channel will collect and convey flows from those sub-basins as well.

4.3.4 Alternative 4

Alternative 4 proposes structural storage in three planning units: Estrella, Sonora, and Mobile (Figures 4-5 to 4-6). This alternative consists of storage basins that are interconnected by a series of channels that will convey flow to Waterman Wash. The dimensions for these storage basins used a top area of 20 acres, 10-horizontal to 1-vertical side slopes (10H:1V), and a depth of 5 feet. An overflow weir was used to prevent warnings in the HEC-1 output when needed. The channel parameters were the same as those used in Alternative 3.

4.3.4.1 Estrella Planning Unit

Storage basins are proposed to collect the flows at the apices of the alluvial fans in the Estrella Planning Unit. These storage basins will drain into channels that flow southwest toward the proposed Loop 303 alignment. These channels drain into larger storage basins located upstream of the Loop 303 alignment. The Loop 303 storage basins are located within a single sub-basin. The Loop 303 alignment divides this planning unit into two sections, upstream and downstream (of the Loop 303 alignment). The Loop 303 storage basins will be inter-connected to either the north or south where flow will cross the proposed Loop 303 alignment. The southern channel section will cross Loop 303 by a bridge/culvert through sub-basin H71. This flow will be routed to Waterman Wash in an improved channel section. The north Loop 303 channel will split into two channels in sub-basin I29. The two northern channel sections will cross Loop 303 at two locations, in sub-basin I33 and sub-basin I50. These channels flow into Waterman Wash in an improved channel section through the sheet flow areas. There are instances in the upper areas of the planning unit where basins collect flow at the alluvial fan apex and divert the flow to another down gradient alluvial fan basin prior to discharge through the fan to basins along Loop 303.

A stage-storage and stage-discharge curve were used to represent the storage basins located at the alluvial fan apex. The basins were designed so that the maximum outflow during a 100-year storm event is 100 cfs. The channels that transport this flow to the Loop 303 alignment will accept flow from the sub-basins they intercept at the sub-basin concentration points. The channel section increases along its alignment due to this additional flow. The flow from these channels is collected in the Loop 303 storage basins along with the flow from the adjacent upstream drainage basins. These flows are then routed in a series of channels and storage basins along the Loop 303 alignment until they cross the roadway, where they are conveyed to Waterman Wash in an improved channel section. Where alluvial fan basins are inter-connected, flow is collected at the apex and then routed through a channel to the downstream basin. Where a sub-basin is split by Loop 303, a hydrograph for the split downstream basin is developed and discharged as in the present model until flow reaches Waterman Wash.

4.3.4.2 Sonora Planning Unit

The proposed Sonoran Parkway is a drainage barrier to the flows in this planning unit. The parkway's alignment is parallel to Waterman Wash at a distance of 6 miles. Storage basins will be located downstream of this roadway but upstream of the proposed Hassayampa Freeway alignment. These storage basins will be inter-connected and will cross the proposed freeway at six locations. Four of the six proposed crossings have distinct conveyances to Waterman Wash, and the other two washes have confluences downstream where a basin will capture flow. An improved channel section will be designed to convey this flow through the sheet flow area to Waterman Wash.

The diversions in the HEC-1 model due to the alluvial fans will be removed for this planning unit and replaced with storage basins. These storage basins are located upstream of the Hassayampa Freeway and will be inter-connected with improved channels that direct flow to the six crossing locations. Many sub-basins will be intercepted and routed in these new channels, which differ from their historic flowpaths. An additional storage basin will be located downstream of the Hassayampa Freeway at the northern end of sub-basin B65. This storage basin will collect flow from two crossing locations and outlet into one improved channel section that drains into Waterman Wash through this sheet flow area. At the northwest portion of the Hassayampa Freeway, flow will be conveyed to sub-basin A24 and discharged under the Hassayampa Freeway so that an existing wash can be utilized to route flows to Waterman Wash.

4.3.4.3 Mobile Planning Unit

There are two proposed drainage systems in the Mobile Planning Unit. The first drainage system will collect flows into two storage basins located upstream of the proposed Hassayampa Freeway in sub-basins F22 and F24. These storage basins are connected with an improved channel section and drain northwest into another channel that will cross the freeway at sub-basin F24. The second drainage system consists of five inter-connected storage basins collecting flow upstream of the UPRR. The farthest upstream basin begins in sub-basin E31 and crosses the UPRR at sub-basin F27. This drainage system crosses the proposed Hassayampa Freeway at sub-basin E25. The drainage system continues in an improved channel section south of the railroad that drains in a natural wash located in sub-basin F34. The wash flows into Waterman Wash.

Upstream flow will be routed into a storage basin located in sub-basins F22 and F23. The storage basin is inter-connected to the storage basin in sub-basin F24 by an improved channel section. The storage basin drains into a channel that flows into an unnamed wash at the north end of sub-basin F24. A series of storage basins along the UPRR replaces the diversions in the HEC-1 model. The routing of these sub-basins are modified so they drain east and cross the railroad at sub-basin F27. An unsteady HEC-RAS model may be used to size these basins in the Level III analysis.

4.3.5 Alternative 5

Designated Wash Corridors is the proposed solution for Alternative 5. These corridors are proposed in the Estrella, Sonora, Mobile, and Lum Wash Planning Units (Figures 4-7 to 4-9). This alternative will modify or add diversion records to the HEC-1 model to divert flows to the designated wash corridors.

4.3.5.1 Estrella Planning Unit

There are designated wash corridors proposed in the north and south portions of this planning unit. The flow characteristics in the central area of this unit are disturbed (near Waterman Wash due to the agricultural fields) and sheet flooding, so the corridors are not obvious. This limits the use of this alternative.

The HEC-1 model has been modified so that flow from adjacent sub-basins that will be developed in the future will be collected in these drainage corridors. The internal drainage system is expected to be designed by the developer. The HEC-1 modeling methodology assumes the developer will design their development in accordance with current regulations to meet water quality and discharge through basin storage. An improved channel section is assumed to collect and convey the flow from these developments; the developers will build these channels as part of their development.

4.3.5.2 Sonora Planning Unit

There are designated wash corridors proposed in the north and south portions of this planning unit. The drainage corridors are not obvious in the central area because flow characteristics in the central area are disturbed and distributary flow. This limits the use of this alternative. The most significant wash is the West Prong of Waterman Wash that confluences with Waterman Wash in the southern portion of the planning unit. Flows from adjacent sub-basins will be diverted to the designated wash corridors.

4.3.5.3 Mobile Planning Unit

Much of this planning unit's flow characteristics are either sheet flooding or distributary flow, and non-distinctive wash corridors are the result. There are a few corridors that begin south of the UPRR/SR 238 corridor where increasing flows could have a negative impact on existing infrastructure because increased peak flows could overtop structures where culvert and bridge crossings are undersized for the existing 100-year flood. Selection of these washes will require evaluation of the flow structures under SR 238 and the railroad. There are a few washes that can be used as wash corridors north (downstream) of the UPRR/SR 238 corridor.

Flow from sub-basins that will be developed adjacent to the designated wash corridors have been diverted to designated wash corridors. The developer would design their internal drainage system. The HEC-1 model assumes the developers would account for storage using existing regulations. The attenuated flows will be routed to the wash corridor utilizing a travel length equal to the average for the entire sub-basin being diverted. An improved channel section will be assumed as the means of flow conveyance, which means a grouping of developments will work together to convey flow to the designated wash corridors.

4.3.5.4 Lum Wash Planning Unit

The two existing washes located in this planning unit, Lum Wash and Corgett Wash, will be designated as wash corridors in this alternative. The flow from sub-basins that will be developed adjacent to the wash will be diverted into these wash corridors. The HEC-1 model assumes these new developments will account for storage using the existing regulations and the developer will design their internal drainage system. The attenuated flows have been routed to the wash corridor

utilizing a travel length equal to the average for the entire sub-basin being diverted. An improved channel section will be assumed as the means of flow conveyance. A grouping of developments can cooperate in constructing channels to convey flow to the designated wash corridors.

4.3.6 Alternative 6

A series of pocket (storage) basins located along the floodplain fringe of Waterman Wash is proposed for this alternative (Figures 4-10 and 4-11). The dimensions for these pocket basins used a top area of 20 acres, 10-horizontal to 1-vertical side slopes (10H:1V), and a depth of 5 feet. An overflow weir was used to prevent warnings in the HEC-1 output when needed if the pocket basin depth exceeded 5 feet. These basins were located along the entire Waterman Wash alignment in areas of the floodplain fringe where space was available to accommodate the 20-acre footprint. The pocket basins are assumed to capture flow and release this flow at the tail end of the flood hydrograph for Waterman Wash.

4.4. PROPOSED ALTERNATIVE 1 – NO NEW ACTION

4.4.1 Description

Flood hazard mitigation planning and development will occur according to the existing regulatory requirements and review. Flood protection will be the responsibility of local municipalities and developers to enforce and/or follow local and federal floodplain regulations and ordinances. Figure 4-12 shows the planning units and flood hazard ratings for the study area.

4.4.2 Estimated Cost

There are no capital costs associated with this alternative because there are no proposed structures or land that will need to be purchased.

4.4.3 Flood Hazard Protection

There was no additional analysis conducted for this alternative. The constraints, strengths, and weaknesses for this alternative remain the same as those resulting from the alternatives formulation (Section 3.4.2).

4.4.4 Multi-Purpose Benefits

Biological Resources. The No New Action alternative likely would provide a patchwork solution that would have little or no incentive to provide for biological resources (Figure 4-13). As the area develops, natural features that could convey wildlife movement would be lost or modified to an unsuitable condition, the quality of native habitat along Waterman Wash could decline, and there would be little or no preservation of east-west connections between the undeveloped open space on either side of Rainbow Valley. This likely would truncate wildlife movement and isolate populations of highland species that remain outside of developed areas.

BLM plans to maintain the identified open space north of the previously proposed Montage Development as a wildlife linkage between the Sierra Estrella Mountains and the Sonoran Desert National Monument will likely occur under this alternative. However, the planned development of large regional transportation corridors that will bisect the linkage may result in truncated wildlife movement. The maintenance of this linkage will require Arizona Game and Fish

Department (AGFD) along with MCDOT and ADOT to ensure that freeway development includes appropriate wildlife crossings.

Cultural Resources. Under the No New Action alternative, cultural resources would continue to be managed in accordance with federal and state regulations applicable to development of flood protection measures by local municipalities and developers. Opportunities for coordinated public interpretation of selected cultural resources would be unlikely.

Open Space, Scenery, and Recreational Resources. The implementation of multi-use benefits within the study area under the No New Action alternative will likely follow similar patterns as found throughout Maricopa County where development has recently occurred (Figure 4-14).

One important consideration under this alternative is the distinction between the implementation of facilities where multiple beneficial uses can be developed within one site as opposed to the development of single-use facilities that continue to meet the individual goals identified by the project stakeholders. This relationship between developing multi-use functionality on publicly owned lands and the increased density of benefits will likely be more difficult under this alternative, where the lack of regional flood hazard mitigation facilities and properties may result in single-use, privately developed drainage and storage features that are not co-located with other uses to meet any of the following goals.

To date, Maricopa County Parks and Recreation has successfully implemented segments of the Maricopa Trail in a variety of settings. The existing Intergovernmental Agreement (IGA) between the District and County Trails has served to facilitate this implementation process in areas where trail segments could be aligned with flood hazard mitigation projects. In the absence of the District as a partner, it is likely that the City of Goodyear and County Trails will need to partner to implement the primary segment along Waterman Wash. While this probably will occur, providing some opportunity to implement the trail, the possibility that all segments will not be implemented is a consideration under this alternative. The Waterman Wash segment will be the most likely trail segment developed as a true multi-use facility.

The development of local trail systems likely will occur as required by local municipalities and development planning. These potentially will be associated with existing and planned drainage features as well as along roadways.

Recreation facilities planned by the City of Goodyear also will likely occur under this alternative. The possibility of providing a multi-use facility where regional flood protection could be layered with recreational uses and facilities will be less likely under this alternative.

East-west connectivity under this alternative is likely to be minimal. While a few segments of the Maricopa Trail are shown to connect from the east and west to Waterman Wash, no known existing planning documents show an extensive multi-modal system for connecting the recreation and open space resources on both sides of the valley.

The establishment of a multi-use facility of some type at the confluence of the Gila River and Waterman Wash has not been shown on any known planning documents and will not likely occur under this alternative.

The impacts of the visual character of the region under this alternative will most likely be consistent with impacts of other development in the metropolitan Phoenix area (Figure 4-15). The maintenance of critical views of both the mountains from the valley as well as the overall character of the valley plains will change over time to one with more dense development and minimally preserved open-space. Impacts permitted under existing FEMA guidelines to Waterman Wash will have some of the most undesirable effects on the character of the valley for all viewers. The *Waterman Wash City of Goodyear Conceptual Corridor Study* (Preliminary Final Draft, February 25, 2008) will serve to mitigate some of these impacts within Waterman Wash if implementation measures can be adopted, although the opportunity for the District and the City of Goodyear to work together to accomplish the goals identified within the study will not be realized in this alternative.

Montage Development had originally developed plans that would extend the character of Waterman Wash to the south, at least to the UPRR. With the change of ownership of this property, the current plans to accomplish this goal are unknown and should be considered unlikely.

An existing problem in the Rainbow Valley ADMP study area is the continued disturbance of the visual and open space resources by off-highway vehicles (OHVs). Additionally, wildcat dumping in Waterman Wash occurs in many locations where roads cross the river and neighboring development is not dense enough to discourage this activity. These activities are unlikely to change under the No New Action alternative, though future development within the area may see the locations of disturbance move to less developed reaches. While individual landowners and developers may enhance or restore portions of the washes or improve open space resources within their property limits, a regionally significant plan to enhance or improve these resources is unlikely to occur.

404 Jurisdictional Delineation. Under the No New Action alternative, the area would retain its existing characteristics, modified by the effects of surrounding development and urban growth, as discussed above. Jurisdictional Waters of the United States in the area would not be impacted by actions from a drainage master plan but could be impacted by cumulative impacts of piecemeal off-site activities and developments. The U.S. Army Corps of Engineers encourages no impacts on Waters of the United States and supports retention of overall watershed connectivity to downstream/adjacent washes from upland activities. Thus, this alternative would be less advantageous than Alternatives 3, 4, 5, and 6 discussed below.

4.4.5 Regional Land Planning Compatibility

Land Use Plans and Development. Development will follow existing general plans, development regulations, and floodplain ordinances. This is acceptable for providing adequate flood protection where standard drainage and floodplain management practices can adequately control flows to adjacent and downstream properties. In the Estrella, Sonora, and Mobile Planning Units where alluvial fans are present and flow paths are unpredictable, developing properties to their maximum potential could be difficult because of lack of an integrated drainage system that controls floods. Similarly, where distributary and sheet flow are the predominate flow characteristics, regulators will need to be careful in permitting development as to not cause adverse impacts to neighboring property. This is especially true where off-site flow is collected

at multiple locations upstream at the property line, concentrated in channels, and then discharged downstream.

Present floodplain regulations allow for encroachment to the limits of the floodway along Waterman Wash in planning units WR 1, 2, and 3. Present regulations provide guidelines and regulation for these encroachments but may not provide adequate means to enforce compatibility between adjacent properties.

Regional Transportation Corridors. These linear impediments to flow can act as levees that pool water and discharge at set locations to downstream properties. It is incumbent on the owner to ensure the pooling does not flood upstream property and maintain downstream flow patterns. This is done through existing regulations by utilizing existing natural drainage features and providing for a means to spread concentrated flows downstream. If flows are concentrated, then an outfall will need to be provided to convey the flow to receiving bodies such as Waterman Wash and the Gila River.

Significant Utility Corridors. Existing regulations require coordination with utilities to ensure conflicts are remediated successfully. There are existing and proposed gas lines and transmission lines (overhead and underground) in most of the planning units that could require conflict resolutions. Existing regulations provide the means to resolve conflicts. Regulators should consider the location of new major infrastructure for water, sewer, cable, gas, and electric and the impact on implementation of existing regulations.

4.4.6 Implementation

The No New Action alternative requires no specific implementation steps as a follow-up to this ADMP. Planning units where no new action is deemed ineffective are not being considered for this alternative. As a result, for the remaining planning units where no new action is being considered, implementation will occur as part of the regular District and City of Goodyear oversight and regulation of development.

4.5 PROPOSED ALTERNATIVE 2 – NEW REGULATIONS

4.5.1 Description

Flood hazard mitigation planning and development will be guided by new regulations and/or rules of development. These regulations/rules of development will focus on reducing flood hazard risk through modifications to land-use plans, developing guidelines for areas with distributary flows, and coordinating planned road development to be responsive to flooding characteristics in a manner that minimizes structural flooding mitigation requirements and their associated costs. Other measures would include working with the City of Goodyear to develop additional implementation strategies for the *Waterman Wash City of Goodyear Conceptual Corridor Study*, developing guidelines for development in other floodplains to preserve or enhance the beneficial functions, and developing regional Section 404 mitigation banking strategies. Flood protection methods and design themes are described in Section 3.4.3. See typical plan and section (Figure 4-16).

4.5.2 Estimated Cost

There are no capital costs associated with this alternative because there are no proposed structures or land that will need to be purchased. There will be minimal costs associated with reviewing proposed developments using the new guidelines, but that cost can be recovered by the review fee associated with the proposed development.

4.5.3 Flood Hazard Protection

There are many opportunities for new regulations associated with planning units Estrella, Sonora, and Waterman South, especially in alluvial fan, distributary, and sheet flow areas where present regulations do not adequately address these flow characteristics. These new regulations will need to go through the governmental process for approval but will provide for more effective drainage and flood management through rules of development, ordinance changes, and new floodplain mapping. Specific studies could be done to evaluate the impact of existing regulations pertaining to erosion, flow attenuation through storage and use (filling) of the floodway fringe (encroachment to the outer limits of the floodway).

The existing drainage regulations for the City of Goodyear require retention for the 100-year, 6-hour rainfall event, while the County's retention regulation only requires the 100-year, 2-hour rainfall event. Alternative 2 proposed changes to the retention requirements but has not suggested any changes to the floodplain regulations. The hydrology for the study area was modified for the proposed changes to retention requirements as described in Section 4.3.2. By changing retention requirements to a smaller rainfall event, less retention volume will be required. Less required retention volume translates into less area required for retention basins, allowing more land to be developed. The results showed that the future condition flows into Waterman Wash will increase due to the reduction in required retention volume in the areas lying within the City of Goodyear's limits. As such, future developments that are adjacent to the floodplain fringe for Waterman Wash will have a higher pre-development discharge to contend with when conducting a "pre versus post" analysis. As mentioned previously, this alternative should be effective in responding to the future flooding context by addressing the potential impacts caused by future development in areas with flow characteristics that would result in a high flooding hazard risk level. The impacts to the peak discharges in Waterman Wash are presented below.

Table 4-2 Waterman Wash Flow Summary – Proposed Alternative 2

HEC-1 Location along Waterman Wash	Distance ¹ (miles)	Existing Conditions (cfs)	Future Conditions (cfs)	Alternative 2 (cfs)
F33RIV	25.9	1,050	650	900
E49RIV	24.4	2,000	2,550	2,600
D29RIV	20.7	5,400	5,050	5,100
D40RIV	17.2	5,650	4,700	4,850
B15RIV	15.4	10,400	10,000	10,050
B62RIV	11.0	12,900	12,350	12,300
H86RIV	10.1	13,000	12,400	12,450
A42RIV	8.7	13,100	12,450	12,600
I37RIV	7.1	13,050	12,350	12,650
A51RIV	4.2	13,400	12,650	13,350
A62RIV	0.4	13,550	12,950	13,700

Note: All models are the 100-year 24-hour with railroad models

¹ Distance upstream from the Waterman Wash confluence with the Gila River

4.5.4 Multi-Purpose Benefits

Biological Resources. New development regulations could accommodate biological values better than Alternative 1 (Figure 4-17). New regulations for drainage could secure natural channels, set aside high-quality natural areas as non-development easements, and maintain connections for wildlife movement east-west across Rainbow Valley. Where development encroaches on the floodplain of Waterman Wash, there would be a decrease in the quality of habitats in those areas. The greatest drawback to this alternative is the uncertainty of implementing regulations that do accommodate biological values.

BLM plans to maintain the identified open space as a wildlife corridor between the Sierra Estrella Mountains and the Sonoran Desert National Monument, which will likely occur under this alternative. Specific wash areas within this open space could serve as mitigation banks, which with other value-added features could provide a layer of protection that would serve to preserve planned protections in the face of changing political objectives. Road crossing issues would be similar to the No New Action alternative, requiring coordination between AGFD and transportation planning agencies, unless new regulations include requirements for road construction in this area. One example could be the use of “land swaps” to help protect the large western tributary of Waterman Wash Reach 2, which could, in turn, be identified as the major wildlife crossing location for the corridor.

Cultural Resources. The new regulations alternative could result in coincidental protection of cultural resources in conjunction with Section 404 mitigation banking or land exchanges associated with the alternative. Drainage development districts might provide a framework for coordinated public interpretation of selected cultural resources.

The opportunity to designate the confluence of the Gila River and Waterman Wash as an area of cultural and biological significance could occur under this alternative if appropriate planning and policy guidelines are developed to this end. As an area where two important drainage features meet, this goal could have positive impacts for many other of the above goals, including recreation, open space, and wildlife linkage impacts. Opportunities to interpret cultural resources

in this area may be possible at this location as well. However, no currently proposed plans or new regulations have been identified specifically for this area.

Open Space, Scenery, and Recreational Resources. Important measures that could positively impact the inclusion of multi-use benefits in flood hazard mitigation planning under this alternative include the opportunities to limit impacts to Waterman Wash through implementation and improvement of the *Waterman Wash City of Goodyear Conceptual Corridor Study* goals and objectives; working with local municipalities and agencies to develop guidelines for development in other floodplains to preserve or enhance the beneficial functions served by these floodplains; and developing Section 404 mitigation banking strategies for the project area that allow developers to work with local and regional agencies to focus floodplain restoration or enhancement measures where they will have a greater cumulative beneficial impact than individual, project-by-project mitigation may be able to be accomplished (Figures 4-18 and 4-19).

As with the No New Action alternative, it is important to consider the distinction between the implementation of facilities where multiple beneficial uses can be developed within one site as opposed to the development of single-use facilities that continue to meet the individual goals identified by the project stakeholders. Taking a regional approach to the relationship between land use planning and flood hazard mitigation planning should provide many opportunities to co-locate regional flood hazard mitigation facilities and properties with other uses to meet many of the following goals.

The success of this alternative in achieving the identified goals below is dependent on successful adoption and implementation of the new regulations.

Implementation of the Maricopa Regional Trail segments identified within the Rainbow Valley ADMP study area will be reliant on the existing IGA between the District and County Parks & Recreation Department as well as new agreements with the City of Goodyear. Inclusion of the regional trail as part of the implementation of the *Waterman Wash City of Goodyear Conceptual Corridor Study* will be an important part of ensuring this pedestrian linkage is established as well as serving to provide a higher value open space experience for the trail users. Additional trail segment implementation will be dependent on integration of multi-use recreation as one of the beneficial functions associated with floodplain preservation and enhancement. Existing significant washes could be identified for preservation or enhancement that could serve to meet this linkage goal.

As with the regional trail, the development of a regionally significant local trail system will be enabled through the recognition that the preservation and enhancement of existing floodplains as natural drainage corridors, and this is coupled with their use as passive recreation routes.

Recreation facilities planned by the City of Goodyear will also likely occur under this alternative, although no currently identified new regulations would have a significant impact on facilitating active recreation development. The possibility of providing a nature-based multi-use facility associated with areas identified for mitigation banking could be achieved under this alternative.

East-west connectivity under this alternative is likely to be associated with drainage district development and preserved or enhanced natural drainages.

Successfully implementing new regulations that focus on preserving the existing character of Waterman Wash as well as enhancing or protecting the natural and beneficial functions served by existing floodplains can have positive impacts on the visual character of the region. These goals should result in flood mitigation measures being undertaken that fully complement the desired character of the region as natural or enhanced natural drainages. Working with the City of Goodyear to develop implementation measures for the *Waterman Wash City of Goodyear Conceptual Corridor Study* will serve to protect and enhance this significant wash which is a major part of the character of the Rainbow Valley area.

One goal of the new regulations would be to use the disturbed or poorly defined reaches of Waterman Wash for the drainage functions and enhancement, resulting in an extension of the wash character farther south. These same regulations could serve to improve other damaged floodplains and disturbed open space areas.

404 Jurisdictional Delineation. Similar to the No New Action alternative, Jurisdictional Waters of the United States would not be directly impacted. However, continued surrounding development and urban growth could contribute to cumulative impacts on Waters of the United States.

4.5.5 Regional Land Planning Compatibility

Land Use Plans and Development. Existing local, state, and federal regulations should be adequate in providing development with guidance in the Lum Wash, PIR, Vekol South, and Mobile Planning Units. The Secured Open Space and Sevenmile Mountain Planning Units are mostly local, state, and federally (BLM) owned lands that are protected by existing regulations too. Opportunities for new regulations and guidelines such as proposed in the *Waterman Wash City of Goodyear Conceptual Corridor Study* can be implemented for WR 1 through WR 5. Section 4.5.3 briefly discusses the means for developing new regulations for the Estrella, Sonora, and Waterman South Planning Units.

Regional Transportation Corridors. These corridor alignments presently block sheet and concentrated flow. The present regulations only require the transportation or local agency ensure they meet existing regulations pertaining to adverse floodplain impacts, water quality impacts, and drainage patterns. New regulations could provide incentives to the roadway owner to directly plan and construct water crossings that minimize their hydraulic impact, maintain sub-basin and downstream flow integrity, sediment continuity, and allow for partnerships with the private community in developing joint use projects.

Significant Utility Corridors. Partnerships between the utilities and local governments when planning new corridor alignments is vital to maintaining existing flow characteristics. Locating underground utilities may be detrimental to existing natural wash alignments. Cities should obtain buy-in from utilities that own linear corridors that could impact the potential for taking advantage of opportunities in developing new regulations. Regulators should consider the location of new major infrastructure for water, sewer, cable, gas, and electric and the impact on implementation of new regulations.

4.5.6 Implementation

Depending on the nature of the regulations, implementation will require ordinances, policies, guidelines, and/or manuals to be adopted and enforced. For implementation to be successful, political and agency support would be required so that the enabling documents could be approved by governing bodies. The cost of implementation would be relatively low as compared to structural alternatives. The partner cities would become partners and in many cases would take the lead in implementation. The potential for phasing of implementation would need to be investigated; however, phasing of new regulations would not have the same economic impact as phasing of structural improvements. The District is currently considering initiating further investigation and development of this alternative.

4.6 PROPOSED ALTERNATIVE 3 – STRUCTURAL CONVEYANCE

4.6.1 Description

This alternative provides flood protection through the construction of floodwater interception and conveyance structures (Figure 4-20). Proposed structures include a series of training berms-levees within the alluvial fan in the planned development areas; a single diversion channel along the apex of the alluvial fans in the Estrella Planning Unit; a proposed channel downstream of the proposed Hassayampa Freeway adjacent to the Sonoran Desert National Monument in the Sonora Planning Unit; a channel-levee upstream of the UPRR within the limits of proposed development in the Mobile Planning Unit; and additional alluvial fan apex basins in the Waterman-South Planning Unit. Flood protection methods and design themes are described in Section 3.4.4.

4.6.2 Estimated Cost

The estimated cost for this alternative ranges from \$106.1 million to \$110.6 million depending on the alternative used through the Estrella development, which is described in Section 4.6.1 (see Table 4-3). This alternative has the second lowest cost estimate for structural alternatives. The main cost component of this alternative is land cost associated with the required right-of-way. See Appendix B for detailed cost estimates.

The next significant cost associated with this alternative is the channel construction, which mainly consists of excavation costs. The channel sizes were determined in the HEC-1 model and costs for the channel construction were estimated per linear foot. The disposal of the excavated material was not considered at this stage of analysis. A summary of the Alternative 3 cost estimate for each planning unit is presented below. See Appendix B for detailed cost estimates.

Table 4-3 Alternative 3 Cost Estimate

Cost Estimate Totals	Alternative 3			
	Planning Unit	Total	Range in Value	
			Low Value	High Value
Lum Wash	\$3,700,000	–	–	
Mobile	\$11,400,000	–	–	
Sonora	\$16,600,000	–	–	
Estrella Alt 1	\$49,800,000	–	–	
Estrella Alt 2	\$49,800,000	–	–	
Estrella Alt 3	\$53,200,000	–	–	
Total		\$81,600,000¹	\$85,000,000²	
with Contingency (30%)		\$106,100,000	\$110,600,000	

¹ Estrella Alternative 1 or 2

² Estrella Alternative 3

4.6.3 Flood Hazard Protection

This alternative evaluated the use of channels, as structural conveyance, to mitigate the various types of flooding that occur throughout the planning area. The channels evaluated in this analysis consist of a trapezoidal section with side slopes of 6-foot horizontal to 1-foot vertical (6H:1V), a depth of 5 feet, a weighted Manning’s roughness coefficient of 0.045, and a varying bottom width. Structural conveyance was evaluated for the Lum Wash, Estrella, Sonora, and Mobile Planning Units. The 100-year 24-hour storm event was used to size the channels (see Table 4-4). The natural channel routing sections in the HEC-1 models were updated with the proposed trapezoidal channel sections. The initial results of the HEC-1 analysis were evaluated to ensure that the proposed channel sections have sufficient conveyance capacity. The channel sections were adjusted when needed to provide sufficient capacity. The resulting channel top-widths ranged from 80 feet to 260 feet.

The results of the analysis show that the structural conveyance alternative is an effective means of addressing the flooding context. A channel can eliminate existing flooding problems by consolidating the flooding to a set width. In turn, this maximizes the developable area that is subjected to flooding. This is most apparent in the Estrella Planning Unit where the flooding characteristics are predominantly distributary and sheet flow type flooding. This alternative responds to the existing flooding context by mitigating the areas of known flooding near SR 238.

The proposed channel system confines the flooding to the channel corridors and eliminates the flood hazard that would otherwise be spread out over a large area. The structural conveyance alternative is a low to moderate passive system, where little to moderate human intervention is required for the channels to function properly during a flood event. The vegetation in the channel would have to be maintained so that conveyance capacity would not be hindered. Sedimentation or erosion also would have to be monitored and maintained depending on how the channel was designed.

This alternative would assume that the appropriate retention requirements be provided for developments draining to the various channel alignments. The implementation of the proposed channels would deviate from the natural hydrologic processes by concentrating flows to specific corridors. The concentrated flows could increase the peak discharges to Waterman Wash if the

retention regulations were not enforced. The impact to the peak flows in Waterman Wash are presented below.

Table 4-4 Waterman Wash Flow Summary – Proposed Alternative 3

HEC-1 Location along Waterman Wash	Distance ¹ (miles)	Existing Conditions (cfs)	Future Conditions (cfs)	Alternative 3 (cfs)
F33RIV	25.9	1,050	650	650
E49RIV	24.4	2,000	2,550	3,300
D29RIV	20.7	5,400	5,050	5,050
D40RIV	17.2	5,650	4,700	4,700
B15RIV	15.4	10,400	10,000	9,950
B62RIV	11.0	12,900	12,350	12,000
H86RIV	10.1	13,000	12,400	12,050
A42RIV	8.7	13,100	12,450	12,100
I37RIV	7.1	13,050	12,350	12,600
A51RIV	4.2	13,400	12,650	12,550
A62RIV (confluence with Gila River)	0.4	13,550	12,950	12,400

Note: All models are the 100-year 24-hour with railroad models

¹ Distance upstream from the Waterman Wash confluence with the Gila River

4.6.4 Multi-Purpose Benefits

Biological Resources. The second option within this alternative would provide the best preservation of biological characteristics in Rainbow Valley (Figure 4-21). Diversion berms at alluvial fans could serve to direct wildlife into channels. The numerous channels that lead into Waterman Wash in the Sonoran and Estrella Planning Units would preserve the shortest east-west connections for wildlife movement across the valley. These could enhance the available habitat in developed areas if channels are constructed with natural characteristics. The channels also could provide wildlife-friendly undercrossings where these pass beneath the Hassayampa Freeway and Sonoran Valley Parkway. The absence of modifications to Waterman Wash would preserve its natural biological qualities.

The first option in the Estrella Planning Unit under this alternative would create the most unnatural change to the biological character of Rainbow Valley of any of the six alternatives. Two 100-year capacity channels that direct flows north or south before turning east would block the majority of east-west movements for wildlife and direct wildlife into only two movement areas. The additional flows into the two channels could degrade the vegetation in those areas. If the channels would require hard structures to prevent erosion, then these would be partially or wholly unusable for wildlife. This option also would provide many fewer possible wildlife undercrossings beneath the Sonoran Valley Parkway.

The third option in the Estrella Planning Unit would provide intermediate benefits and some negative impacts to biological resources relative to Option 1 or 2. The smaller, 5-year capacity of the north-south channels would be less of an obstruction for wildlife, and the numerous east-west channels could still preserve natural movement patterns for wildlife across the valley. This option also would include the benefit of numerous and possibly wildlife-friendly undercrossings beneath the Sonoran Valley Parkway.

In the Mobile Planning Unit, proposed channels could help to direct wildlife to two underpasses beneath the UPRR and SR 238. Improvements to Waterman Wash in this planning unit could enhance the biological value of vegetation along its banks, which could help to enhance the area as a possible wildlife corridor.

The Lum Wash Planning Unit would provide channels that could function to move wildlife toward the Gila River and the northern end of Waterman Wash. This may help to partially restore an historic wildlife corridor from the northern Sierra Estrella to the Buckeye Hills that has been lost to development.

No new conveyance features are planned within the identified wildlife corridor between the Sierra Estrella Mountains and the Sonoran Desert National Monument. However, the District's drainage development or specific wash areas within this open space could serve as mitigation banks, which with other value-added features could provide a layer of protection that would serve to preserve planned protections in the face of changing political objectives. Road crossing issues will be similar to the No New Action alternative, requiring coordination between AGFD and transportation planning agencies.

Cultural Resources. Construction of facilities for the structural conveyance alternative could disturb archaeological and historical sites but they would be inventoried, evaluated, and treated in accordance with applicable state and federal regulations. If outdoor recreation facilities are developed in conjunction with construction of conveyance channels in the Mobile Planning Unit, there could be opportunities to publicly interpret the history of the Mobile African-American community, and the Juan Bautista de Anza National Historic Trail. Similarly, the Komatke Trail might be publicly interpreted in conjunction with conveyance channels in the Estrella Planning Unit. [The Komatke Trail is an aboriginal shortcut across the bend of the Gila River. Father Kino and Captain Manje followed the Komatke Trail in 1699 on a return trip from the Colorado River (*Trails, Rock Features and Homesteading in the Gila Bend Area: A Report on the State Route 85, Gila Bend to Buckeye, Archaeological Project*, 2003, edited by John L. Czarasty, Kathleen Peterson, and Glen E. Rice, Anthropological Field Studies 43, Arizona State University, Tempe, Arizona). The trail was not identified in the cultural overview prepared prior to initiation of the ADMP and no physical evidence of the trail has been identified in the Rainbow Valley. Nevertheless, the trail has potential for public interpretation.]

Open Space, Scenery, and Recreational Resources. The implementation of regional drainage facilities will have a varied impact on the opportunity to co-locate multi-use facilities with these drainages. As a general guideline, linear recreation facilities will be benefited by the addition of linear drainages while the effects of these drainages could have both positive and negative impacts on biological and open space resources as discussed below (Figures 4-22 and 4-23).

Implementation of the Maricopa Regional Trail segments identified within the Rainbow Valley ADMP study area will be likely under this alternative. In addition to the segment along the Waterman Wash reaches, opportunities to connect the Gila River system with the Estrella Mountain Region Park could occur through a trail in the proposed drainage in the Lum Wash Planning Unit. Trail linkages along any one or combination of drainages planned for the Estrella and Sonora Planning Units could be used as part of the regional or local trail system, while the

proposed drainage in the Mobile Planning Unit could also serve to create a linkage along the SR 238 alignment.

The City of Goodyear has proposed an open space or linear recreation area along the SR 238 route. The proposed drainage in the Mobile Planning Unit upstream of the railroad line could be co-located with this proposed recreation facility. Also, the majority of the other planned parks occur within the Estrella Planning Unit. While it is not likely that the drainages would be able to fully accommodate an active-use facility, the drainage and proposed parks could be co-located in a way that provides some shared area and benefit.

East-west connectivity is very likely to be achieved under this alternative if the east-west conveyances are selected. The success of this alternative in achieving this goal is associated with the inclusion of a multi-modal trail system in conjunction with the tributary drainages being proposed in the Estrella, Sonora, Lum Wash, and Mobile Planning Units. If the alternative drainages are proposed that capture flows along the apex of the alluvial fans (shown in pink), this goal could still be achieved though it would be limited to the few drainages that empty directly into Waterman Wash.

No plans have been developed for Waterman Reach 1 under this alternative that would include a multi-use facility at the confluence of the Gila River and Waterman Wash.

Implementation of semi-soft channels with sufficient right-of-way to allow for channel meander and buffering would be considered complementary to the visual character of Rainbow Valley. In future urban areas, the use of hard structures with enhanced aesthetics could also be complementary assuming that the design of the channel serves to provide for additional benefits within a similar zone of use and maintains a high level of visual aesthetic in its overall design. New drainages should each be planned and designed in accordance with the local visual context to ensure they complement the desired character.

The creation of new drainages that replicate natural washes would serve to enhance the overall landscape character for the region. These benefits are best realized in the Lum Wash and Estrella Planning Units where the proposed drainages will likely occur where there is not currently a natural drainage system and, in the case of the proposed Lum Wash channel, could serve to enhance the existing drainage that this proposed channel empties into. However, where flood hazard mitigation requires channelization of an existing drainage, the impacts to the natural vegetation and channel character would result in a decrease in visual character of that area. Channel alignments that provide for open space preservation and align with the mountain regions that form the distant views from within the valley would help preserve viewshed corridors within future development regions. Preserving or enhancing Waterman Wash along with other natural tributary washes and adding additional naturally themed channels would help to preserve some of the character of the valley for viewers from the mountains, though it is unlikely this will be able to fully mitigate the impacts that future development will have on the views for these users.

By creating new drainages that replicate natural washes in areas where future development is planned to occur, open space areas associated with these drainages will be preserved in areas where they would have otherwise been lost.

404 Jurisdictional Delineation. This alternative could result in dredge and fill impacts on Jurisdictional Waters of the United States. Dredge and fill activities would only occur within documented ordinary high-water mark areas within a wash which has not yet been identified. Under this alternative, dredge and fill activities would be required at approximately 11 locations on Waterman Wash for development of conveyance channels. No dredge and fill activities would occur on Corgett Wash or Lum Wash. Although the activities would result in semi-soft channels or natural channels, dredging activities would likely be required to accomplish the structural conveyance alternative versus no dredge and fill activities under Alternatives 1 and 2.

4.6.5 Regional Land Planning Compatibility

Land Use Plans and Development. Structural conveyance projects are proposed for the Sonora, Estrella, Mobile, and Lum Wash Planning Units. The conveyance channels are compatible with the City of Goodyear's general plan amendment by providing the Sonoran Valley Planning Area a means for positive drainage from the foothills/alluvial fan areas to Waterman Wash. Coordination with development will enhance opportunities for concentrating flows in selected corridors with tie-ins from the adjacent internal drainage facilities. There will be less chance of haphazard control of both on- and off-site drainage that can cause unexpected flood impacts. Dedicating corridors for flood conveyance can also improve land use by having a receiving body accept and control flows. These conveyance corridors also will improve community connectivity if planned properly. In the Sonora Planning Unit, structural conveyance reduces upstream off-site flows from Sonoran Desert National Monument, which will assist development in controlling off-site flow in the distributary flow areas southwest of Waterman Wash.

Regional Transportation Corridors. In the Mobile and Sonora Planning Units, this alternative takes advantage of the UPRR alignment and proposed Hassayampa Freeway. Flows are collected upstream of these transportation structures and diverted by channels to specific locations (existing conveyance corridors) where the flow is discharged to Waterman Wash. The channel design should be coordinated with the design of the Hassayampa Freeway to reduce the number of culvert crossings of the freeway and outfall channel systems to Waterman Wash.

Significant Utility Corridors. Coordination will be required with El Paso Gas (gas pipeline), Tucson Electric and Power Company (overhead transmission lines), and APS (overhead transmission lines) where proposed conveyance alignments may intersect with existing above- and underground facilities. The conveyance corridors need to be coordinated with future infrastructure associated with water, sewer, electric, gas, and cable lines. Providing multi-use utility corridors that co-exist with the conveyance channels is preferable. Since this alternative is structural, engineering solutions are viable.

4.6.6 Implementation

Implementation of the structural conveyance alternative will require participation through partnering from the cities and developers in terms of funding and construction. With these partners in place, there would be multiple funding sources available. Due to the multiple, parallel conveyance channels aligned between the headwaters in the mountains and the outfalls at Waterman Wash, there are good opportunities for phasing implementation. Each channel system is independent of the other channels identified in the plan. Therefore, the implementation of one or more of the channels could be initiated as triggered by a new development project. The level

and means of participation by the District would need to be determined. It is conceivable that implementation could be accomplished through developers via development agreements established with the City of Goodyear. The District may become involved to fill in development gaps to create a complete system.

4.7 PROPOSED ALTERNATIVE 4 – STRUCTURAL STORAGE, TRANSPORTATION CORRIDORS

4.7.1 Description

This alternative provides flood protection through the construction of floodwater interception and storage structures that would be shared with the large planned transportation facilities such as the Loop 303 and the proposed Hassayampa Freeway. Flood storage basins would be located upstream of these roads with the opportunity to partner with MCDOT or ADOT sharing the use of these basins to concentrate floodwaters in a single series of facilities rather than using two separate flood protection systems. Other structures proposed in this alternative include a storage basin upstream of the UPRR within the Mobile Planning Unit and small apex storage basins on the alluvial fans. Flood protection methods and design themes are described in Section 3.4.5 (Figure 4-24).

4.7.2 Estimated Cost

The estimated cost for this alternative is \$218.1 million, which is the second largest cost estimate (see Table 4-5). There are two main cost components for this alternative—land cost and excavation. Excavation costs are greater than Alternative 3, and land costs are not significantly different. The land costs are for the required right-of-way. There are no access roads or maintenance roads that were considered for the storage basins. The estimated costs for the channel construction considered as a contingency cost grade control structures, erosion protection, and roadway culverts. See Appendix B for detailed cost estimates.

The channel sizes were determined in the HEC-1 model and costs for the channel construction were estimated per linear foot. The storage basin used in this alternative assumed a 20-acre top width footprint with 10-horizontal to 1-vertical (10H:1V) side slopes and a 5-foot depth. The disposal of the excavated material was considered as a contingency cost. The amount of material that will need to be disposed is greatest for this alternative. A summary of the Alternative 4 cost estimate for each planning unit is presented below. See Appendix B for detailed cost estimates.

Table 4-5 Alternative 4 Cost Estimate

Cost Estimate Totals	Alternative 4
Planning Unit	Total
Lum Wash	–
Mobile	\$14,200,000
Sonora	\$68,000,000
Estrella	\$85,600,000
Total	\$167,800,000
with Contingency (30%)	\$218,100,000

4.7.3 Flood Hazard Protection

Storage basins in the planning area have been located along the upstream side of planned transportation corridors and at the apices of alluvial fans. The retention basins along the transportation corridors will be interconnected with channels and will ultimately discharge into Waterman Wash. The retention basins at the alluvial fan apices will discharge into designated channel corridors that either discharge into the retention basins along the transportation corridors or discharge directly into Waterman Wash. The Structural Storage alternative was applied to the Estrella, Sonora, and Mobile Planning Units.

The HEC-1 model for this alternative assumed that retention basins would have a 20-acre footprint and have a depth of 5 feet. The outlet structure consisted of a weir that discharged 100 cfs during the 100-year 24-hour storm event. In the case where the 100 cfs outlet discharge was exceeded, the basins were allowed to overtop. The outlet discharges were then routed through a trapezoidal channel section to the next downstream retention basin. The channel geometry was defined as a channel with a depth of 5 feet, 6 feet horizontal to 1-foot vertical (6H:1V) side slopes, a composite Manning's roughness coefficient of 0.045, and a varying bottom width. The overall results of the proposed configuration of the proposed retention basins show that the flows in Waterman Wash would decrease by about 10 percent (see Table 4-6).

The transportation corridors will require flood protection on the upstream side of the corridor alignments, thereby providing an opportunity to consolidate regional retention basins along these alignments and allowing additional lands to be available for development. Areas downstream of the transportation corridors in the Estrella Planning Unit do not have any proposed retention basins since the flow will be diverted away from these areas. The location of the retention basins in the Sonora Planning Unit may allow the effective floodplains to be eliminated downstream of the proposed alignment of the Hassayampa Freeway. The location of retention basins in the Mobile Planning Unit will mitigate the areas of known flooding near SR 238. Future flooding risk also will be effectively mitigated through this alternative by capturing flows and diverting them to specific outlet points. As a result, several of the effective floodplains may be eliminated downstream of the UPRR.

The retention basins for the alluvial fan apices are in the upstream portions of the watershed and are only located in the Estrella Planning Unit. These basins alleviate the downstream flooding and direct the flows to the proposed channel alignments that convey the flows to retention basins farther downstream or directly into Waterman Wash. They also provide a means of capturing any sediment that may flow out of the Estrella Mountains through the alluvial fan apices.

Retention basins disrupt the natural hydrologic processes, but they do mitigate downstream flooding by either eliminating floodplains or reducing the size of conveyance channels. In doing so, more land is available for development. Low to moderate maintenance would be required for sedimentation and/or debris removal in the retention basins. The channels receiving flow from the basins would be receiving a metered amount of flow, which may allow for more feasible vegetation management. However, the channels would also have to be monitored and/or maintained for erosion hazards associated with clear water scour. The proposed retention basins and interconnected channels could provide multi-use benefits for recreation and/or wildlife. The impacts to the peak flows in Waterman Wash are presented below.

Table 4-6 Waterman Wash Flow Summary – Proposed Alternative 4

HEC-1 Location along Waterman Wash	Distance ¹ (miles)	Existing Conditions (cfs)	Future Conditions (cfs)	Alternative 4 (cfs)
F33RIV	25.9	1,050	650	650
E49RIV	24.4	2,000	2,550	550
D29RIV	20.7	5,400	5,050	5,000
D40RIV	17.2	5,650	4,700	4,700
B15RIV	15.4	10,400	10,000	9,900
B62RIV	11.0	12,900	12,350	11,050
H86RIV	10.1	13,000	12,400	11,200
A42RIV	8.7	13,100	12,450	11,250
I37RIV	7.1	13,050	12,350	11,100
A51RIV	4.2	13,400	12,650	10,900
A62RIV (confluence with Gila River)	0.4	13,550	12,950	11,400

Note: All models are the 100-year 24-hour with railroad models

¹ Distance upstream from the Waterman Wash confluence with the Gila River

4.7.4 Multi-Purpose Benefits

Biological Resources. This alternative would affect biological resources similar to Option 2 of Alternative 3 (Figure 4-25). This alternative would be somewhat more limiting to wildlife movement beneath the Sonoran Valley Parkway because routes through channels to Waterman Wash would be longer and fewer. However, the Hassayampa Freeway would have more undercrossings that could be designed to accommodate wildlife. The addition of surface basins could provide a source of water for wildlife during the summer monsoon and wet winter months, which could enhance native habitats in undeveloped areas.

No new storage or conveyance features are planned within the identified wildlife corridor between the Sierra Estrella Mountains and the Sonoran Desert National Monument. However, the District’s drainage development or specific wash areas within this open space could serve as mitigation banks, which with other value-added features could provide a layer of protection that would serve to preserve planned protections in the face of changing political objectives. Road crossing issues will be similar to the No New Action alternative, requiring coordination between AGFD and transportation planning agencies.

The proposed basins in the Mobile Planning Unit also could serve to provide a wildlife-accessible crossing under the railroad and highway where these facilities outlet into Waterman Wash to the north. Additionally, wildlife linkages could be associated with greenbelt planning efforts to a lesser degree.

Cultural Resources. Construction of facilities for the structural storage, transportation corridors alternative could disturb archaeological and historical sites but they would be inventoried, evaluated, and treated in accordance with applicable state and federal regulations. Similar to the structural conveyance alternative, there could be opportunities to publicly interpret the Mobile African-American community, Juan Bautista de Anza National Historic Trail, and Kotmatke Trail if outdoor recreation facilities are developed in conjunction with the conveyance channels and storage channels in the Mobile, Estrella, and Sonora Planning Units.

Open Space, Scenery, and Recreational Resources. The implementation of a network of regional drainages and basins associated with the planned transportation corridors also will have a varied impact on the opportunity to co-locate multi-use facilities and benefits (Figures 4-26 and 4-27). In a general sense, it is reasonable to conceive of these facilities as forming a ring around the future developed portions of the Estrella and Sonora Planning Units that could be developed to form a greenbelt “necklace” that buffers adjacent residents and other property owners from the transportation systems. This greenbelt could serve multiple functions, such as an open space corridor that would act as an additional “break” between the mountain lands and Waterman Wash, or as a series of active parks and trails that would be co-located with the necklace loop.

Implementation of the Maricopa Regional Trail segments identified within the Rainbow Valley ADMP study area will be likely under this alternative. In addition to the segment along the Waterman Wash reaches, opportunities to connect the Regional Trail with the greenbelt would allow for connectivity of the trail to the Estrella Mountains to the east and the Sonoran Desert National Monument to the west. Trail linkages could be co-located with the drainage/basins planned for the Estrella and Sonora Planning Units that would serve as part of the local trail system, while the basin-and-drainage system proposed in the Mobile Planning Unit could also serve to create a linkage along the SR 238 alignment.

The City of Goodyear has proposed an open space or linear recreation area along the SR 238 route. The basin and conveyances proposed in the Mobile Planning Unit upstream of the railroad line could be co-located with this proposed recreation facility. The location of these parks within the proposed greenbelt could create a linked active recreation corridor within the City of Goodyear that would allow for significant opportunities to implement recreation facilities under this alternative.

East-west connectivity is likely to be achieved under this alternative provided that the trail linkages from Waterman Wash are included in the greenbelt configuration that then ties into trails associated with the alluvial fan basin and channels. This connectivity is associated with the proposed flood hazard mitigation projects identified in the Estrella, Sonora, Lum Wash, and Mobile Planning Units.

No plans have been developed for Waterman Reach 1 under this alternative that would include a multi-use facility at the confluence of the Gila River and Waterman Wash.

New basins and conveyance systems should each be planned and designed in accordance with the local visual context to ensure they complement the desired character. In almost all cases, the proposed landscape design theme for the channel segments is to replicate the visual form, vegetation, and materials found in a natural Sonoran desert wash. Implementation of semi-soft channels with sufficient right-of-way to allow for channel meander and buffering would be considered complementary to the visual character of Rainbow Valley. Within the greenbelt, some use of a Developed theme may be appropriate, especially when an active recreation use is planned within a given facility. Connectivity of the greenbelt should be maintained even in conditions where a combination of structures with both Natural and Developed themes are used. In future urban areas, the use of hard structures with enhanced aesthetics could also be complementary assuming that the design of the channel serves to provide for additional benefits within a similar zone of use and maintains a high level of visual aesthetic in its overall design.

The development of basins and channels that use a semi-soft method and a natural design theme would help preserve the existing landscape character of the region as future development takes place. The use of basins would result in larger areas of open space being preserved which may help in the preservation of internal viewsheds toward the mountains. The creation of the greenbelt, in conjunction with the preservation of the existing natural character of Waterman Wash, may also help preserve some of the viewshed character for viewers from the mountains down into the valley.

The creation of open space made possible with basins may result in greater areas of open space enhancement and creation than with any of the other alternatives, although other alternatives will result in greater areas of existing open space and landscape character being preserved.

404 Jurisdictional Delineation. This alternative could result in dredge and fill impacts on Jurisdictional Waters of the United States. These dredge and fill activities would only occur within documented ordinary high-water mark areas within the wash, which has not yet been identified. The development of conveyance channels would require dredge and fill activities on Waterman Wash at approximately 13 locations. No dredge and fill activities would occur on Corgett Wash or Lum Wash. Therefore, this alternative would be slightly less advantageous on Jurisdictional Waters of the United States than Alternative 3.

4.7.5 Regional Land Planning Compatibility

Land Use Plans and Development. Structural storage using transportation corridors are proposed in the Sonora, Estrella, and Mobile Planning Units. The flood control concept takes advantage of existing and proposed linear transportation corridors to block the flow and store water upstream. These linear corridors are already part of the development concept for the area, and the facilities will require some type of drainage system to collect and convey water through them. This alternative allows for coordination and collaboration between development, the City of Goodyear, and the regional transportation authority and partners (Maricopa Association of Governments, ADOT, and MCDOT) to take advantage of a planned drainage system. Flows are collected by basins upstream of the roadway alignments (concentrated in channels and natural washes), stored and conveyed to specific existing outfall channels that discharge flows to Waterman Wash in the case of the Sonora and Estrella Planning Units. The collector and outfall channels can have multipurpose functions as desired by the community as well as providing collection channels for development (as in the case of the structural conveyance alternative). In the Mobile Planning Unit, a similar basin system will collect flows upstream of the UPRR and discharge to Waterman Wash. Presently, the UPRR has multiple openings that require downstream development to accept flows. The area downstream from the UPRR embankment is also a floodplain. There will be less off-site impact to downstream development and some areas will be out of the floodplain.

Regional Transportation Corridors. This alternative will be developed in cooperation with transportation agencies. The proposed corridors are the Hassayampa Freeway (Sonora and Mobile) and Loop 303 Extension (Estrella). Coordination will be required with the UPRR to ensure that adequate conveyance can be provided where the outfall channel crosses the railroad alignment. Any joint upstream storage and conveyance along within the UPRR right-of-way will also need a permit or other type of agreement for implementation.

Significant Utility Corridors. Coordination will be similar to the structural conveyance alternative. Channel and basin conflicts with above and underground utilities will need to be remediated in some cases. Since this alternative is structural, engineering solutions are viable.

4.7.6 Implementation

The concept of implementing storage basins adjacent to transportation corridors is based on the potential for partnering with transportation agencies such as ADOT, MCDOT, or the cities. Providing basins along the upstream side of roadways allows the transportation agency to reduce the number and size of drainage crossings on their roadway. This additional partner helps to spread the cost of drainage improvements. Phasing of the drainage improvements can be aligned with the phasing of roadway construction and can in fact be combined with roadway construction, which could have benefits in terms of earthwork balance by utilizing basin and channel excavated materials to construct roadway fills and embankments. A downside to partnering with transportation agencies for implementation is the dependence on the scheduling of the roadway projects. They may be constructed sooner or later than the drainage improvements are needed or could be cancelled and never implemented. As a result, close coordination and development of IGAs or Memoranda of Understanding should be completed as early as practical.

4.8 PROPOSED ALTERNATIVE 5 – PROTECT SIGNIFICANT WASH CORRIDORS

4.8.1 Description

This alternative recognizes that development will occur in the Rainbow Valley area and seeks to establish opportunities to include the preservation of open spaces and the beneficial functions served by floodplains with development planning (Figure 4-28). Flood protection is provided through the identification of significant drainage corridors. Flood protection methods and design themes are described in Section 3.4.6.

4.8.2 Estimated Cost

The estimated capital cost for this alternative is zero because it is expected that developers cooperate with the City of Goodyear by paying for or donating land or providing easements. This can be done through development agreements or new ordinances (special drainage districts). Protecting these washes is an assumed benefit to development as a means of conveying flows to Waterman Wash.

4.8.3 Flood Hazard Protection

The purpose of this alternative was to enhance existing flood conveyance corridors in order to use them as regional conveyance corridors. The existing flood conveyance corridors would be enhanced with nonstructural methods. There are a limited number of existing conveyance corridors in the planning area that this alternative could be applied to due to the terrain and the associated flood characteristics. This alternative was evaluated for the Lum Wash, Estrella, Sonora, and Mobile Planning Units.

Flow from developable sub-basins that are adjacent to the designated corridors would be diverted to the corridor to allow for a more predictable flow path (outfall) to Waterman Wash while enhancing existing significant wash corridors. This approach assumes that the retention

requirements would still apply to the development in sub-basins discharging into the corridors. Therefore, the attenuated flows from the adjacent sub-basins would be routed to the receiving conveyance corridor. The future condition HEC-1 model for the 100-year 24-hour event was modified to reflect the proposed alignments for the conveyance corridors (see Table 4-7). Flows from the adjacent sub-basins were diverted into the designated wash corridor and then routed through the natural cross section of the specific conveyance corridor. The channel routing cross section for the designated conveyance corridors was not modified for this analysis. This approach also assumes that a grouping of developments would need to cooperate in their drainage design to convey flows to the designated conveyance corridors.

This alternative would take advantage of the existing conveyance corridors where, in some cases, the conveyance corridors are already mapped as a regulatory floodplain. This would provide future development with designated outfall locations for flood control within their project limits and could make more land available for development. This alternative makes use of historic flowpaths, but may eliminate them in sub-basins that are next to the designated corridors. Providing more flow to the designated corridors could lead to enhancing vegetation which could benefit the local wildlife. Little maintenance of the corridors is anticipated since the intent is to provide a corridor where natural hydraulic processes can occur. Development will address flooding as part of their projects. The impact to the peak flows in Waterman Wash are presented below.

Table 4-7 Waterman Wash Flow Summary – Proposed Alternative 5

HEC-1 Location along Waterman Wash	Distance ¹ (miles)	Existing Conditions (cfs)	Future Conditions (cfs)	Alternative 5 (cfs)
F33RIV	25.9	1,050	650	650
E49RIV	24.4	2,000	2,550	2,450
D29RIV	20.7	5,400	5,050	5,050
D40RIV	17.2	5,650	4,700	6,450
B15RIV	15.4	10,400	10,000	10,150
B62RIV	11.0	12,900	12,350	13,150
H86RIV	10.1	13,000	12,400	13,250
A42RIV	8.7	13,100	12,450	13,300
I37RIV	7.1	13,050	12,350	13,200
A51RIV	4.2	13,400	12,650	13,300
A62RIV (confluence with Gila River)	0.4	13,550	12,950	13,600

Note: All models are the 100-year 24-hour with railroad models

¹ Distance upstream from the Waterman Wash confluence with the Gila River

4.8.4 Multi-Purpose Benefits

Biological Resources. Designated Wash Corridors in Alternative 5 would produce fewer benefits for biological resources than Alternative 3 or Alternative 4 (Figure 4-29). This alternative would have fewer east-west connections along fewer channels and fewer underpasses beneath highways in the valley. However, the biological resources around these channels could remain more natural, because of their naturally larger sizes, and could benefit from the increased amount of water from development diversions. This could lead to increased growth and cover provided to the natural vegetation.

Currently under this alternative, no significant washes were identified to serve as a regional drainage in the wildlife corridor area located in the Sevenmile Mountain Planning Unit. However, any of the larger washes shown on the plans could provide east-west connectivity for most wildlife species that may not need the larger corridor for movement or migration purposes. This alternative also provides for passive recreational viewing of wildlife.

The proposed preservation of the wash in the Mobile Planning Unit also could serve to provide a wildlife-accessible crossing under the railroad and highway where this facility outlets into Waterman Wash to the north.

Cultural Resources. Designation of wash corridors for protection could coincidentally protect cultural resources within those corridors. If outdoor recreation facilities are developed along any of the protected washes, there could be opportunities for publicly interpreting the Mobile African-American community and Juan Bautista de Anza National Historic Trail in the Mobile Planning Unit, the Kotmatke Trail in the Estrella and Sonora Planning Units, and possibly the Waterman farmstead site/Hohokam village site AZ T:10:46(ASM) near the confluence of Waterman Wash and the Gila River.

Open Space, Scenery, and Recreational Resources. The identification and preservation of large natural existing drainages to serve as regional flood water conveyance will be generally compatible with most multi-use goals identified for the ADMP. As a general guideline, the preservation and enhancement of these washes will assist to both protect and enhance the natural and beneficial functions served by the floodplains which also tend to be similar to the desired functions identified for the project (Figures 4-30 and 4-31).

Implementation of the Maricopa Regional Trail segments identified within the Rainbow Valley ADMP study area will be likely under this alternative provided that an appropriate setback for the trail is identified as part of each flood hazard mitigation project. Along with the segment in Waterman Wash, opportunities to connect the Gila River system with the Estrella Mountain Regional Park could occur through a trail in the proposed drainage along both Lum and Corgett washes in the Lum Wash Planning Unit. Trail linkages along one of preserved existing drainages identified in the Estrella and Sonora Planning Units could be used as part of the regional or local trail system.

The City of Goodyear planned parks within the Estrella Planning Unit could potentially be located adjacent to one of the two significant washes. While it is not desirable that the drainages would be able to fully accommodate an active use facility, the drainage and proposed parks could be co-located in such a way that park users could access the passive recreational activities associated with the washes.

East-west connectivity may be achieved in more planning units, but through fewer possible connections than identified in Alternative 3. Washes in the Lum Wash, Estrella, and Sonora Planning Units could all serve to connect the east and west sides of the valley to Waterman Wash.

No plans have been developed for Waterman Reach 1 under this alternative that would include a multi-use facility at the confluence of the Gila River and Waterman Wash.

The preservation of existing washes is highly complementary of the existing and planned character of Rainbow Valley.

The preservation of natural washes serves to enhance the overall landscape character for the region as development begins to impact the existing natural character of the Rainbow Valley. These benefits could be realized in any planning unit where a significant wash is identified for preservation. Where flood hazard mitigation results in an increase in the floodplain of the existing wash, channelization of an existing drainage should be avoided in favor of expanding the wash corridor and using regulatory means such as the establishment of drainage districts to distribute the potential burden this change in conditions may cause. Preserving or enhancing Waterman Wash along with other natural tributary washes would help to preserve some of the character of the valley for viewers from the mountains as well, though it is unlikely this will be able to fully mitigate the impacts that future development will have on the views for these users.

Open space preservation is greatest under this alternative and could result in significant areas of open space being maintained as adjacent development occurs.

404 Jurisdictional Delineation. This alternative would not require dredge and fill activities on Jurisdictional Waters of the United States. Therefore, this alternative would be the same as Alternatives 1 and 2 for being the most advantageous on Jurisdictional Waters of the United States.

4.8.5 Regional Land Planning Compatibility

Land Use Plans and Development. This alternative is compatible with the city general plans in the project area, state, and federal regulations. The corridors being protected are all governed by federal regulations pertaining to 404 impacts. Development in areas where flows are diverted to the wash corridor will need to meet both Clean Water Act water quality requirements and peak flow attenuation requirements of the appropriate regulating municipality or Maricopa County. Analysis is needed to determine whether enhancement of flow to these corridors will cause floodplain limits and base flood elevations to increase. However, as part of this alternative, additional flow easements will be needed to allow the washes to naturally conform to their new dominant (bankfull) and flood discharges. Protecting significant wash corridors are an amenity to the area as they provide scenic and open space opportunities as well as recreation opportunities as previously discussed for this alternative. Significant wash corridors are located in the Sonora, Estrella, Mobile, and Lum Wash Planning Units. In the other Rainbow Valley Planning Units either existing regulations protect the corridors (Sonoran Desert National Monument) or there are no identified washes with 100-year flood discharges greater than 500 cfs.

Regional Transportation Corridors. Coordination will be required between the owner of the transportation corridor and the responsible entity for the wash corridor to ensure adequate conveyance is provided through the linear corridor by bridges or culverts.

Significant Utility Corridors. Utilities already are required to account for these washes when planning and designing their facilities. Additional coordination will be necessary to ensure adequate conveyance is attained without impacting existing facilities. Cooperation is needed where new utilities are being planned so that adequate conveyance is available for the new flows and the flow regime is in conformance with natural systems.

4.8.6 Implementation

Implementation of this alternative is non-structural and as such has a low cost to the District. Enabling regulations or policies would need to be developed to allow increased discharges into the wash corridors designated for protection. Additional set-backs or easements would be required for the increased floodplain and the expected natural re-adjustment of the channel system, which would include widening and erosion and deposition processes based on a new dominant discharge. Assuming implementation is coordinated with adjacent development, it is anticipated that developers would cooperate in setting aside the required corridors. A phasing challenge could arise if an upstream development implements the concept before downstream development has begun. Once the additional runoff is directed into the wash corridor, the additional flood and erosion setback area will be required all the way to the downstream limit at Waterman Wash.

4.9 PROPOSED ALTERNATIVE 6 – POCKET BASINS

4.9.1 Description

This alternative recognizes that development will occur in the Rainbow Valley area and seeks to establish opportunities to include the preservation of open spaces and the beneficial functions served by floodplains with development planning (Figure 4-32). Flood protection is provided through off-line basins in the floodway fringe of the existing washes outside of the incised channel. These basins would serve to store high flood flows without eliminating low flows and give more flexibility to developers for developing within other areas of the floodway fringe. Flood protection methods and design themes are described in Section 3.4.7.

4.9.2 Estimated Cost

The estimated cost for this alternative is approximately \$74.7 million, which is the lowest cost (see Table 4-8). The two significant cost components are land cost and excavation. The land cost was assumed to be the same amount used in the previous alternatives; however, this land is located in an existing floodplain, which would be expected to have a lower cost. The excavation costs are for the storage basins using the same storage basin dimensions (20-acre footprint, 10-horizontal to 1-vertical [10H:1V] side slopes, 5 feet deep) used in the previous alternatives. See Appendix B for detailed cost estimates.

The costs of maintenance are not considered for these storage basins. These basins also may need to be designed for erosion because they are located in the floodplain (contingency cost). A summary of the Alternative 6 cost estimate for each planning unit is presented below. See Appendix B for detailed cost estimates.

Table 4-8 Alternative 6 Cost Estimate

Cost Estimate Totals	Alternative 6
Planning Unit	Total
WR2	\$37,700,000
WR3	\$7,200,000
WR4	\$12,600,000
Total	\$57,500,000
with Contingency (30%)	\$74,700,000

4.9.3 Flood Hazard Protection

This alternative makes use of the Waterman Wash floodplain by placing pocket basins in the area between the regulatory floodway and the flood fringe. Under the current regulations, encroachment could occur within the floodplain fringe up to the limits of the floodway. Although this regulation would benefit a developer by allowing more land to be developed, the peak discharges flowing in Waterman Wash could be increased due to the removal of overbank (i.e., floodplain) storage (see Table 4-9). Increased discharges due to encroachment could have adverse impacts to downstream reaches or properties. By placing pocket basins in the floodplain fringe, storage could be provided to maintain or reduce the peak discharges flowing in Waterman Wash that would otherwise be lost to encroachment. Thus, a balance could be achieved between increasing the amount of land that could be developed and the peak discharges flowing in Waterman Wash. The impacts to the peak flows in Waterman Wash are presented below.

Table 4-9 Waterman Wash Flow Summary – Proposed Alternative 6

HEC-1 Location along Waterman Wash	Distance ¹ (miles)	Existing Conditions (cfs)	Future Conditions (cfs)	Alternative 6 (cfs)
F33RIV	25.9	1,050	650	650
E49RIV	24.4	2,000	2,550	2,450
D29RIV	20.7	5,400	5,050	2,800
D40RIV	17.2	5,650	4,700	3,050
B15RIV	15.4	10,400	10,000	9,600
B62RIV	11.0	12,900	12,350	10,500
H86RIV	10.1	13,000	12,400	10,300
A42RIV	8.7	13,100	12,450	10,350
I37RIV	7.1	13,050	12,350	10,450
A51RIV	4.2	13,400	12,650	10,400
A62RIV (confluence with Gila River)	0.4	13,550	12,950	10,700

Note: All models are the 100-year 24-hour with railroad models

¹ Distance upstream from the Waterman Wash confluence with the Gila River

4.9.4 Multi-Purpose Benefits

Biological Resources. Pocket basins along Waterman Wash would cause some impacts and provide some benefits to biological resources (Figure 4-33). No east-west movement areas likely would be preserved by this plan, and undercrossings beneath the Sonoran Valley Parkway and Hassayampa Freeway would be indeterminate. Pocket basins could provide some temporary surface water for wildlife, but the presence of pocket basins in the Waterman Wash floodplain could introduce a source of disturbance to existing habitats along or near the wash. Revegetation with plants characteristic of the flood-fringe and other restoration activities in the floodplain can mitigate this disturbance. Preservation of the flood-fringe outside Waterman Wash would maintain a greater variety of vegetation and habitats compared to the No New Action alternative, which also could benefit more wildlife species and better preserve their use of Waterman Wash and its nearby surroundings. Because flood control measures outside Waterman Wash would be decided by individual developers, there would be little or no incentive to provide additional gains to biological resources that are better addressed by other alternatives.

Cultural Resources. Construction of pocket basins along Waterman Wash could disturb archaeological and historical sites but they would be inventoried, evaluated, and treated in accordance with applicable state and federal regulations. If outdoor recreation facilities are developed at any of the pocket basins, there could be opportunities for publicly interpreting the Mobile African-American community and Juan Bautista de Anza National Historic Trail within Waterman Wash Reach 4 through the Mobile Planning Unit. Similarly, the Kotmatke Trail could be publicly interpreted in Reach 2 between the Estrella and Sonora Planning Units.

Open Space, Scenery, and Recreational Resources. The multi-use benefits associated with this alternative are primarily limited to the Waterman Wash Reaches and two small floodplains in the Mobile Planning Unit. These impacts could, if planned correctly, serve as a positive addition to the benefits associated with other alternatives in the other planning units (Figures 4-34 and 4-35).

While this alternative would not facilitate the implementation of the Maricopa Regional Trails, this alternative would have an impact on the trail by helping enhance trail user experiences within the Waterman Wash segment. Trails in other areas of the study area would not be impacted by this alternative, though pocket basins could serve as trailheads or campgrounds for other trail connections facilitated by the implementation of other alternatives.

The City of Goodyear planned parks could potentially be located in or adjacent to one of pocket basins, though the location of active recreational facilities within the Waterman Wash floodplain is discouraged under the *Waterman Wash City of Goodyear Conceptual Corridor Study* and not preferred over the other functions intended for these basins.

East-west connectivity is not facilitated by this alternative.

No pocket basins have been identified within Waterman Reach 1 under this alternative. Therefore, the development of a multi-use facility at the confluence of the Gila River and Waterman Wash would not be facilitated under this alternative.

While the impacts of implementing these pocket basins will be minimal within the scale of the overall study area, the potential to preserve, enhance, and create new areas of high scenic and open space value within the Waterman Wash Reaches should be considered significant compared to the No New Action alternative impacts on Waterman Wash itself. These impacts could assist in enhancing sensitive views, enhancing minimal landscape fringe areas and degraded landscapes, as well as enhance the existing open space associated with the preserved floodplain.

The construction and enhancement of pocket basins along Waterman Wash under this alternative would help preserve and restore some of the beneficial functions of natural floodplains within the Sonoran Desert. This preservation also could serve to provide some benefits to wildlife (and wildlife-viewing) by creating wider patches of habitat along the wash and flood fringe. The project goal would be to re-establish, within the basins, the vegetative and habitat character of the flood fringe.

404 Jurisdictional Delineation. This alternative could result in the largest amount of dredge and fill activities on Jurisdictional Waters of the United States. Dredge and fill activities would only occur within documented ordinary high-water mark areas within a wash, which has not yet been identified. Dredge and fill activities could occur on Waterman Wash at approximately

45 locations for the development of pocket basins. However, many of the pocket basins would likely be developed in upland areas and not within an ordinary high-water mark in a jurisdictional wash. No dredge and fill activities would occur on Corgett Wash or Lum Wash. This alternative could be the least advantageous of all the alternatives on Jurisdictional Waters of the United States.

4.9.5 Regional Land Planning Compatibility

Land Use Plans and Development. Pocket basins are only proposed along Waterman Wash WR1 to WR4. They appear to be compatible with the *Waterman Wash City of Goodyear Conceptual Corridor Study*. Coordination with the City of Goodyear and development will be needed to locate the basins to meet the intent of the guidelines and this alternative. One benefit from the pocket basins is providing storage that can be used to mitigate peak flood flows as development encroaches to the floodway limits.

Regional Transportation Corridors. Any corridor that traverses Waterman Wash will need to obtain a floodplain use permit. There will also be coordination with the City of Goodyear regarding their guidelines for Waterman Wash. Pocket basin locations will be part of these discussions if this alternative is implemented.

Significant Utility Corridors. Specific locations of pocket basins will be coordinated with utility companies if this alternative is implemented. Pocket basin locations should be configured to avoid utility corridors where feasible.

4.9.6 Implementation

The pocket basin alternative presents an opportunity for developers to increase developable area without adversely impacting the natural floodplain storage. Implementation of this alternative would be initiated and completed by developers, presumably at no cost to the partner agencies. As such, they could be phased as needed by developers.

4.10 PROPOSED ALTERNATIVES EVALUATION

The Evaluation Matrix, shown in Table 1-1, was used for the Proposed Alternatives Evaluation. The review committee, which is made up of agency stakeholders and District personnel, met at the Agency Stakeholder Proposed Alternatives Evaluation Meeting on December 16, 2009. The project team gave an overview presentation of the proposed alternatives on a planning unit basis. That is, for each planning unit the feasible alternatives shown highlighted in green in Table 4-1 were described. Following each planning unit presentation, there was an opportunity for discussion and questions about the merits of each alternative. By evaluating each planning unit independently, the best alternative can be selected for each planning unit that is based on the identified appropriate flood mitigation strategies and unique setting of that unit. The resulting recommended plan is made up of the optimal combination of flood mitigation solutions and tools. Each evaluator was given a set of score sheets, one for each planning unit, to complete after the meeting. The completed score sheets were then returned to be tallied. The highest scoring alternative for each planning unit is presented in Table 4-10. The alternative receiving the highest context sensitivity rating is also shown. The context sensitivity rating will be discussed later in this section.

Table 4-10 Evaluation Results

Planning Unit	Highest Performance Alternative	Most Context Sensitive Alternative
A – Phoenix International Raceway (PIR)	1 – No New Action	N/A – Only one alternative
B – Estrella	5 – Protect Significant Wash Corridors	5 – Protect Significant Wash Corridors
C – Sonora	5 – Protect Significant Wash Corridors	5 – Protect Significant Wash Corridors
D – Sevenmile Mountain	1 – No New Action	N/A – Only one alternative
E – Mobile	5 – Protect Significant Wash Corridors	5 – Protect Significant Wash Corridors
F – Waterman South	2 – New Regulations	2 – New Regulations
G – Vekol South	1 – No New Action	N/A – Only one alternative
LW – Lum Wash	5 – Protect Significant Wash Corridors	5 – Protect Significant Wash Corridors
SOS – Secured Open Space	1 – No New Action	N/A – Only one alternative
WR1, WR2, WR3	2 – New Regulations	2 – New Regulations
WR4, WR5	2 – New Regulations	2 – New Regulations

As has been previously stated, the planning framework employed with this project is designed to lead to identification and selection of context sensitive flood mitigation solutions that add value beyond the flood control function. The evaluation matrix is organized around this approach with the project objectives grouped according to the identified flooding, land and resource, and community contexts. Implementation is also included in the matrix, but was not considered within one of the contexts as part of the evaluation process. Due to this arrangement of the matrix, the alternatives receiving the highest score would be expected to be the most context sensitive solutions. However, it could be that for a given alternative, a single context could receive a very high score and the other two contexts receive a median to low score with the combination still receiving the highest overall score. This alternative would be skewed to favor one context rather than being truly responsive to all three. With this in mind, the most context sensitive solution would be one that responds best to all three contexts. It also follows that the most context sensitive solution may not necessarily be the highest scoring alternative.

4.10.1 Context Sensitivity Rating

As a means to evaluate the context sensitivity of an alternative based on how well it responds to all three contexts, the Context Sensitive Flood Hazard Planning Model described in Section 3.2 and shown graphically on Figure 3-1 was used as a tool for geometrically determining the context sensitivity rating for a given alternative. This was done by adjusting the radius of each of the three circles according to the relative scores from the matrix evaluation. The area contained within the intersection of the three circles was determined as a percentage of the maximum possible overlap area which would result if all three contexts received a maximum score of five. The resulting context sensitivity rating, expressed as a percentage, provides additional information to be considered in selecting a preferred alternative.

4.10.2 Cost for performance

The cost to implement each alternative was not included in the matrix evaluation. This was done to allow a discrete evaluation of the project performance. The estimated CIP cost to achieve a certain level of performance is then used as another piece of information to be considered in selecting a preferred alternative. A determination can then be made as to whether the cost for a particular level of performance is justified as compared to the level of performance achieved

with another competing alternative. The total score from the matrix evaluation, including the sum of the three context scores plus the implementation score, is used as the measure of performance for each alternative. It should be recognized that this measure of performance is based solely on the professional opinions and evaluations of those completing the evaluation and, as such, is qualitative and somewhat subjective. Even so, it reflects the combined expertise and judgment of a diverse group of evaluators which has been gained through many years of experience.

4.10.3 Selection of Preferred Alternative

In addition to the raw evaluation scores, the context sensitivity rating and cost for performance are useful for selecting a preferred alternative. This information is presented on a planning unit basis in Figure 4-36 through Figure 4-42. These figures show the evaluation scores for each alternative, the context sensitivity rating score with a graphic representation of the three context circles, and the cost for performance of each alternative. The cost for performance is shown by depicting the performance of each alternative as a bar with the four component scores shown. The bar is positioned on the x-axis according to the estimated capital improvement cost to implement. This allows a visual assessment of the cost for various levels of performance.

As shown in Table 4-10, the highest performance alternatives were limited to Alternatives 1 – No New Action, 2 – New Regulations, and 5 – Protect Significant Wash Corridors. These are all alternatives that require no capital improvement project to implement; they are basically regulatory in nature. None of the structural alternatives; Alternatives 3 – Structural Conveyance, 4 – Structural Storage, Transportation, or 6 – Pocket Basins received highest performance scores. Table 4-10 also shows that the highest performance alternatives are also the most context sensitive. A review of the cost for performance reveals that the performance levels of all alternatives are relatively close, but the highest performance alternatives are also the least costly to implement due to no capital improvement cost to construct. In summary, all three evaluation measures—performance score, context sensitivity, and cost for performance—all point to the same alternatives within each planning unit.

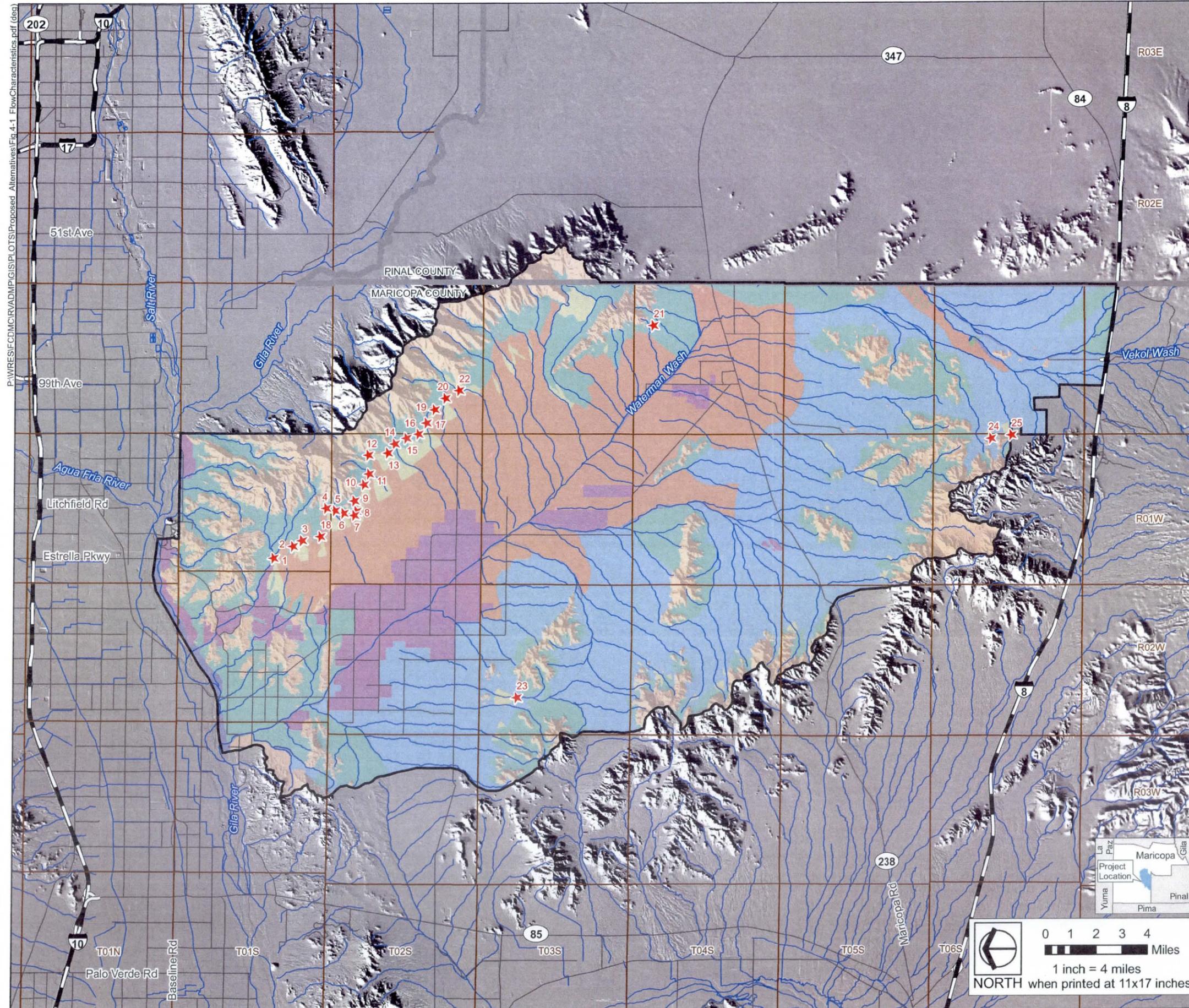
4.10.4 Refinements to Alternatives

In order to identify the best performing alternative, refinements are sometimes made to the alternatives based on input received during the evaluation meeting or based on a combination of the best elements of multiple alternatives into the single recommended alternative. The only improvement that has been identified to date is to combine Alternative 2 – New Regulations, and Alternative 5 – Protect Significant Wash Corridors in the Estrella and Sonora planning units (“hybrid” alternative). This was recommended based on a preference for the Protect Significant Wash Corridors alternative with the recognition that within the Estrella and Sonora Planning units there are large areas between designated corridors that are not addressed by the alternative. The proposed refinement then is to implement new regulations in combination with protecting significant wash corridors to provide a comprehensive solution for those two planning areas. Since the means to protect the significant wash corridors will likely be through regulation, the Protect Significant Wash Corridors alternative is really a subset of a New Regulations approach.

Rainbow Valley
Area Drainage Master Plan
Flow Characteristics



Figure 4-1



Project Features

- ★ Alluvial Fans Selected for Floodplain Delineation

Flow Characteristics

- Alluvial Fan Flooding
- Disturbed Area
- Flood Retarding Structure
- Major River and Tributary Flooding
- Mountains
- Piedmont Distributary Flooding
- Piedmont Tributary Flooding
- Sheet Flooding
- Stockpond

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/Freeway
- Major Road
- River/Stream

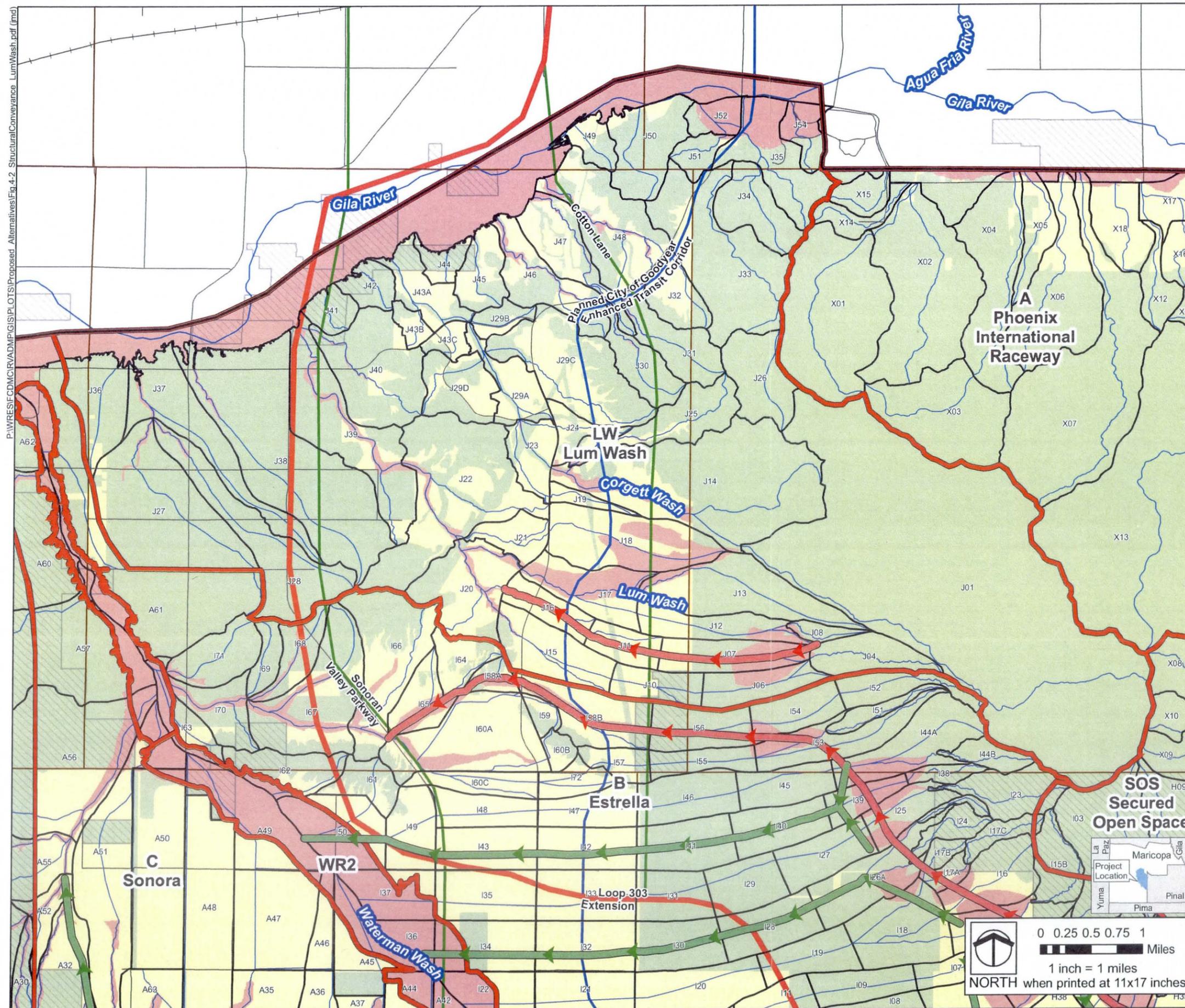
Data Sources

Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
JE Fuller/Hydrology & Geomorphology
Alluvial fan identification and flow characteristics assessment, 2008

Rainbow Valley
Area Drainage Master Plan
Alternative 3 – Structural Conveyance:
Lum Wash Planning Unit



Figure 4-2



Project Features

- Conveyance Channel
 - Alluvial Bypass Channel
 - Planning Unit Boundary
 - Drainage Basin
 - National Monument / Wilderness Area
 - Bureau of Land Management
- Flood Hazard Rating
- Low
 - Medium
 - High
- Future Corridor Type
- Freeway
 - Parkway
 - Transit Corridor

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/ Freeway
- Major Road
- Railroad
- River/Stream

Data Sources

Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
URS Corporation
Flood Hazard Rating and Alternative Data 2009

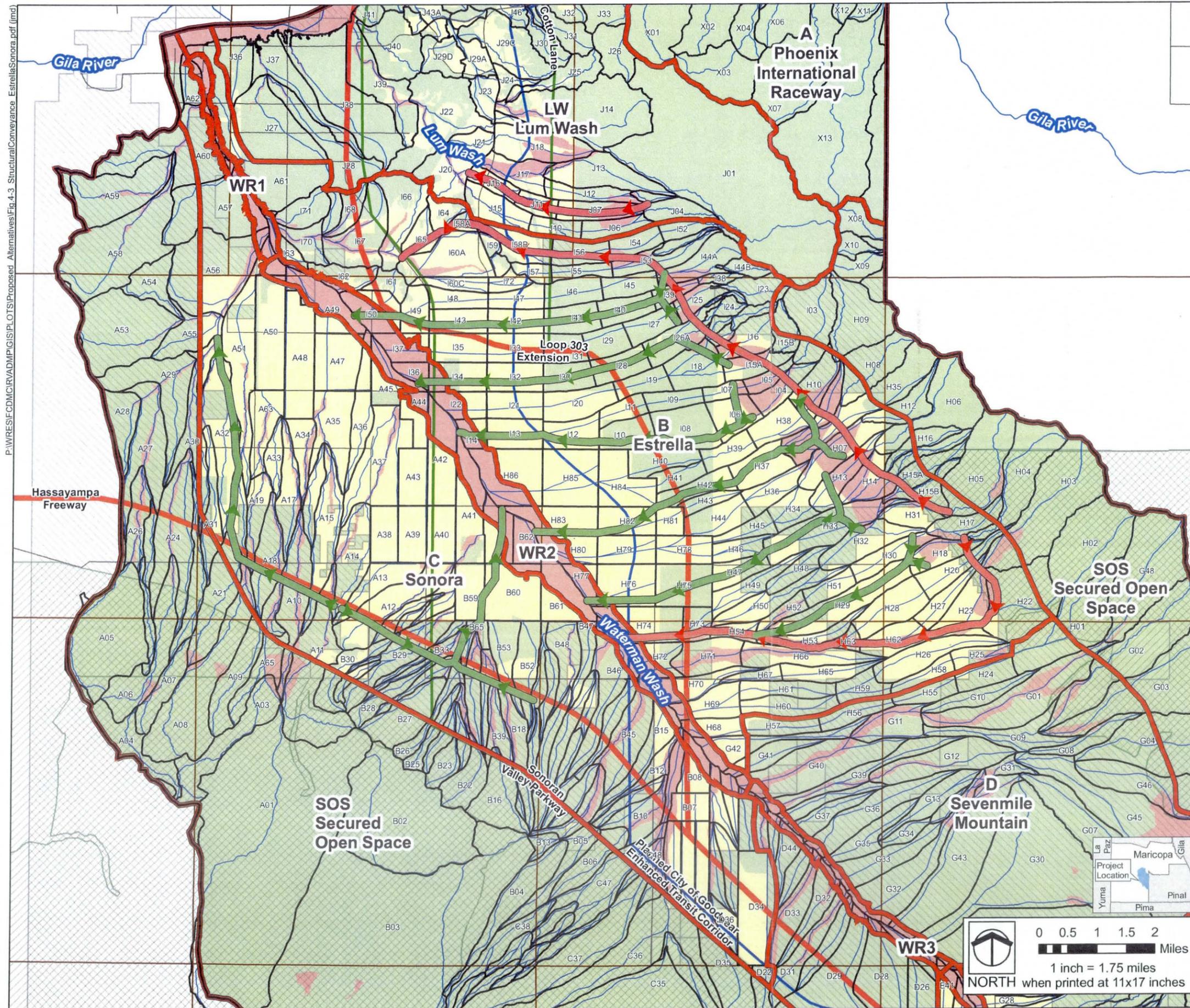
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Miles
1 inch = 1 miles
NORTH when printed at 11x17 inches

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Rainbow Valley
Area Drainage Master Plan
Alternative 3 – Structural Conveyance:
Estrella and Sonora Planning Units



Figure 4-3



Project Features

- Conveyance Channel
 - Alluvial Bypass Channel
 - Planning Unit Boundary
 - Drainage Basin
 - National Monument / Wilderness Area
 - Bureau of Land Management
- Flood Hazard Rating**
- Low
 - Medium
 - High
- Future Corridor Type**
- Freeway
 - Parkway
 - Transit Corridor

Reference Features

- County Boundary
- Interstate Highway/ Freeway
- Rainbow Valley ADMP Boundary
- Major Road
- Township and Range Boundary
- Railroad
- River/Stream

Data Sources

Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
URS Corporation
Flood Hazard Rating and Alternative Data 2009

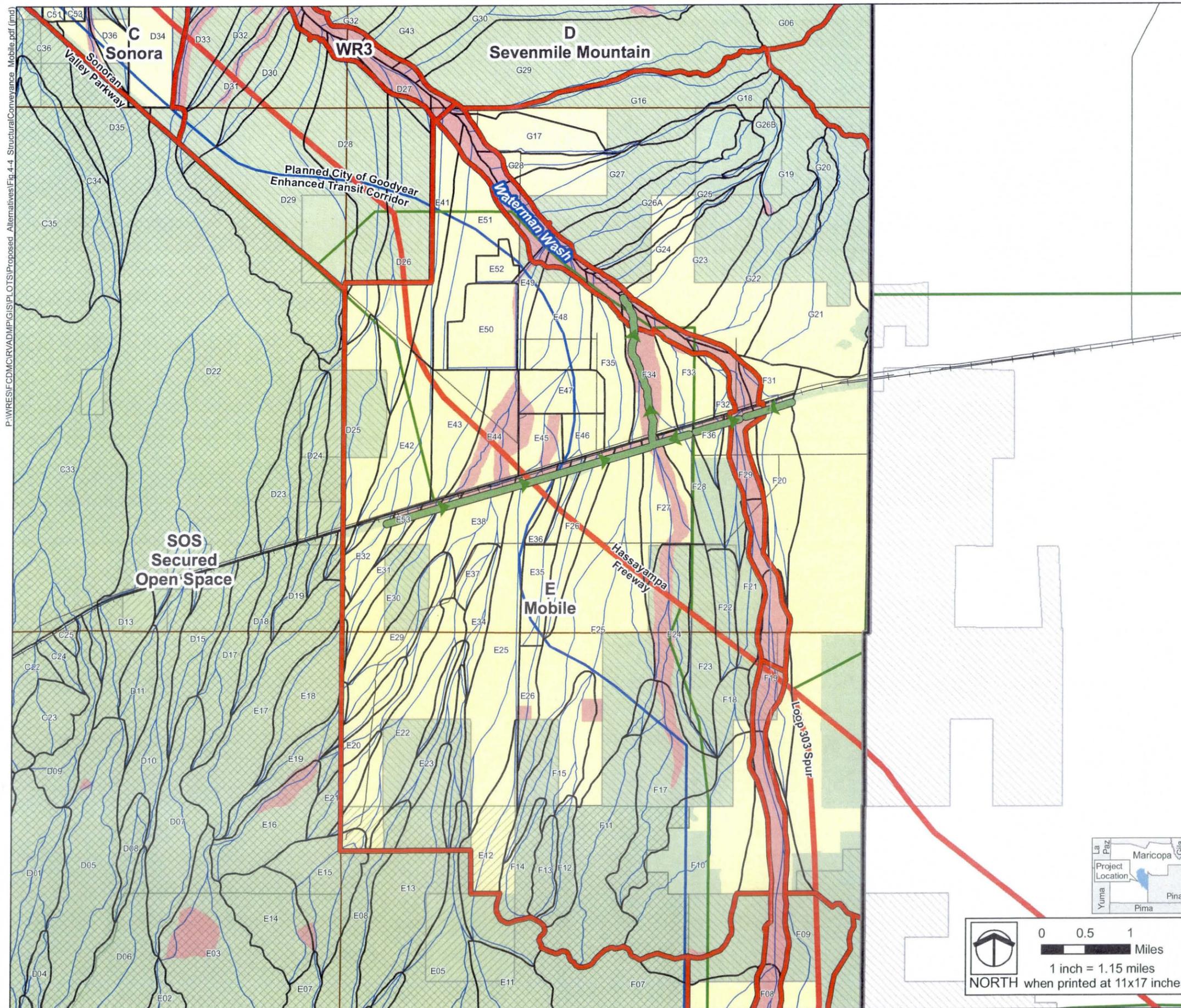
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1 inch = 1.75 miles
NORTH when printed at 11x17 inches

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Rainbow Valley
Area Drainage Master Plan
Alternative 3 – Structural Conveyance:
Mobile Planning Unit



Figure 4-4



Project Features

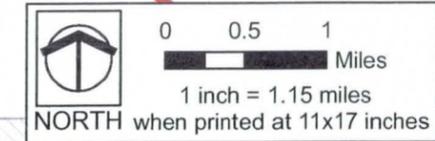
- Conveyance Channel
- Planning Unit Boundary
- Drainage Basin
- National Monument / Wilderness Area
- Bureau of Land Management
- Flood Hazard Rating**
- Low
- Medium
- High
- Future Corridor Type**
- Freeway
- Parkway
- Transit Corridor

Reference Features

- County Boundary
- Interstate Highway/ Freeway
- Rainbow Valley ADMP Boundary
- Major Road
- Township and Range Boundary
- Railroad
- River/Stream

Data Sources

Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
URS Corporation
Flood Hazard Rating and Alternative Data 2009

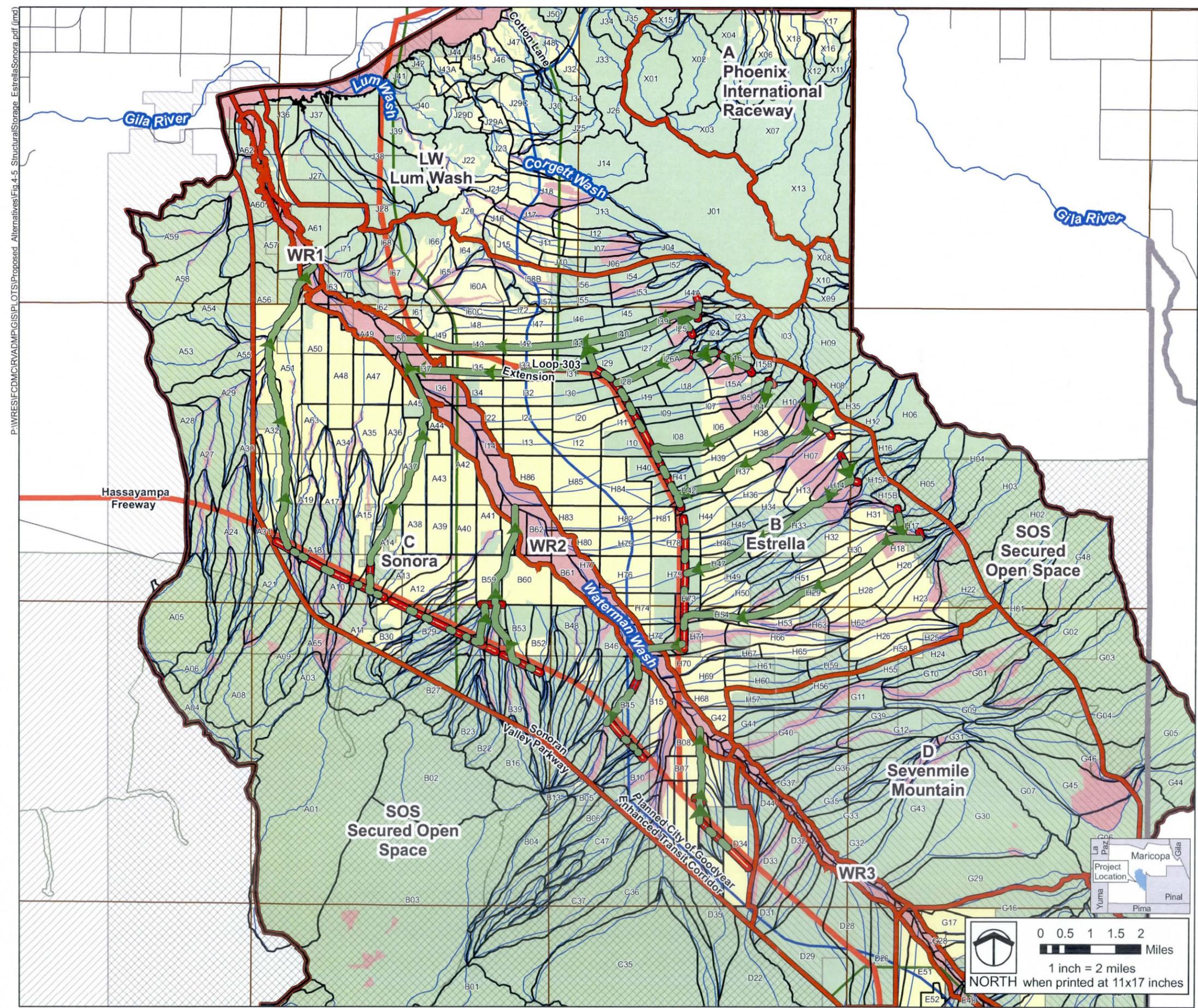


P:\WRES\FCD\WADMP\GIS\PLOTS\Proposed Alternatives\Fig.4-4 StructuralConveyance Mobile.pdf (rmd)

Rainbow Valley
Area Drainage Master Plan
Alternative 4 – Structural Storage:
Estrella and Sonora Planning Units



Figure 4-5



Project Features

- Conveyance Channel
 - Storage Basin
 - Planning Unit Boundary
 - Drainage Basin
 - National Monument / Wilderness Area
 - Bureau of Land Management
- Flood Hazard Rating**
- Low
 - Medium
 - High
- Future Corridor Type**
- Freeway
 - Parkway
 - Transit Corridor

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/ Freeway
- Major Road
- Railroad
- River/Stream

Data Sources

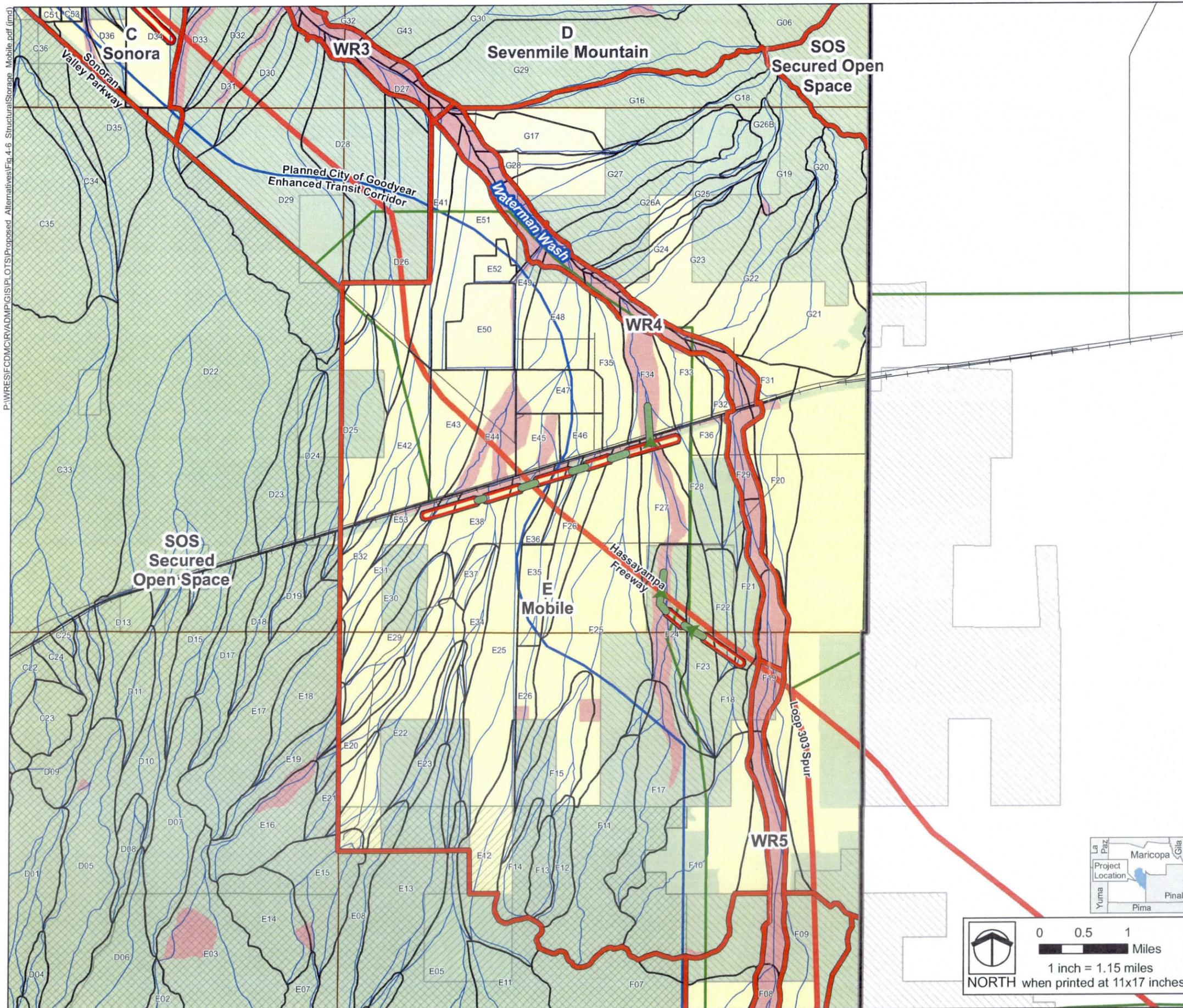
Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
URS Corporation
Flood Hazard Rating and Alternative Data 2009

P:\WRES\FCDM\C\R\ADMP\GIS\PILOTS\Proposed Alternatives\Fig.4-5 StructuralStorage_EstrellaSonora.pdf (jmc)

Rainbow Valley
Area Drainage Master Plan
Alternative 4 – Structural Storage:
Mobile Planning Unit



Figure 4-6



Project Features

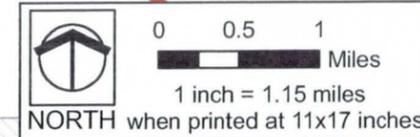
- Conveyance Channel
 - Storage Basin
 - Planning Unit Boundary
 - Drainage Basin
 - National Monument / Wilderness Area
 - Bureau of Land Management
- Flood Hazard Rating**
- Low
 - Medium
 - High
- Future Corridor Type**
- Freeway
 - Parkway
 - Transit Corridor

Reference Features

- County Boundary
- Interstate Highway/ Freeway
- Rainbow Valley ADMP Boundary
- Major Road
- Township and Range Boundary
- Railroad
- River/Stream

Data Sources

Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
URS Corporation
Flood Hazard Rating and Alternative Data 2009

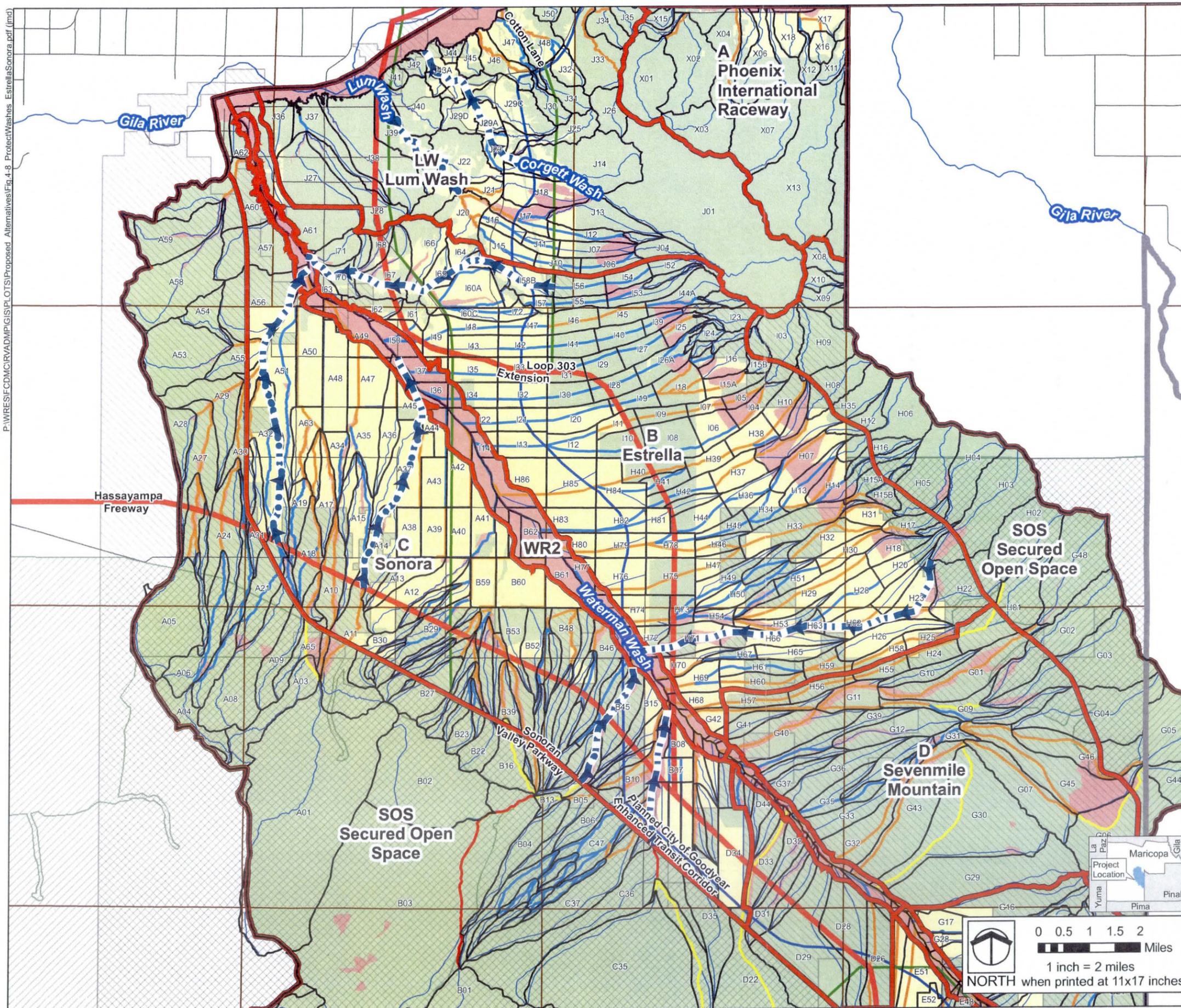


P:\WRES\FCDM\RVADMP\PILOTS\Proposed Alternatives\Fig.4-6 StructuralStorage_Mobile.pdf (mxd)

Rainbow Valley
Area Drainage Master Plan
Alternative 5 – Protect Significant Wash Corridors:
Estrella and Sonora Planning Units



Figure 4-8



Project Features

- Enhanced Wash
 - Planning Unit Boundary
 - Drainage Basin
 - National Monument / Wilderness Area
 - Bureau of Land Management
- Drainage Flow Path with Flow Rates**
- < 500 cfs
 - 501 - 2,000 cfs
 - 2,001 - 5,000 cfs
 - 5,001 - 10,000 cfs
 - > 10,000 cfs
- Flood Hazard Rating**
- Low
 - Medium
 - High
- Future Corridor Type**
- Freeway
 - Parkway
 - Transit Corridor

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/ Freeway
- Major Road
- Railroad
- River/Stream

Data Sources

Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
URS Corporation
Flood Hazard Rating and Alternative Data 2009

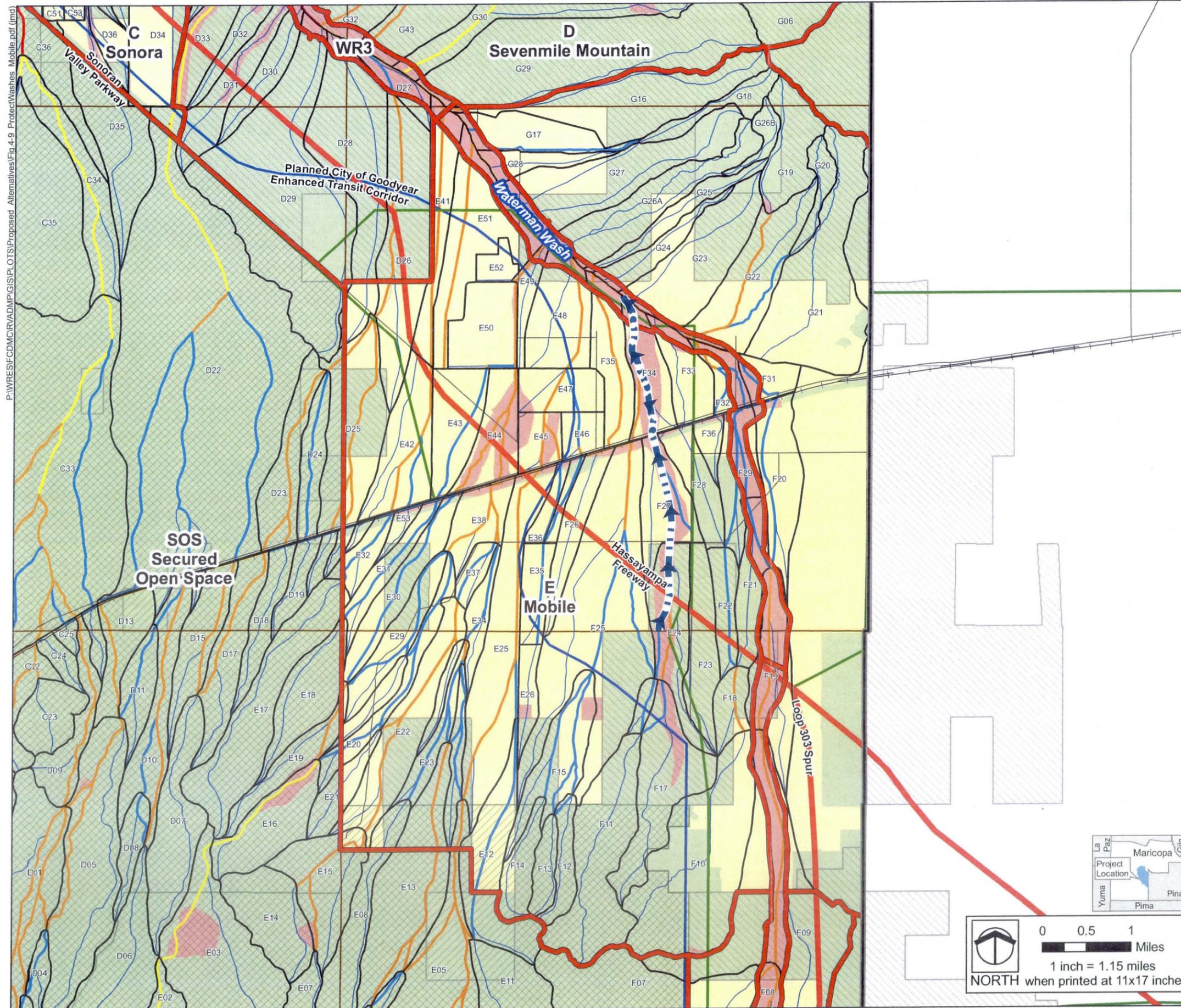
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Miles
1 inch = 2 miles
NORTH when printed at 11x17 inches

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Rainbow Valley
Area Drainage Master Plan
Alternative 5 – Protect Significant Wash Corridors:
Mobile Planning Unit



Figure 4-9



Project Features

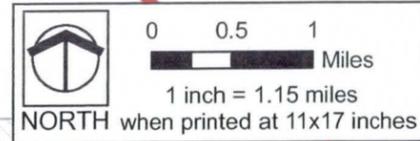
- Enhanced Wash
 - Planning Unit Boundary
 - Drainage Basin
 - National Monument / Wilderness Area
 - Bureau of Land Management
- Drainage Flow Path with Flow Rates**
- < 500 cfs
 - 501 - 2,000 cfs
 - 2,001 - 5,000 cfs
 - 5,001 - 10,000 cfs
 - > 10,000 cfs
- Flood Hazard Rating**
- Low
 - Medium
 - High
- Future Corridor Type**
- Freeway
 - Parkway
 - Transit Corridor

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/ Freeway
- Major Road
- Railroad
- River/Stream

Data Sources

Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
URS Corporation
Flood Hazard Rating and Alternative Data 2009

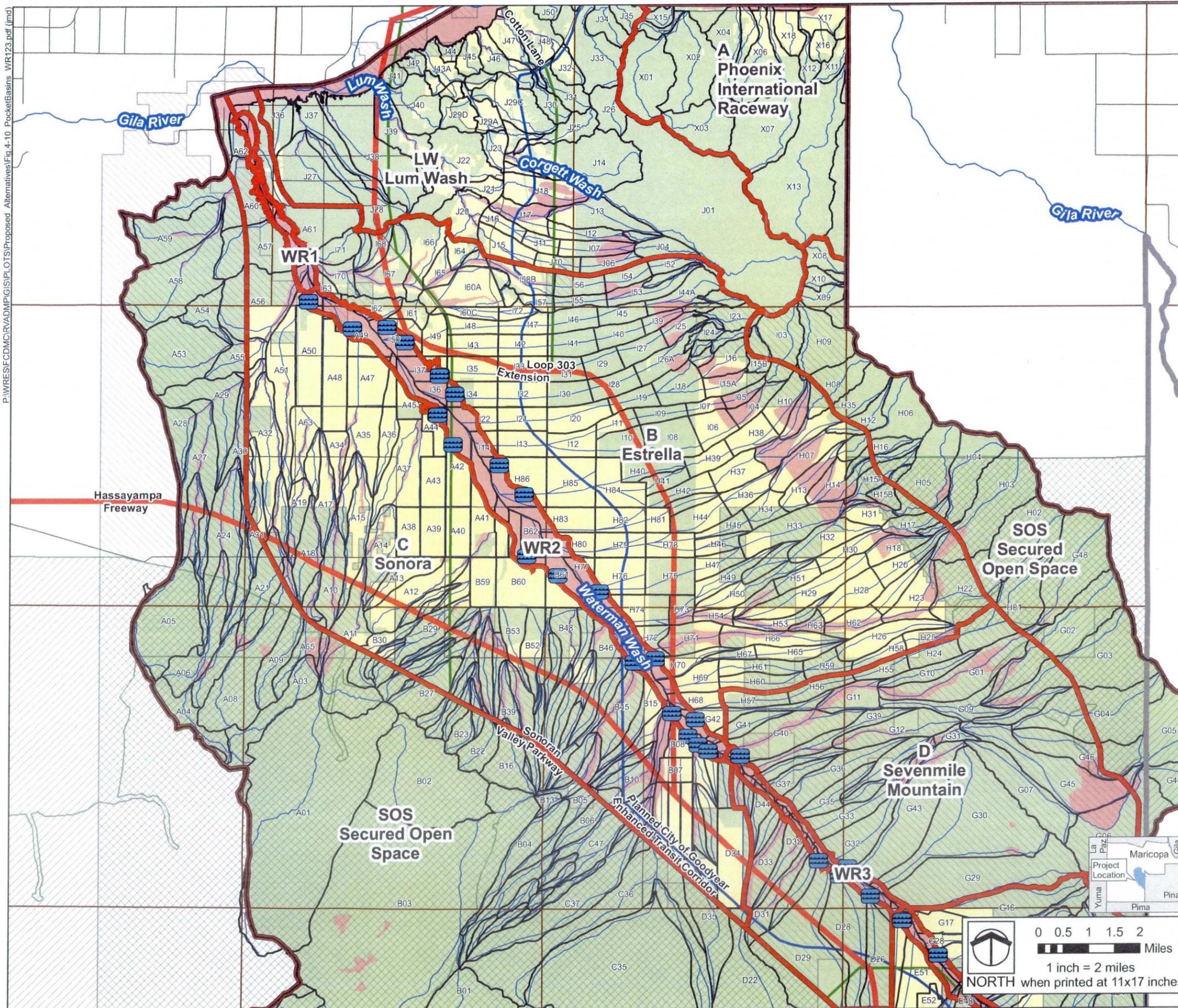


P:\WRES\FCD\CMR\ADMP\GIPLOTS\Proposed Alternatives\Fig.4-9 ProtectWashes Mobile.pdf (rmd)

Rainbow Valley
Area Drainage Master Plan
Alternative 6 – Pocket Basins:
Waterman Wash Reach 1 through Reach 3



Figure 4-10



Project Features

- Pocket Basin
 - Planning Unit Boundary
 - Drainage Basin
 - National Monument / Wilderness Area
 - Bureau of Land Management
- Flood Hazard Rating**
- Low
 - Medium
 - High
- Future Corridor Type**
- Freeway
 - Parkway
 - Transit Corridor

Reference Features

- County Boundary
- Interstate Highway/ Freeway
- Rainbow Valley ADMP Boundary
- Major Road
- Township and Range Boundary
- Railroad
- River/Stream

Data Sources

Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
URS Corporation
Flood Hazard Rating and Alternative Data 2009

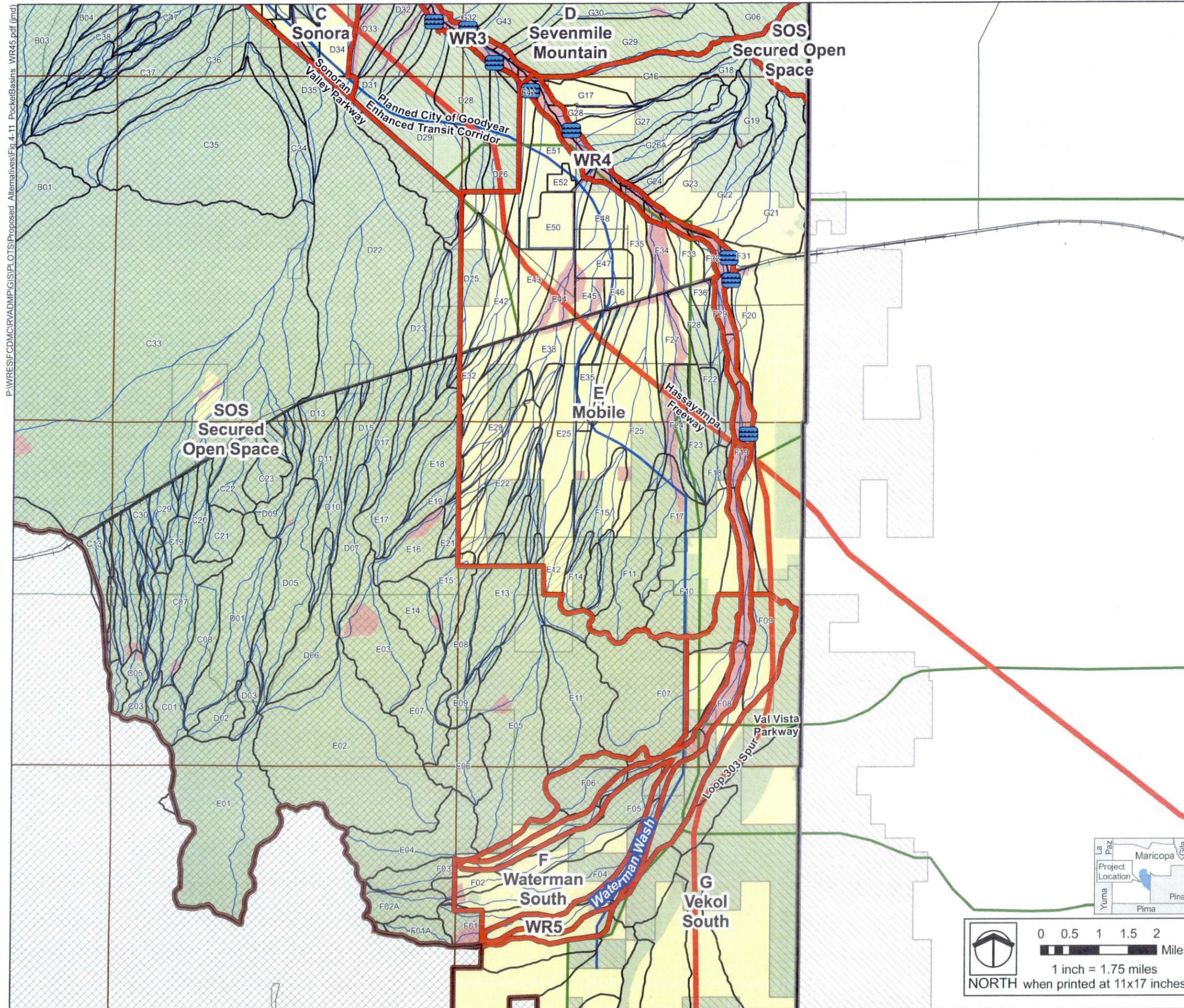
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Miles
1 inch = 2 miles
NORTH when printed at 11x17 inches

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Rainbow Valley
Area Drainage Master Plan
Alternative 6 – Pocket Basins:
Waterman Wash Reach 4 and Reach 5



Figure 4-11

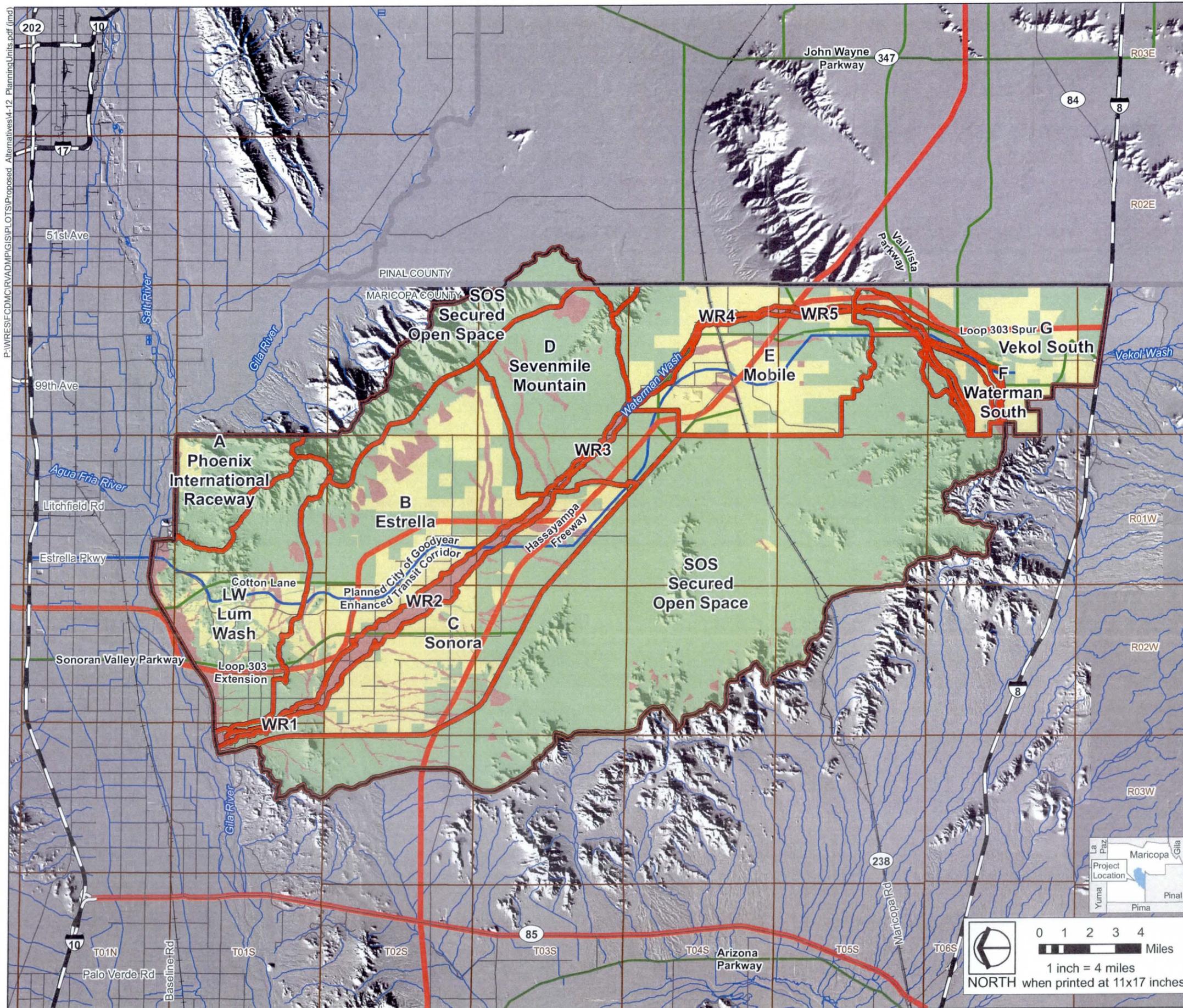


P:\WRES\FCD\IRVAD\MP\GIS\PLTS\Proposed Alternatives\Fig 4-11 PocketBasins WR45.pdf (mxd)

Rainbow Valley
Area Drainage Master Plan
Proposed Alternatives - Planning Units



Figure 4-12



Project Features

- Planning Unit Boundary
- Flood Hazard Rating**
- Low
- Medium
- High
- Future Corridor Type**
- Freeway
- Parkway
- Transit Corridor

Label	Planning Unit
A	Phoenix International Raceway
B	Estrella
C	Sonora
D	Sevenmile Mountain
E	Mobile
F	Waterman South
G	Vekol South
LW	Lum Wash
SOS	Secured Open Space
WR1 to WR5	Waterman Wash Reaches

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/Freeway
- Major Road
- Railroad
- River/Stream

Data Sources

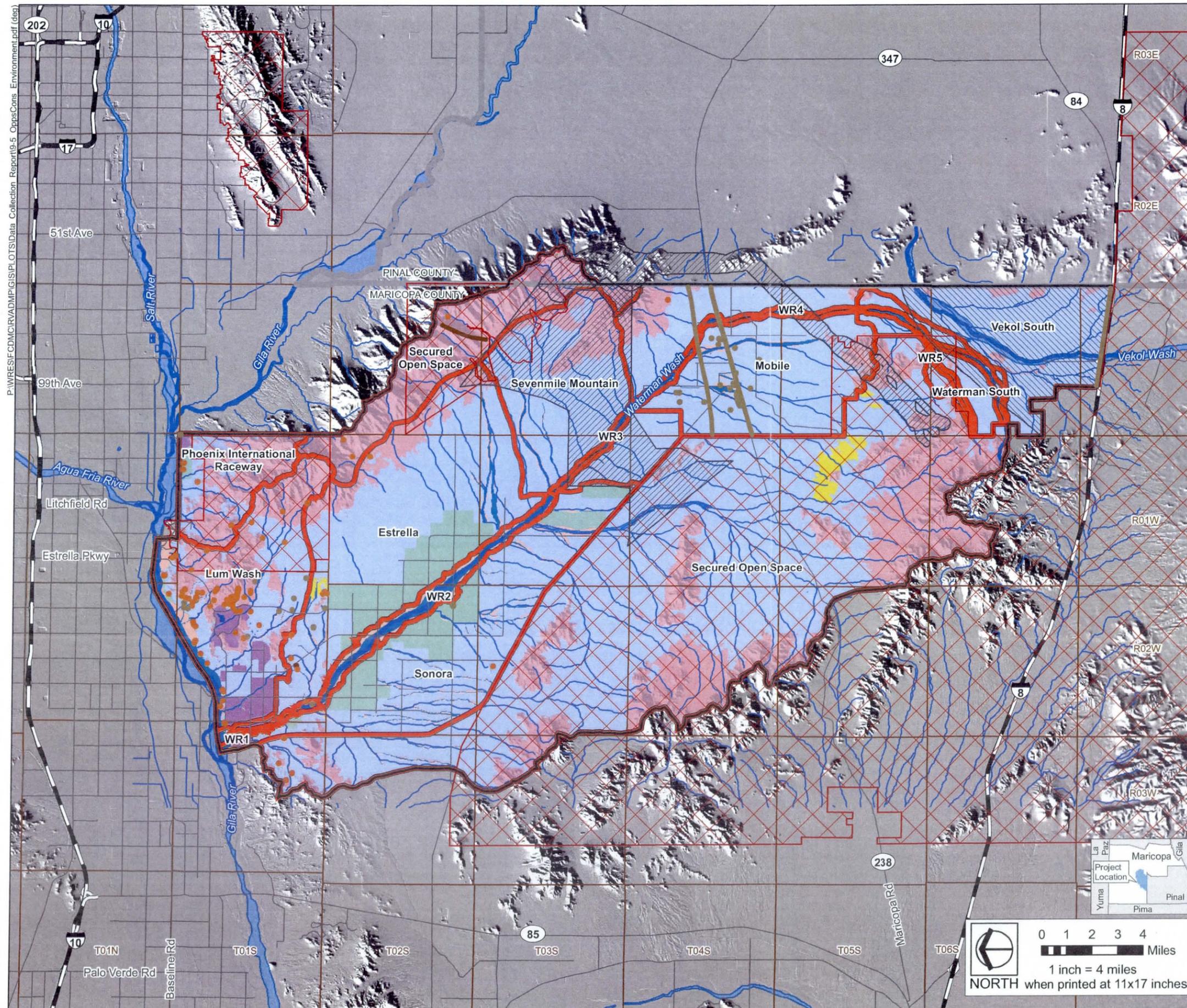
Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
URS Corporation
Flood Hazard Rating and Alternative Data 2009

0 1 2 3 4
Miles
 1 inch = 4 miles
 NORTH when printed at 11x17 inches

Rainbow Valley
Area Drainage Master Plan
Opportunities and Constraints:
Environmental Resources



Figure 4-13



Project Features

Cultural Resources

- Historic Site
- Prehistoric-Historic Site
- Prehistoric Site

Ecological Units

- Agriculture
- Developed
- Floodway Fringe
- Mixed Creosote Scrub
- Mixed Salt Desert Scrub
- Mixed Upland Desert Scrub
- Mountain Woodland
- Open Water
- Riparian

Overlay Areas

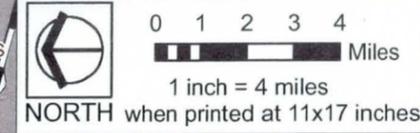
- Secured Open Space
- Vekol Valley Grassland Species Habitat
- Wildlife Corridor

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/Freeway
- Major Road
- Planning Unit Boundary

Data Sources

Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
Arizona Department of Game and Fish
Wildlife Corridors, 2008
URS Corporation
Cultural Resources, Ecological Units, Alternative Data, 2009



Rainbow Valley
Area Drainage Master Plan
Opportunities and Constraints: Parks, Recreation
& Open-Space Resources



Figure 4-14

Project Features

Parks and Recreation Resources

Federal

- Wilderness Area
- National Monument
- Bureau of Land Management
- Juan Bautista de Anza National Historic Trail

State

- Wildlife Area

Regional

- County Regional Park
- City Regional Park
- Maricopa County Regional Trail System

Local

- City Park
- Planned City Park
- Golf Course
- Community Trail

Other Open-Space Resources

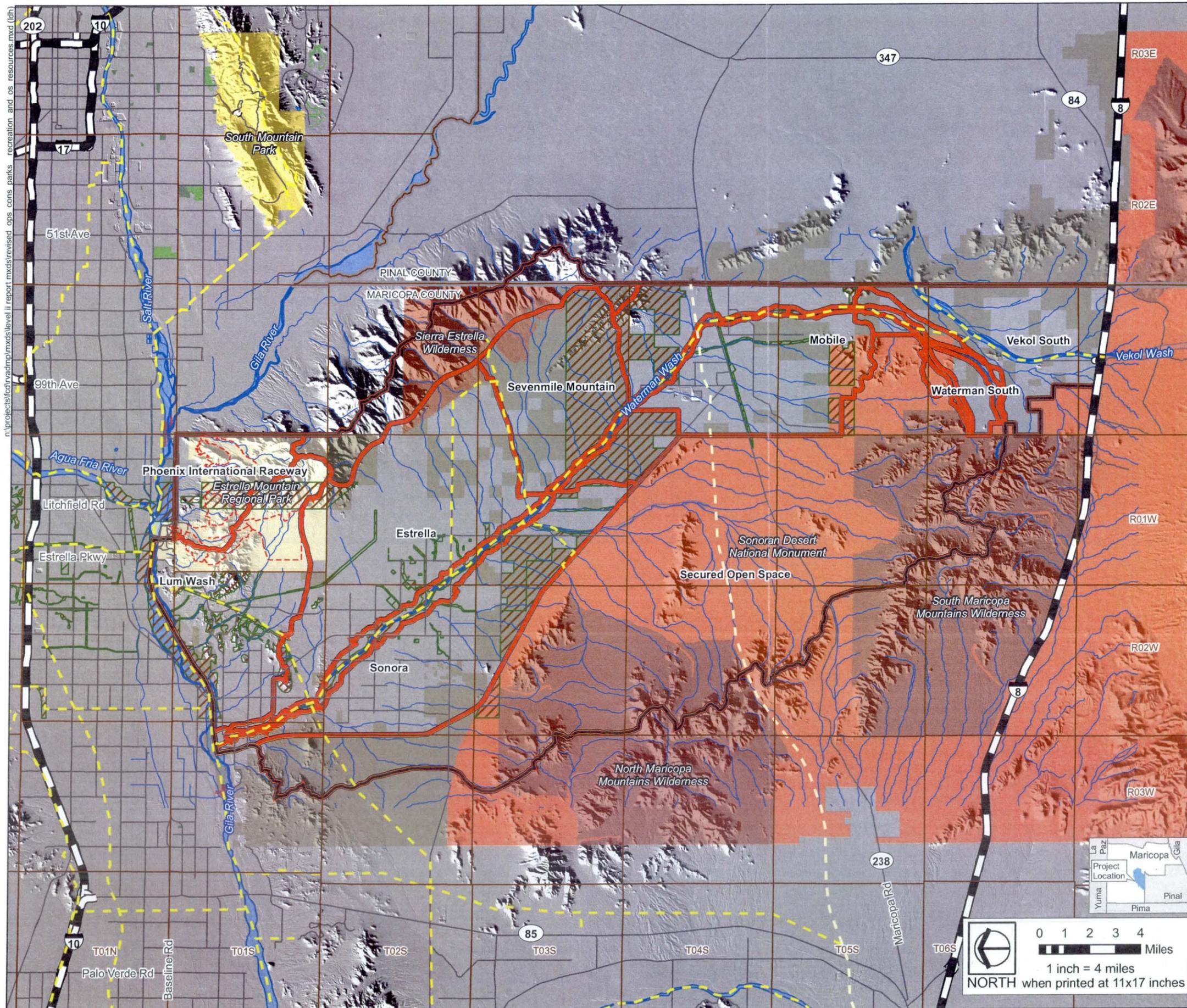
- City of Goodyear Planned Open-Space

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Planning Unit Boundary

Data Sources

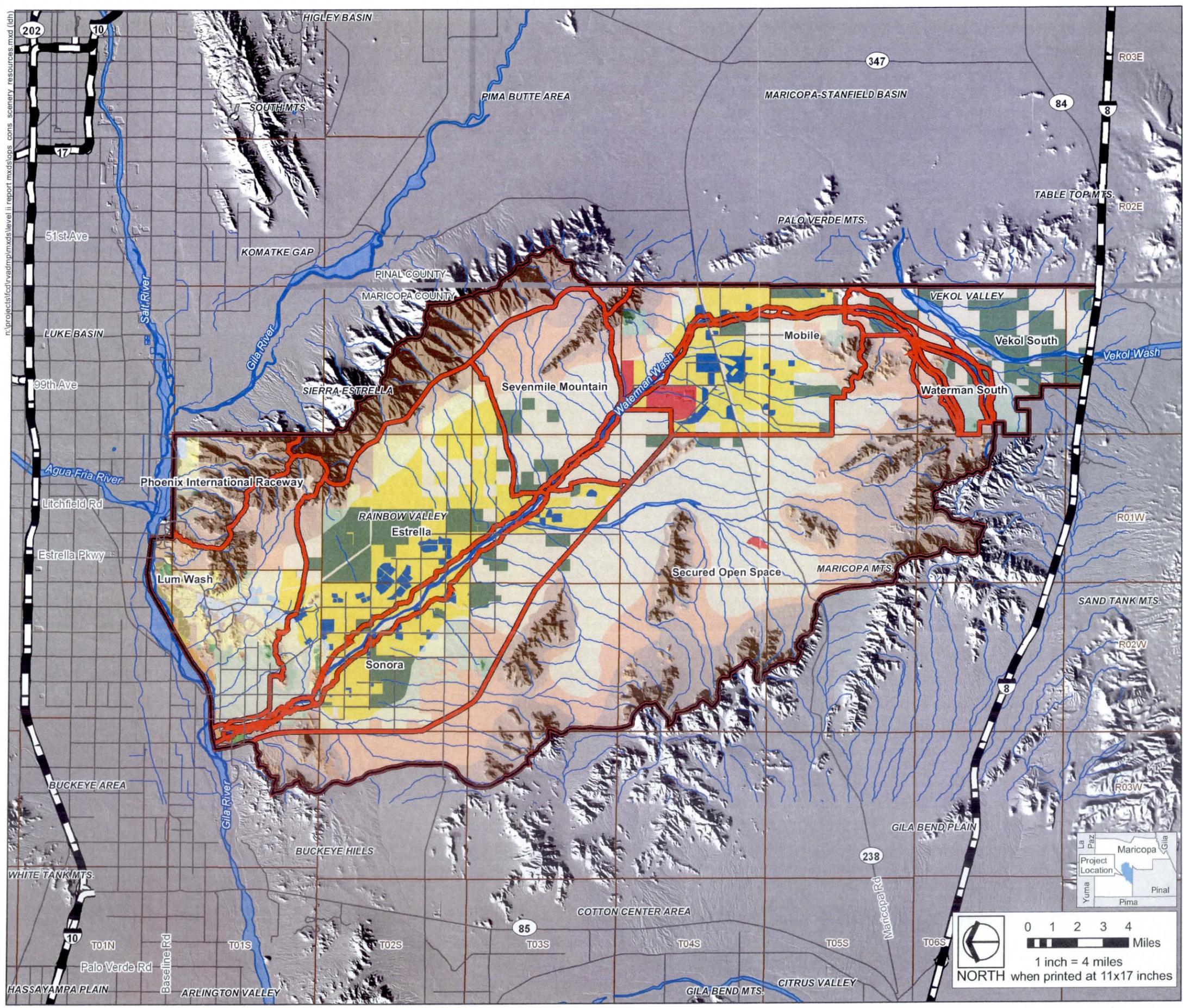
Flood Control District of Maricopa County
Landscape Inventory & Analysis (LIA), 2008
Future Landscape Character Cultural Settings Map, 2008
Landscape Character Physical Settings Map, 2008
City of Goodyear Land Use Plan, 2008
URS Corporations Alternative Data, 2009



Rainbow Valley
Area Drainage Master Plan
Opportunities and Constraints: Scenery Resources



Figure 4-15



- Sonoran River Lands Subtype**
- Natural River Channel
 - Rural River Channel
 - Suburban River Channel
 - Urban River Channel
 - Industrial River Channel
 - Natural River Terrace
 - Rural River Terrace
 - Suburban River Terrace
 - Urban River Terrace
 - Industrial River Terrace

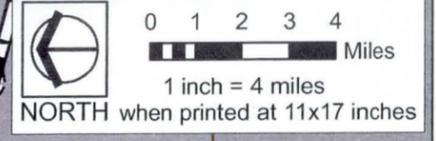
- Sonoran Valley Lands Subtype**
- Natural Valley Plains
 - Rural Valley Plains
 - Suburban Valley Plains
 - Urban Valley Plains
 - Industrial Valley Plains
 - Natural Valley Wash
 - Rural Valley Wash
 - Suburban Valley Wash
 - Urban Valley Wash
 - Industrial Valley Wash

- Sonoran Mountain Lands Subtype**
- Natural Arroyo
 - Rural Arroyo
 - Suburban Arroyo
 - Urban Arroyo
 - Industrial Arroyo
 - Natural Foothills
 - Rural Foothills
 - Suburban Foothills
 - Urban Foothills
 - Industrial Foothills
 - Natural Upper Bajada
 - Rural Upper Bajada
 - Suburban Upper Bajada
 - Urban Upper Bajada
 - Industrial Upper Bajada
 - Natural Lower Bajada
 - Rural Lower Bajada
 - Suburban Lower Bajada
 - Urban Lower Bajada
 - Industrial Lower Bajada
 - Natural Moutains
 - Rural Moutains
 - Suburban Moutains
 - Urban Moutains
 - Industrial Moutains

- Reference Features**
- County Boundary
 - Rainbow Valley
 - ADMP Boundary
 - Township and Range Boundary
 - Planning Unit Boundary

Data Sources

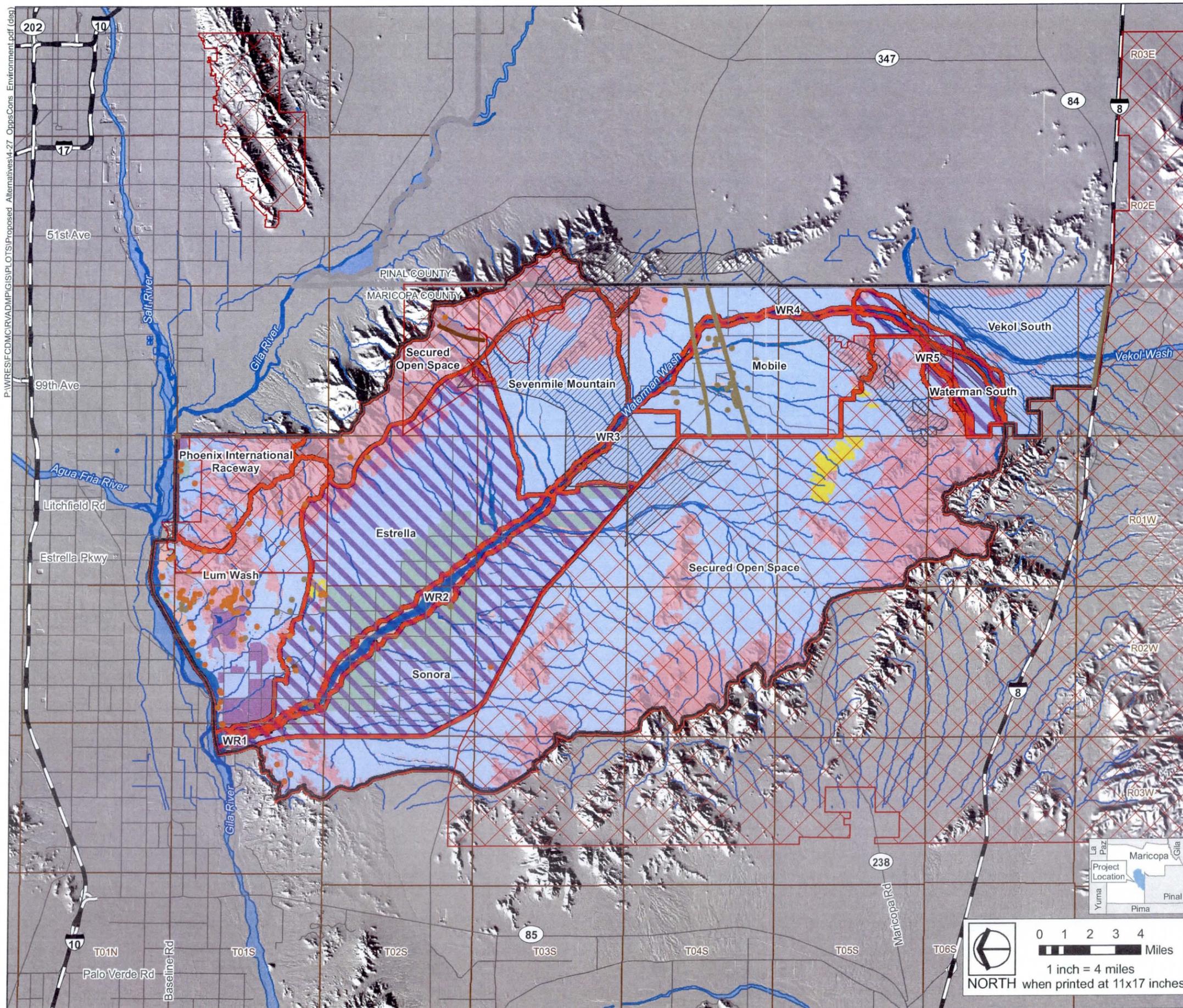
Landscape Inventory & Analysis (LIA), 2008
Flood Control District of Maricopa County
Future Landscape Character Cultural Settings Map, 2008
Landscape Character Physical Settings Map, 2008
URS Corporations Alternative Data, 2009



Rainbow Valley
Area Drainage Master Plan
Alternative 2 – New Regulations:
Environmental Resources



Figure 4-17



Project Features

- Planning Units with New Regulations

Cultural Resources

- Historic Site
- Prehistoric-Historic Site
- Prehistoric Site

Ecological Units

- Agriculture
- Developed
- Floodway Fringe
- Mixed Creosote Scrub
- Mixed Salt Desert Scrub
- Mixed Upland Desert Scrub
- Mountain Woodland
- Open Water
- Riparian

Overlay Areas

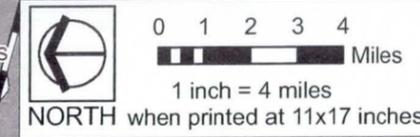
- Secured Open Space
- Vekol Valley Grassland Species Habitat
- Wildlife Corridor

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/Freeway
- Major Road
- Planning Unit Boundary

Data Sources

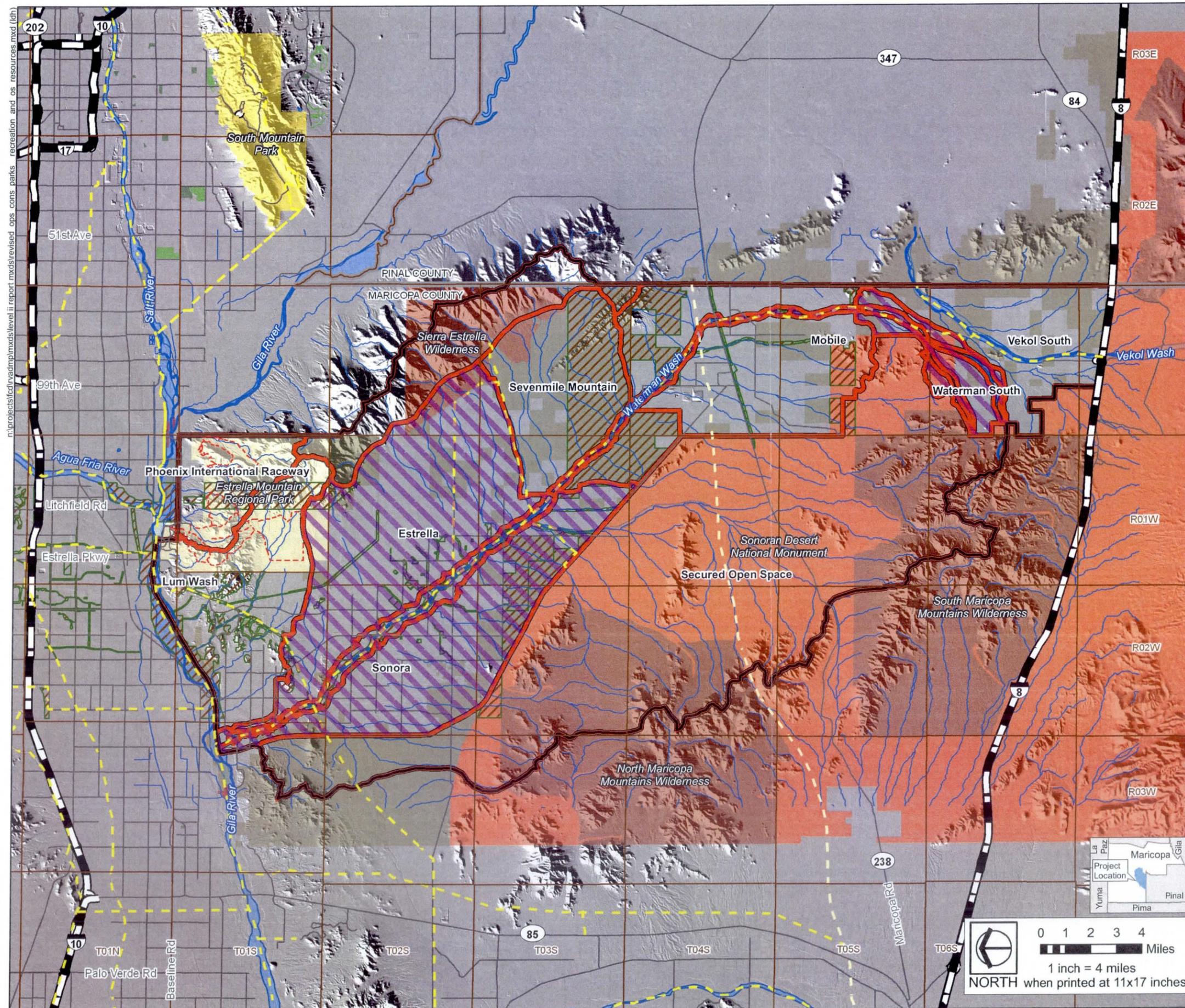
- Flood Control District of Maricopa County Base Vector and Hillshade Data, 2008
- Arizona Department of Game and Fish Wildlife Corridors, 2008
- URS Corporation Cultural Resources, Ecological Units, Alternative Data, 2009



Rainbow Valley
Area Drainage Master Plan
Alternative 2 – New Regulations:
Parks, Recreation & Open-Space Resources



Figure 4-18



Project Features

- Planning Units with New Regulations

Parks and Recreation Resources

Federal

- Wilderness Area
- National Monument
- Bureau of Land Management
- Juan Bautista de Anza National Historic Trail

State

- Wildlife Area

Regional

- County Regional Park
- City Regional Park
- Maricopa County Regional Trail System

Local

- City Park
- Planned City Park
- Golf Course
- Community Trail

Other Open-Space Resources

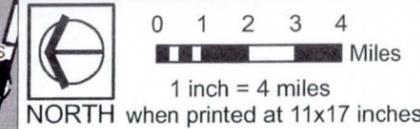
- City of Goodyear Planned Open-Space

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Planning Unit Boundary

Data Sources

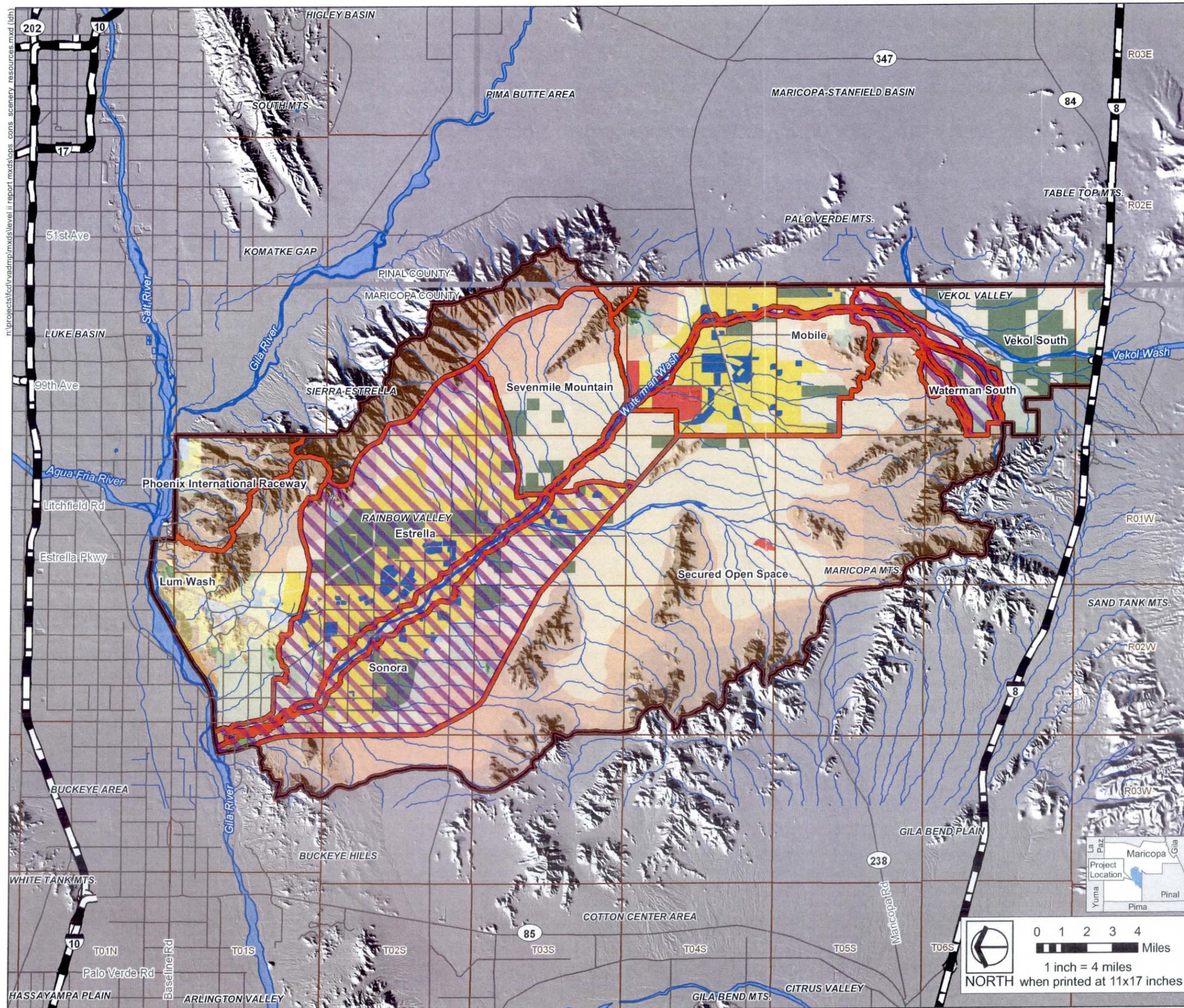
Flood Control District of Maricopa County
Landscape Inventory & Analysis (LIA), 2008
Future Landscape Character Cultural Settings Map, 2008
Landscape Character Physical Settings Map, 2008
City of Goodyear Land Use Plan, 2008
URS Corporations Alternative Data, 2009



Rainbow Valley
Area Drainage Master Plan
Alternative 2 – New Regulations:
Scenery Resources



Figure 4-19



- Planning Units with New Regulations
- Sonoran River Lands Subtype**
- Natural River Channel
 - Rural River Channel
 - Suburban River Channel
 - Urban River Channel
 - Industrial River Channel
 - Natural River Terrace
 - Rural River Terrace
 - Suburban River Terrace
 - Urban River Terrace
 - Industrial River Terrace

- Sonoran Valley Lands Subtype**
- Natural Valley Plains
 - Rural Valley Plains
 - Suburban Valley Plains
 - Urban Valley Plains
 - Industrial Valley Plains
 - Natural Valley Wash
 - Rural Valley Wash
 - Suburban Valley Wash
 - Urban Valley Wash
 - Industrial Valley Wash

- Sonoran Mountain Lands Subtype**
- Natural Arroyo
 - Rural Arroyo
 - Suburban Arroyo
 - Urban Arroyo
 - Industrial Arroyo
 - Natural Foothills
 - Rural Foothills
 - Suburban Foothills
 - Urban Foothills
 - Industrial Foothills
 - Natural Upper Bajada
 - Rural Upper Bajada
 - Suburban Upper Bajada
 - Urban Upper Bajada
 - Industrial Upper Bajada
 - Natural Lower Bajada
 - Rural Lower Bajada
 - Suburban Lower Bajada
 - Urban Lower Bajada
 - Industrial Lower Bajada
 - Natural Moutains
 - Rural Moutains
 - Suburban Moutains
 - Urban Moutains
 - Industrial Moutains

- Reference Features**
- County Boundary
 - Rainbow Valley ADMP Boundary
 - Township and Range Boundary
 - Planning Unit Boundary
- Data Sources**
- Landscape Inventory & Analysis (LIA), 2008
 - Flood Control District of Maricopa County
 - Future Landscape Character Cultural Settings Map, 2008
 - Landscape Character Physical Settings Map, 2008
 - URS Corporations Alternative Data, 2009

0 1 2 3 4 Miles
1 inch = 4 miles
NORTH when printed at 11x17 inches

Rainbow Valley
Area Drainage Master Plan
Alternative 3 - Structural Conveyance:
Typical Plan and Section

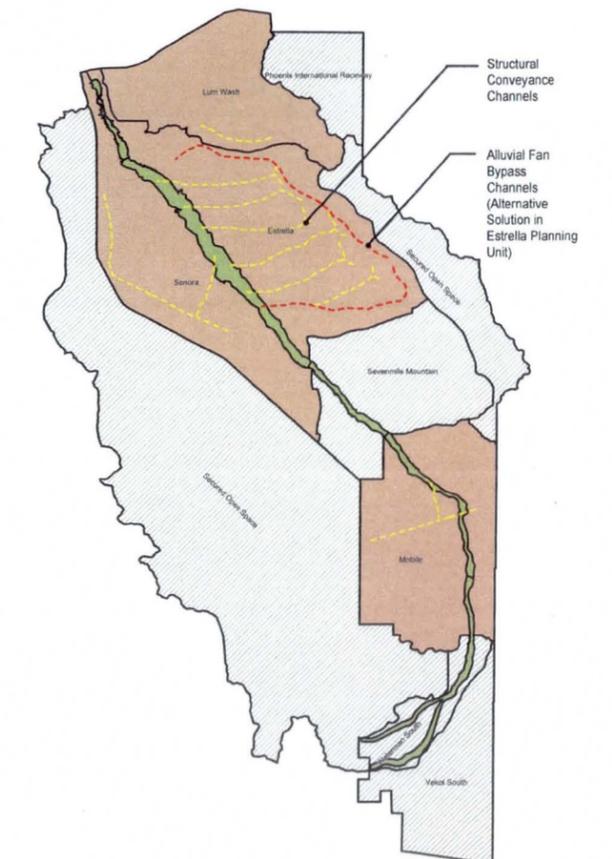


Figure 4-20

Proposed Flood Protection Method:
Natural - Soft-Structural, Semi-Soft Structural
Urban - Semi-Soft Structural, Enhanced Hard Structural

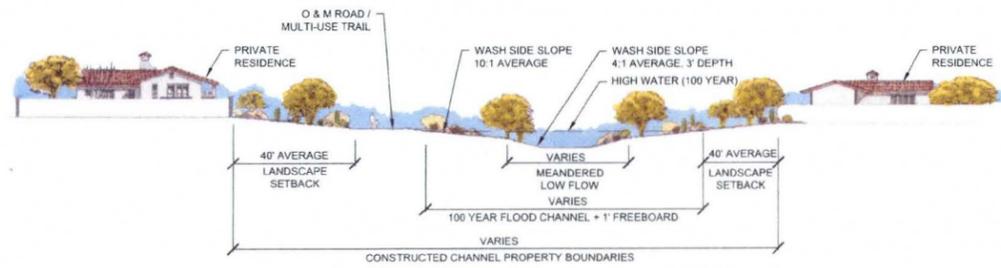
Compatible Landscape Design Themes:
Natural - Natural Sonoran Desert Upland Riparian, Natural Lower Sonoran Desert Riparian
Urban - Semi-Natural Sonoran Desert, Enhanced Desert, Desert Park

KEY MAP



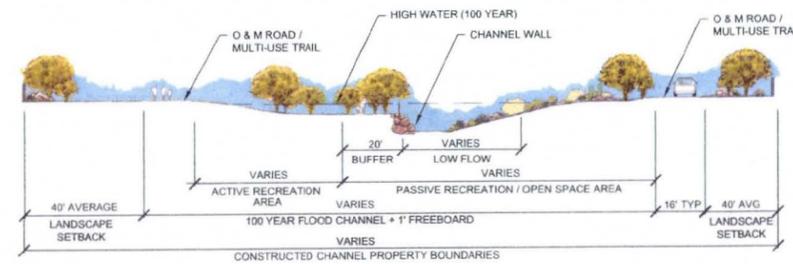
- Planning Unit where Flood Hazard Mitigation is achieved through Structural Conveyance
- Planning Unit where Flood Hazard Mitigation is achieved through Land Use Management or Existing Regulations
- Flood Hazard Mitigation achieved through implementation of updated Waterman Wash Guidelines

NATURAL LANDSCAPE DESIGN THEMES



SECTION A-A

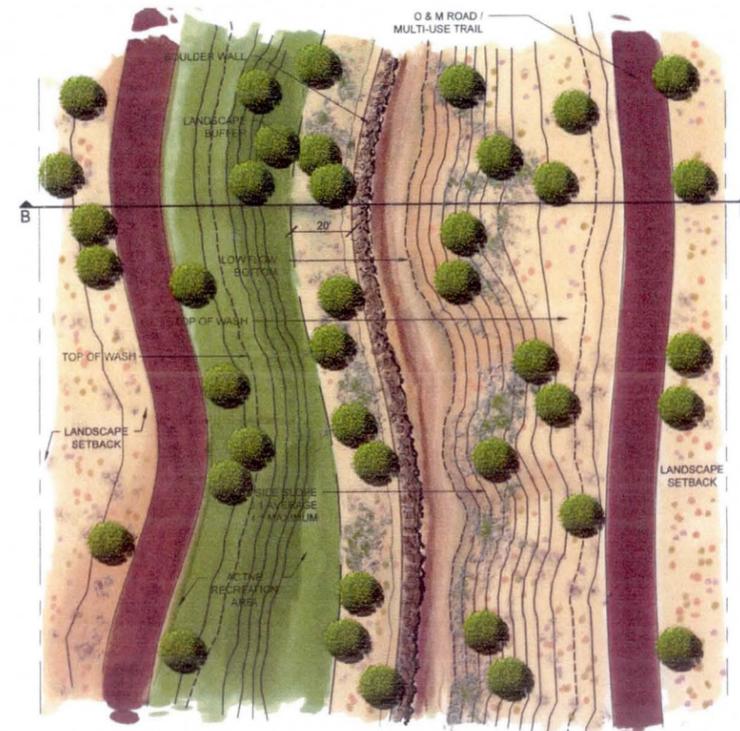
URBAN LANDSCAPE DESIGN THEMES



SECTION B-B



TYPICAL PLAN VIEW

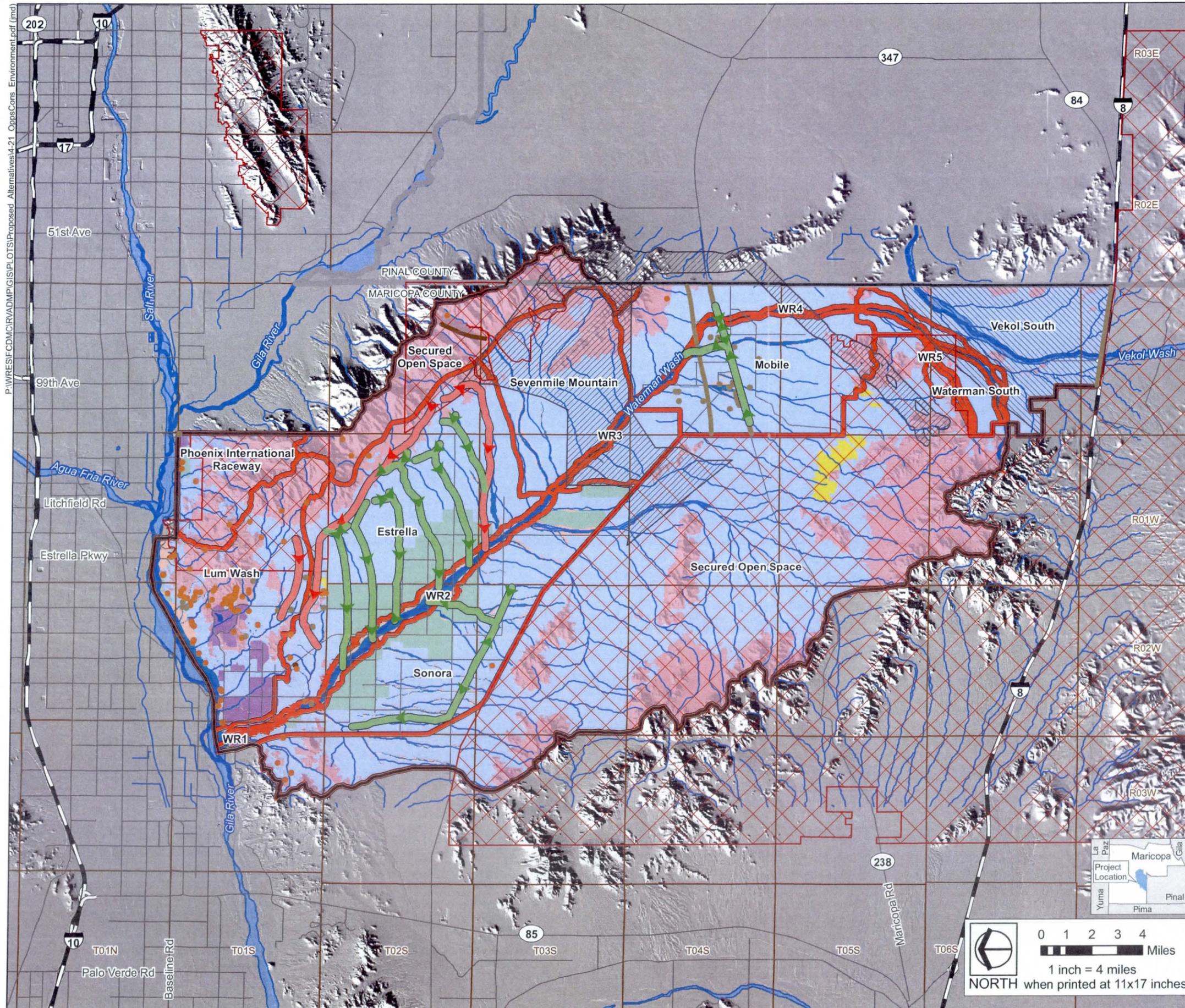


TYPICAL PLAN VIEW

Rainbow Valley
Area Drainage Master Plan
Alternative 3 – Structural Conveyance:
Environmental Resources



Figure 4-21



Project Features

- Conveyance Channel
- Alluvial Bypass Channel

Cultural Resources

- Historic Site
- Prehistoric-Historic Site
- Prehistoric Site

Ecological Units

- Agriculture
- Developed
- Floodway Fringe
- Mixed Creosote Scrub
- Mixed Salt Desert Scrub
- Mixed Upland Desert Scrub
- Mountain Woodland
- Open Water
- Riparian

Overlay Areas

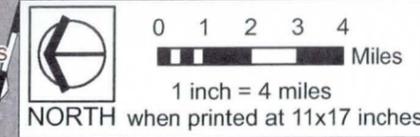
- Secured Open Space
- Vekol Valley Grassland Species Habitat
- Wildlife Corridor

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/Freeway
- Major Road
- Planning Unit Boundary

Data Sources

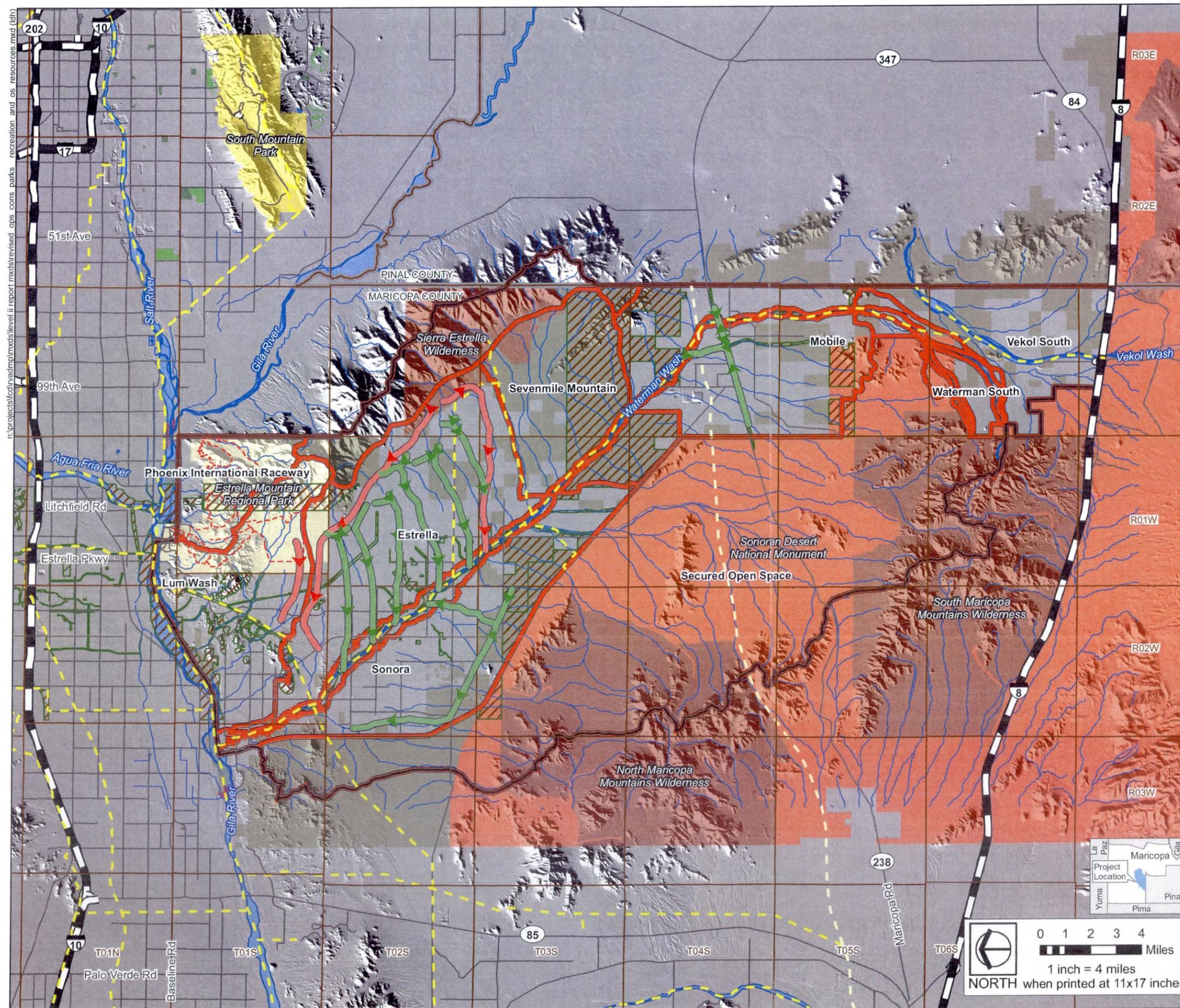
- Flood Control District of Maricopa County Base Vector and Hillshade Data, 2008
- Arizona Department of Game and Fish Wildlife Corridors, 2008
- URS Corporation Cultural Resources, Ecological Units, Alternative Data, 2009



Rainbow Valley
Area Drainage Master Plan
Alternative 3 – Structural Conveyance:
Parks, Recreation & Open-Space Resources



Figure 4-22



Project Features

- Structural Conveyance Line
- Alluvial Bypass Channel

Parks and Recreation Resources

Federal

- Wilderness Area
- National Monument
- Bureau of Land Management
- Juan Bautista de Anza National Historic Trail

State

- Wildlife Area

Regional

- County Regional Park
- City Regional Park
- Maricopa County Regional Trail System

Local

- City Park
- Planned City Park
- Golf Course
- Community Trail

Other Open-Space Resources

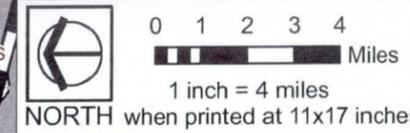
- City of Goodyear Planned Open-Space

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Planning Unit Boundary

Data Sources

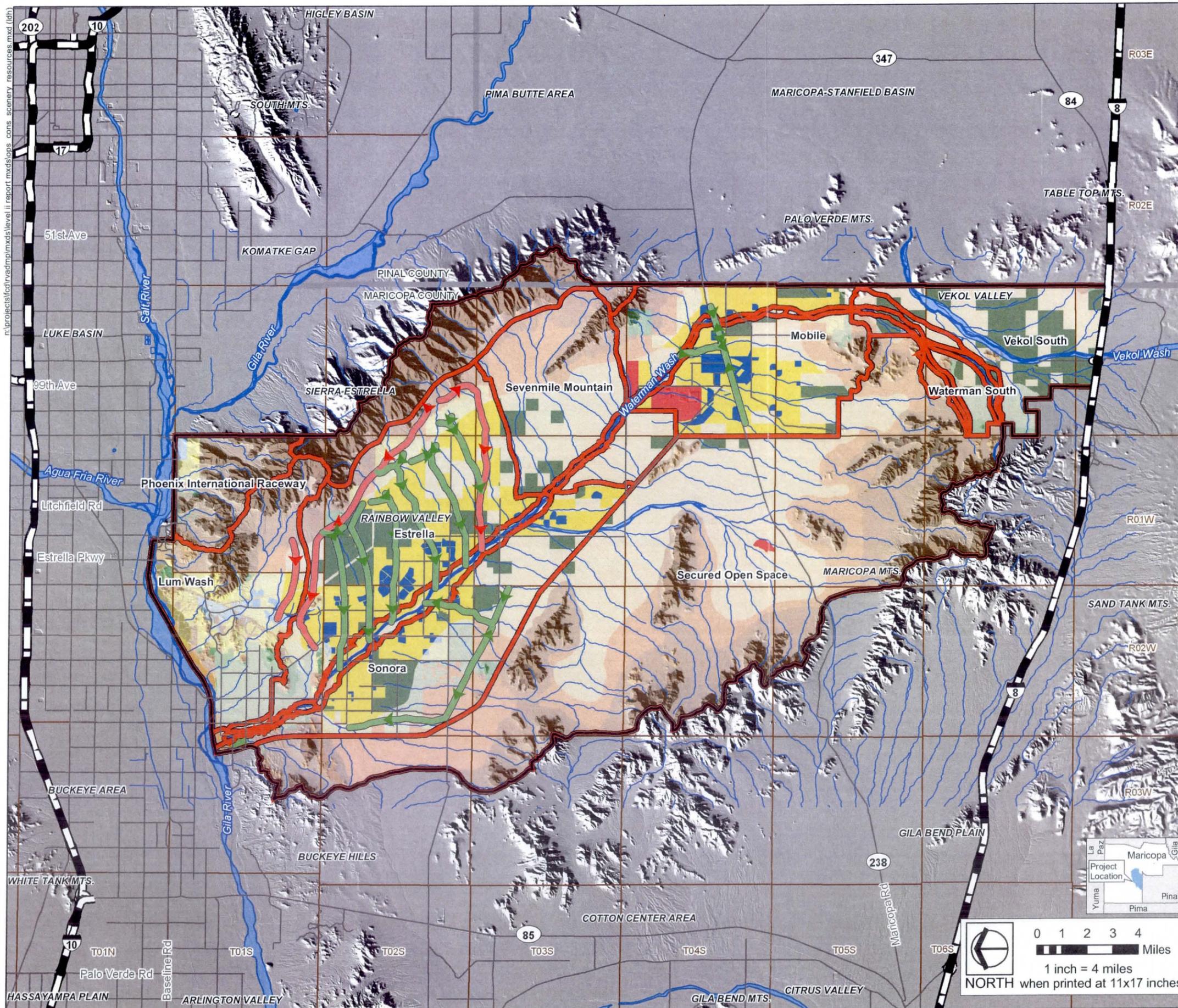
Flood Control District of Maricopa County
Landscape Inventory & Analysis (LIA), 2008
Future Landscape Character Cultural Settings Map, 2008
Landscape Character Physical Settings Map, 2008
City of Goodyear Land Use Plan, 2008
URS Corporations Alternative Data, 2009



Rainbow Valley
Area Drainage Master Plan
Alternative 3 – Structural Conveyance:
Scenery Resources



Figure 4-23



- Structural Conveyance Line
- Alluvial Bypass Channel

- Sonoran River Lands Subtype**
- | | |
|--------------------------|--------------------------|
| Natural River Channel | Natural River Terrace |
| Rural River Channel | Rural River Terrace |
| Suburban River Channel | Suburban River Terrace |
| Urban River Channel | Urban River Terrace |
| Industrial River Channel | Industrial River Terrace |

- Sonoran Valley Lands Subtype**
- | | |
|--------------------------|------------------------|
| Natural Valley Plains | Natural Valley Wash |
| Rural Valley Plains | Rural Valley Wash |
| Suburban Valley Plains | Suburban Valley Wash |
| Urban Valley Plains | Urban Valley Wash |
| Industrial Valley Plains | Industrial Valley Wash |

- Sonoran Mountain Lands Subtype**
- | | |
|-----------------------|-------------------------|
| Natural Arroyo | Urban Upper Bajada |
| Rural Arroyo | Industrial Upper Bajada |
| Suburban Arroyo | Natural Lower Bajada |
| Urban Arroyo | Rural Lower Bajada |
| Industrial Arroyo | Suburban Lower Bajada |
| Natural Foothills | Urban Lower Bajada |
| Rural Foothills | Industrial Lower Bajada |
| Suburban Foothills | Natural Moutains |
| Urban Foothills | Rural Moutains |
| Industrial Foothills | Suburban Moutains |
| Natural Upper Bajada | Urban Moutains |
| Rural Upper Bajada | Industrial Moutains |
| Suburban Upper Bajada | |

- Reference Features**
- County Boundary
 - Rainbow Valley ADMP Boundary
 - Township and Range Boundary
 - Planning Unit Boundary

Data Sources

- Landscape Inventory & Analysis (LIA), 2008
- Flood Control District of Maricopa County
- Future Landscape Character Cultural Settings Map, 2008
- Landscape Character Physical Settings Map, 2008
- URS Corporations Alternative Data, 2009

0 1 2 3 4 Miles
1 inch = 4 miles
NORTH when printed at 11x17 inches

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Rainbow Valley Area Drainage Master Plan Alternative 4 - Structural Storage: Typical Plan and Section

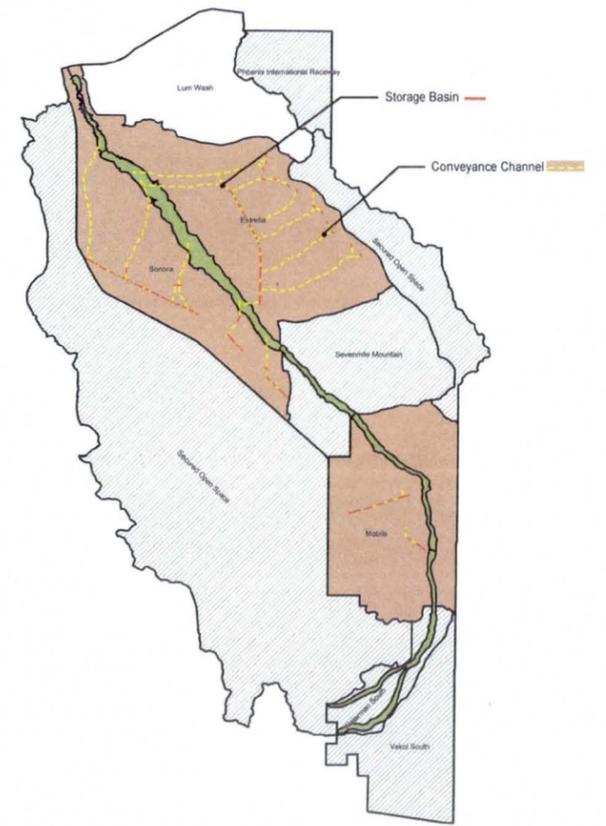


Figure 4-24

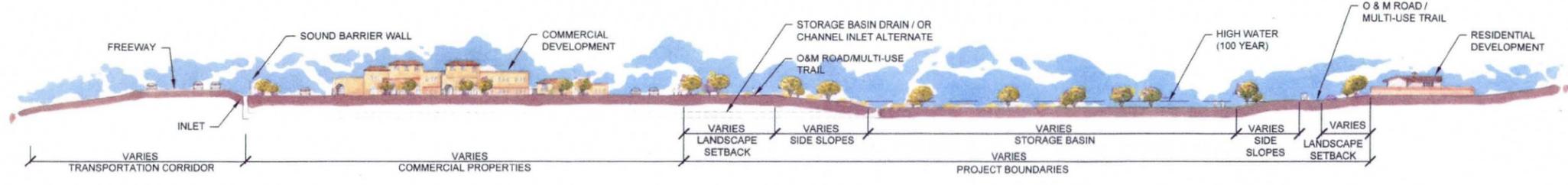
Proposed Flood Protection Method:
Soft-Structural, Semi-Soft Structural

Compatible Landscape Design Themes:
Natural Sonoran Desert Upland, Natural Sonoran Desert Upland Riparian, Natural Lower Sonoran Desert, Natural Lower Sonoran Desert Riparian, Semi-Natural Sonoran Desert, Enhanced Desert, Desert Park, Desert Oasis

KEY MAP



- Planning Unit where Structural Storage is applicable for Flood Hazard Mitigation
- Planning Unit where Flood Hazard Mitigation is achieved through Land Use Management or Existing Regulations
- No Structural Storage Flood Hazard Mitigation proposed for this Planning Unit
- Flood Hazard Mitigation achieved through implementation of updated Waterman Wash Guidelines



SECTION A-A

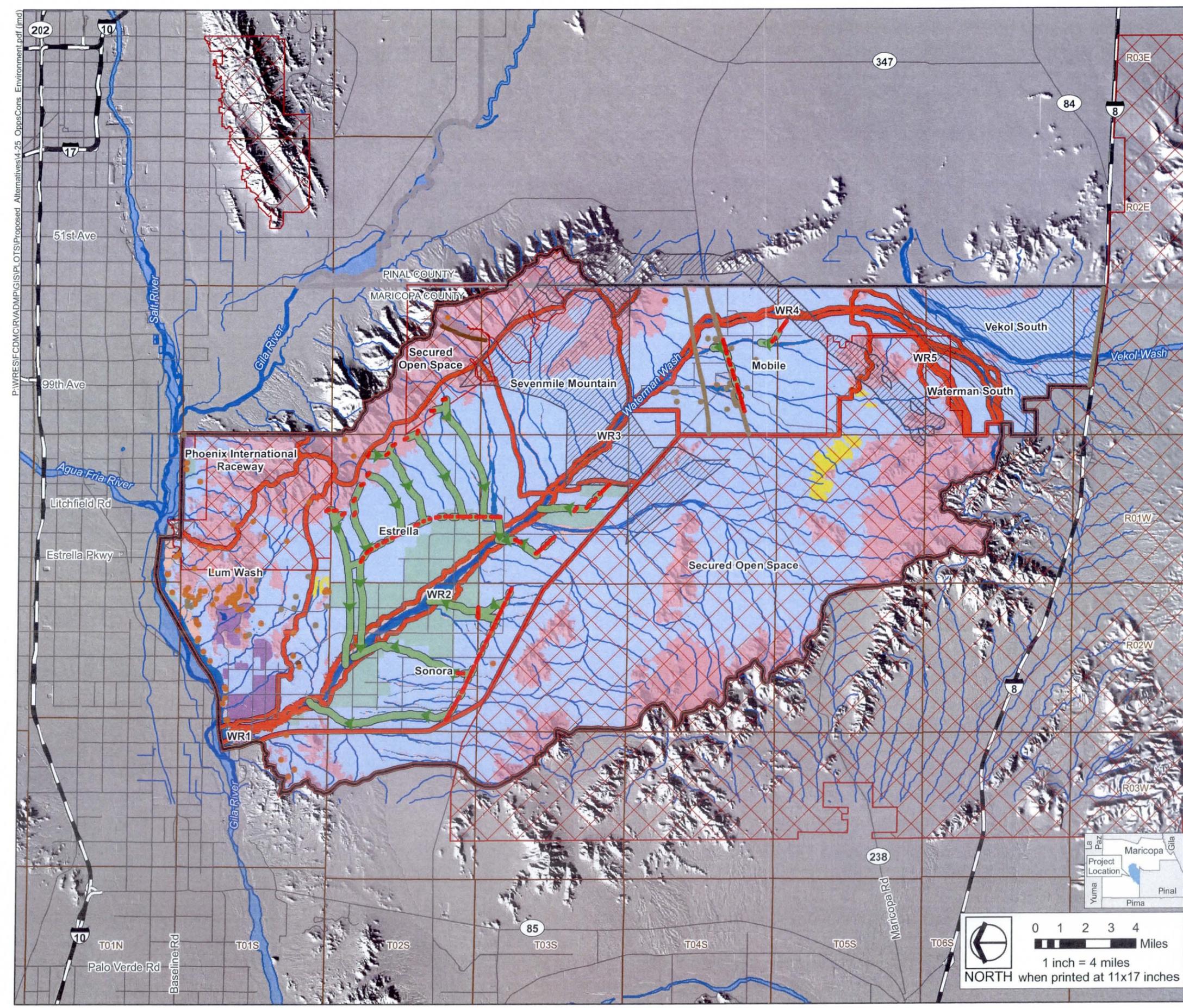


TYPICAL PLAN VIEW

Rainbow Valley
Area Drainage Master Plan
Alternative 4 – Structural Storage:
Environmental Resources



Figure 4-25



Project Features

- Storage Basin
- Conveyance Channel

Cultural Resources

- Historic Site
- Prehistoric-Historic Site
- Prehistoric Site

Ecological Units

- Agriculture
- Developed
- Floodway Fringe
- Mixed Creosote Scrub
- Mixed Salt Desert Scrub
- Mixed Upland Desert Scrub
- Mountain Woodland
- Open Water
- Riparian

Overlay Areas

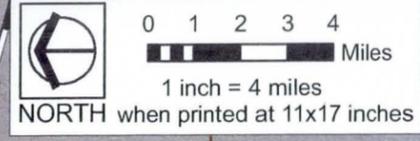
- Secured Open Space
- Vekol Valley Grassland Species Habitat
- Wildlife Corridor

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/Freeway
- Major Road
- Planning Unit Boundary

Data Sources

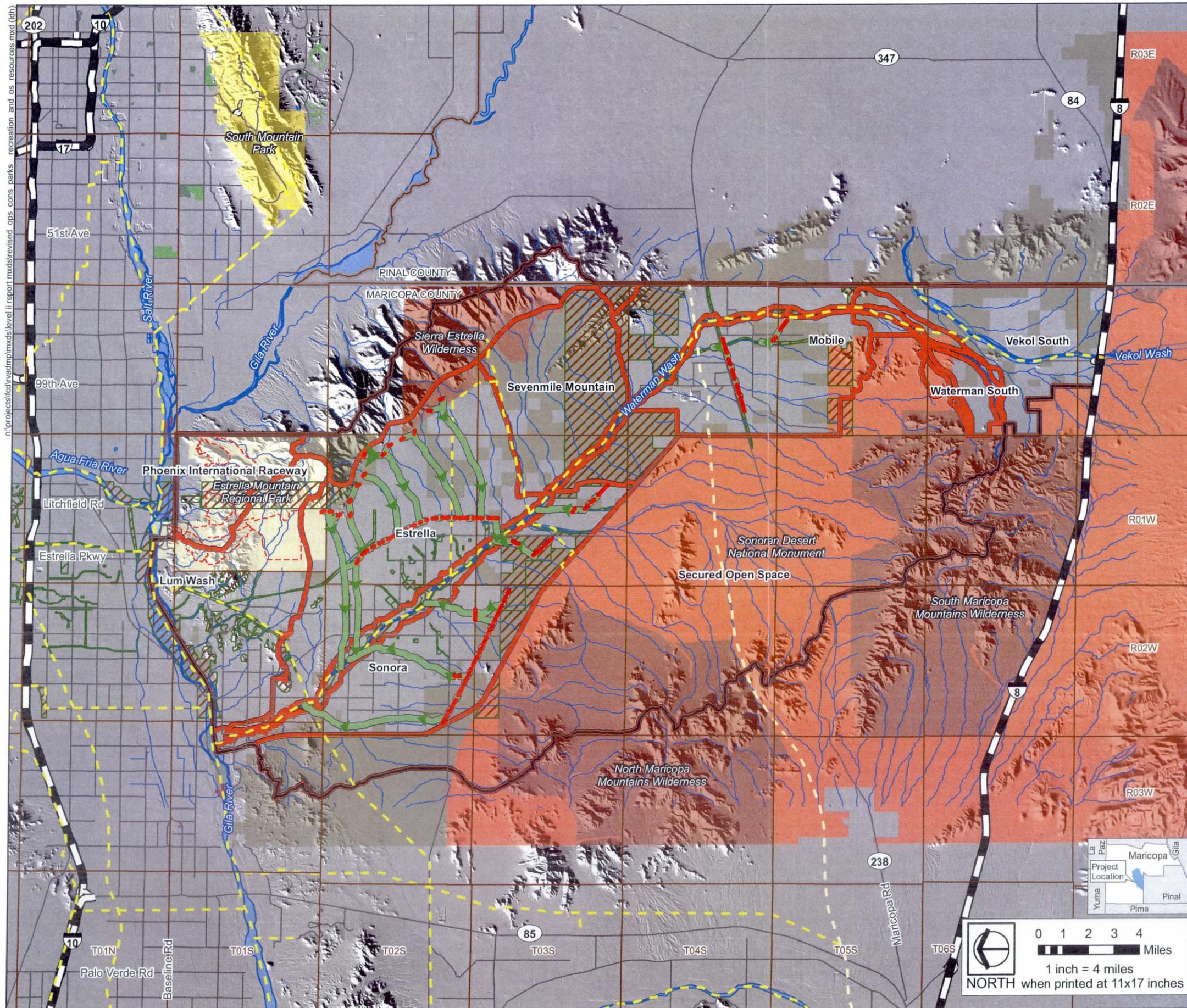
Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
Arizona Department of Game and Fish
Wildlife Corridors, 2008
URS Corporation
Cultural Resources, Ecological Units, Alternative Data, 2009



Rainbow Valley
Area Drainage Master Plan
Alternative 4 – Structural Storage:
Parks, Recreation
& Open-Space Resources



Figure 4-26



Project Features

- Storage Basin
- Conveyance Channel

Parks and Recreation Resources

Federal

- Wilderness Area
- National Monument
- Bureau of Land Management
- Juan Bautista de Anza National Historic Trail

State

- Wildlife Area

Regional

- County Regional Park
- City Regional Park
- Maricopa County Regional Trail System

Local

- City Park
- Planned City Park
- Golf Course
- Community Trail

Other Open-Space Resources

- City of Goodyear Planned Open-Space

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Planning Unit Boundary

Data Sources

- Flood Control District of Maricopa County Landscape Inventory & Analysis (LIA), 2008
- Future Landscape Character Cultural Settings Map, 2008
- Landscape Character Physical Settings Map, 2008
- City of Goodyear Land Use Plan, 2008
- URS Corporations Alternative Data, 2009

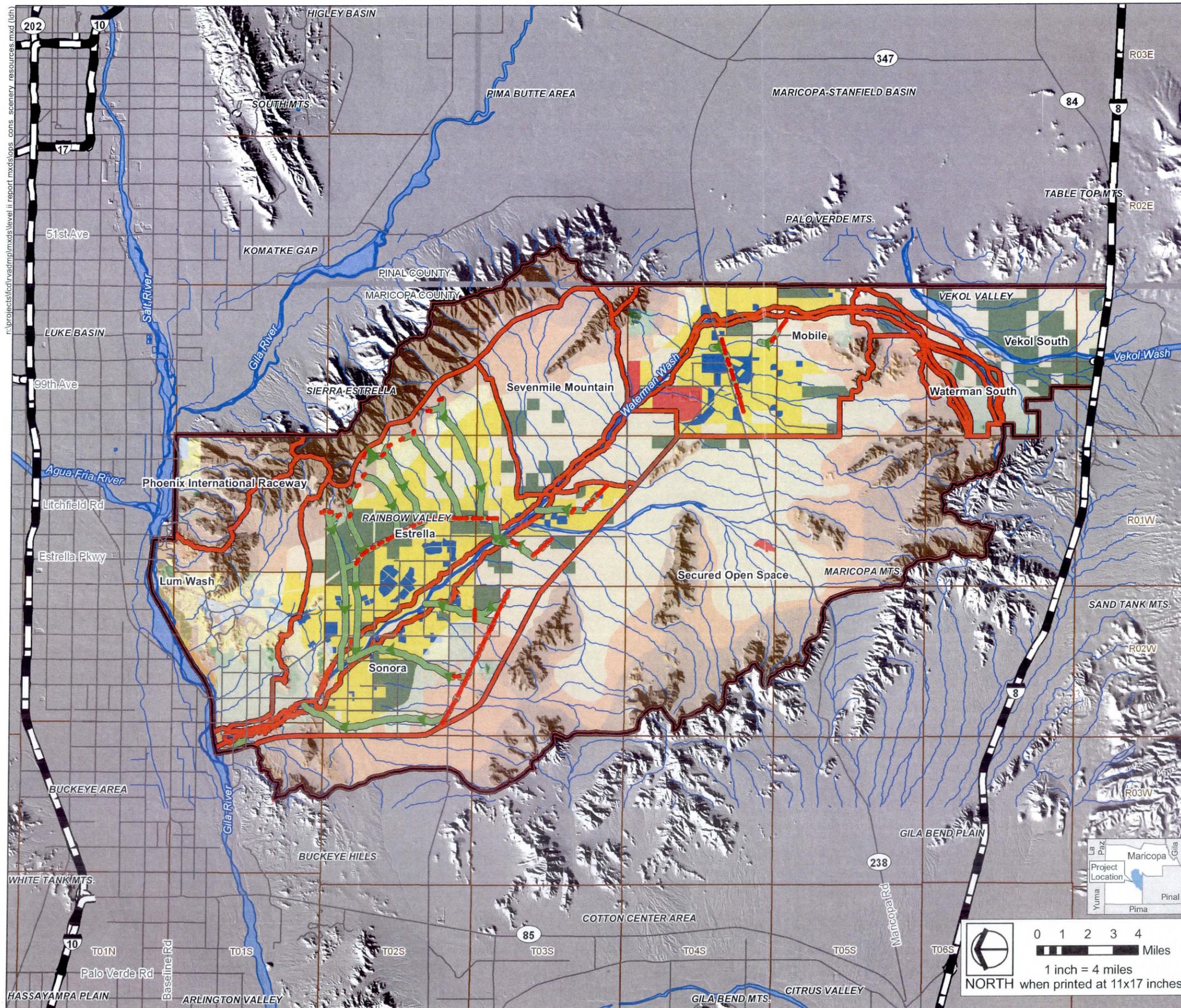
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1 inch = 4 miles
NORTH when printed at 11x17 inches



Rainbow Valley
Area Drainage Master Plan
Alternative 4 – Structural Storage:
Scenery Resources



Figure 4-27



Project Features

- Storage Basin
- Conveyance Channel

Sonoran River Lands Subtype

- | | |
|---|---|
| ■ Natural River Channel | ■ Natural River Terrace |
| ■ Rural River Channel | ■ Rural River Terrace |
| ■ Suburban River Channel | ■ Suburban River Terrace |
| ■ Urban River Channel | ■ Urban River Terrace |
| ■ Industrial River Channel | ■ Industrial River Terrace |

Sonoran Valley Lands Subtype

- | | |
|---|---|
| ■ Natural Valley Plains | ■ Natural Valley Wash |
| ■ Rural Valley Plains | ■ Rural Valley Wash |
| ■ Suburban Valley Plains | ■ Suburban Valley Wash |
| ■ Urban Valley Plains | ■ Urban Valley Wash |
| ■ Industrial Valley Plains | ■ Industrial Valley Wash |

Sonoran Mountain Lands Subtype

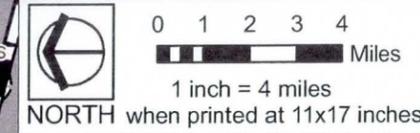
- | | |
|--|--|
| ■ Natural Arroyo | ■ Urban Upper Bajada |
| ■ Rural Arroyo | ■ Industrial Upper Bajada |
| ■ Suburban Arroyo | ■ Natural Lower Bajada |
| ■ Urban Arroyo | ■ Rural Lower Bajada |
| ■ Industrial Arroyo | ■ Suburban Lower Bajada |
| ■ Natural Foothills | ■ Urban Lower Bajada |
| ■ Rural Foothills | ■ Industrial Lower Bajada |
| ■ Suburban Foothills | ■ Natural Moutains |
| ■ Urban Foothills | ■ Rural Moutains |
| ■ Industrial Foothills | ■ Suburban Moutains |
| ■ Natural Upper Bajada | ■ Urban Moutains |
| ■ Rural Upper Bajada | ■ Industrial Moutains |
| ■ Suburban Upper Bajada | |

Reference Features

- County Boundary
- Rainbow Valley
- ADMP Boundary
- Township and Range Boundary
- Planning Unit Boundary

Data Sources

Landscape Inventory & Analysis (LIA), 2008
Flood Control District of Maricopa County
Future Landscape Character Cultural Settings Map, 2008
Landscape Character Physical Settings Map, 2008
URS Corporations Alternative Data, 2009



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Rainbow Valley
 Area Drainage Master Plan
 Alternative 5: Protect Significant Wash Corridors:
 Typical Plan and Section

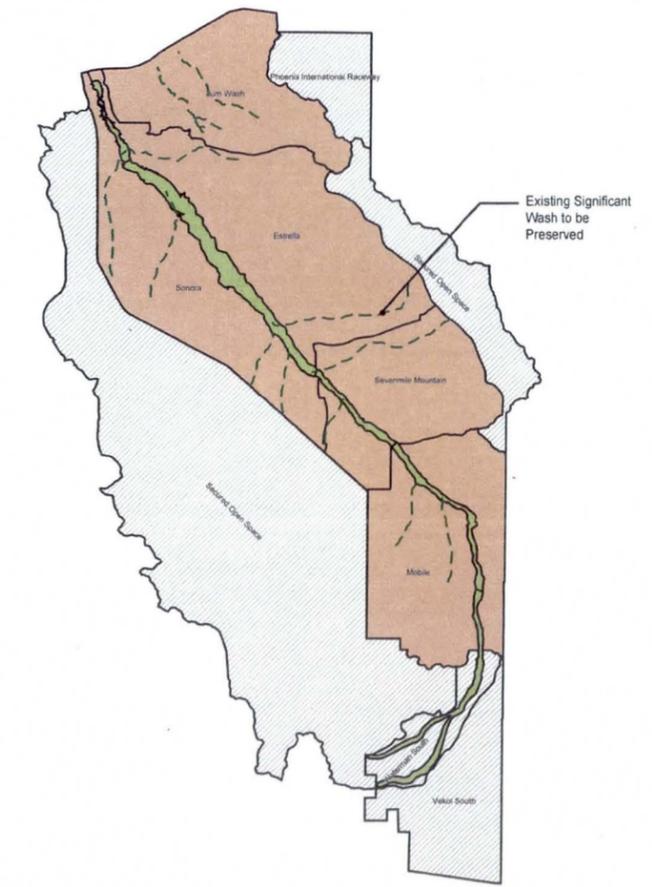


Figure 4-28

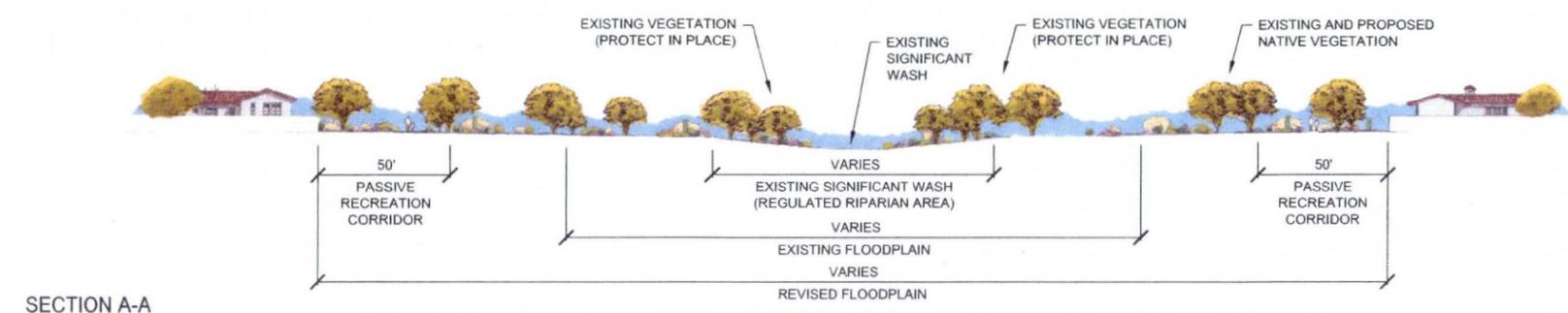
Proposed Flood Protection Method:
 Non-Structural, Soft-Structural, Semi-Soft Structural

Compatible Landscape Design Themes:
 Natural Sonoran Desert Upland Riparian
 Natural Lower Sonoran Desert Riparian

KEY MAP



- Planning Unit where Flood Hazard Mitigation is achieved through New Regulations to protect Significant Washes (Q>500 cfs)
- Planning Unit where Flood Hazard Mitigation is achieved through Land Use Management or Existing Regulations
- Flood Hazard Mitigation achieved through implementation of updated Waterman Wash Guidelines



SECTION A-A

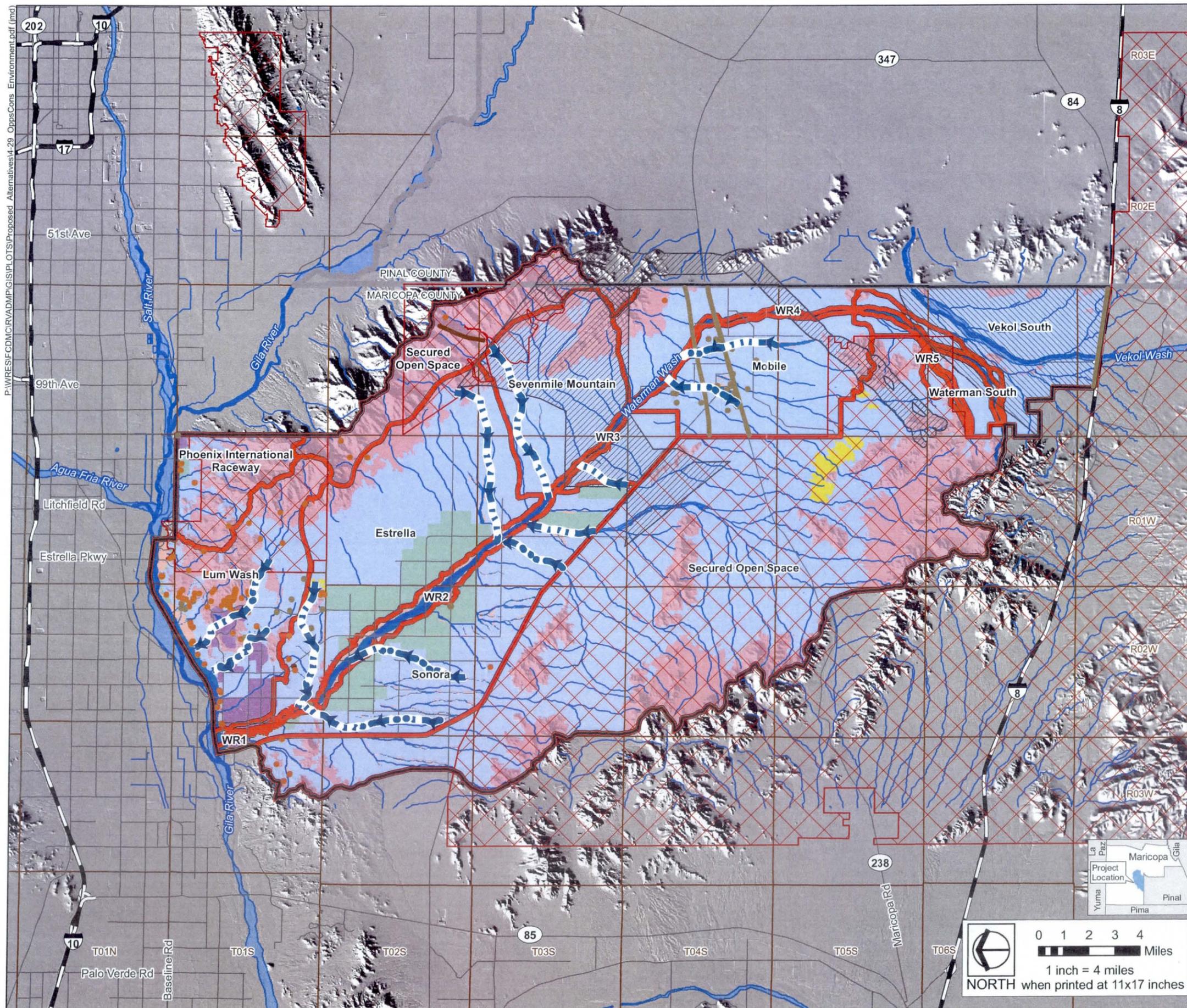


TYPICAL PLAN VIEW

Rainbow Valley
Area Drainage Master Plan
Alternative 5 – Protect Significant Wash Corridors:
Environmental Resources



Figure 4-29



Project Features

- Enhanced Wash

Cultural Resources

- Historic Site
- Prehistoric-Historic Site
- Prehistoric Site

Ecological Units

- Agriculture
- Developed
- Floodway Fringe
- Mixed Creosote Scrub
- Mixed Salt Desert Scrub
- Mixed Upland Desert Scrub
- Mountain Woodland
- Open Water
- Riparian

Overlay Areas

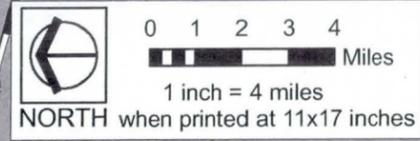
- Secured Open Space
- Vekol Valley Grassland Species Habitat
- Wildlife Corridor

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/Freeway
- Major Road
- Planning Unit Boundary

Data Sources

- Flood Control District of Maricopa County Base Vector and Hillshade Data, 2008
- Arizona Department of Game and Fish Wildlife Corridors, 2008
- URS Corporation Cultural Resources, Ecological Units, Alternative Data, 2009

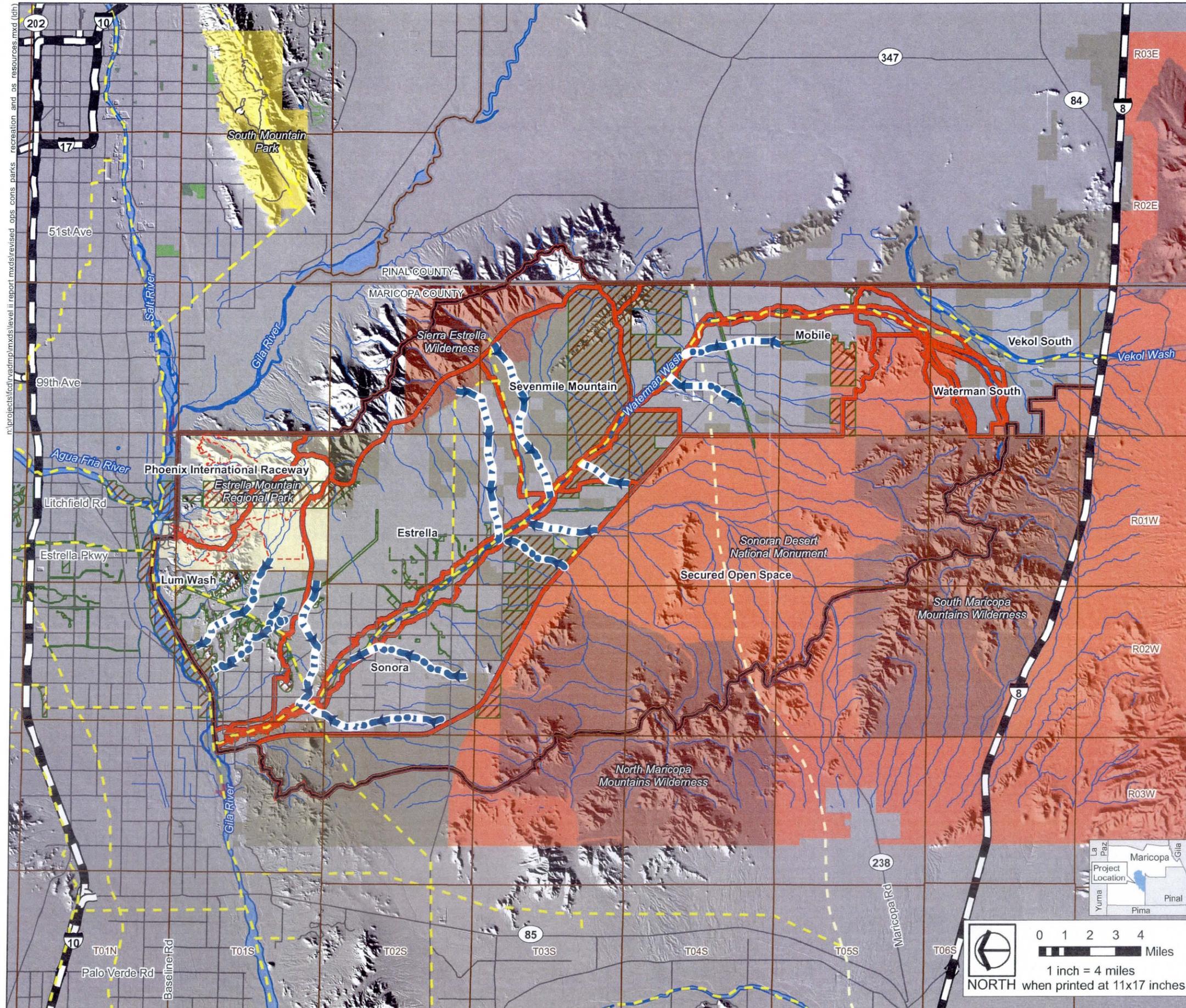


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Rainbow Valley
Area Drainage Master Plan
Alternative 5 – Protect Significant Wash Corridors:
Parks, Recreation & Open-Space Resources



Figure 4-30



Project Features

Enhanced Wash

Parks and Recreation Resources

Federal

- Wilderness Area
- National Monument
- Bureau of Land Management
- Juan Bautista de Anza National Historic Trail

State

- Wildlife Area

Regional

- County Regional Park
- City Regional Park
- Maricopa County Regional Trail System

Local

- City Park
- Planned City Park
- Golf Course
- Community Trail

Other Open-Space Resources

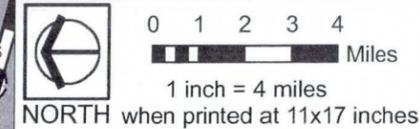
- City of Goodyear Planned Open-Space

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Planning Unit Boundary

Data Sources

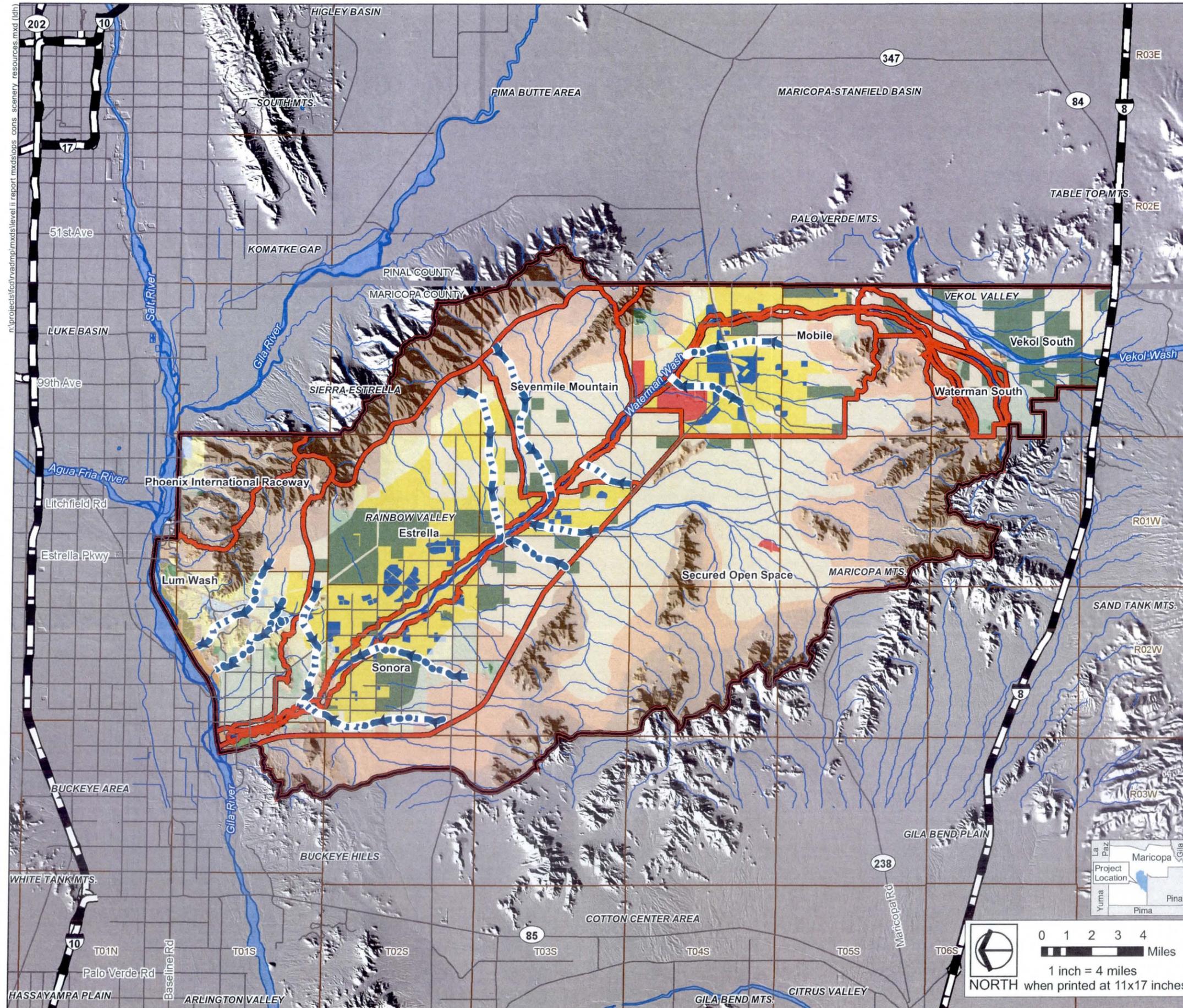
- Flood Control District of Maricopa County Landscape Inventory & Analysis (LIA), 2008
- Future Landscape Character Cultural Settings Map, 2008
- Landscape Character Physical Settings Map, 2008
- City of Goodyear Land Use Plan, 2008
- URS Corporations Alternative Data, 2009



Rainbow Valley
Area Drainage Master Plan
Alternative 5 – Protect Significant Wash Corridors:
Scenery Resources



Figure 4-31



Enhanced Wash

Sonoran River Lands Subtype

- Natural River Channel
- Rural River Channel
- Suburban River Channel
- Urban River Channel
- Industrial River Channel
- Natural River Terrace
- Rural River Terrace
- Suburban River Terrace
- Urban River Terrace
- Industrial River Terrace

Sonoran Valley Lands Subtype

- Natural Valley Plains
- Rural Valley Plains
- Suburban Valley Plains
- Urban Valley Plains
- Industrial Valley Plains
- Natural Valley Wash
- Rural Valley Wash
- Suburban Valley Wash
- Urban Valley Wash
- Industrial Valley Wash

Sonoran Mountain Lands Subtype

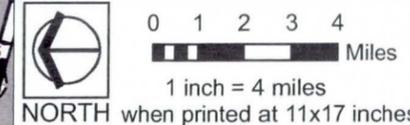
- Natural Arroyo
- Rural Arroyo
- Suburban Arroyo
- Urban Arroyo
- Industrial Arroyo
- Natural Foothills
- Rural Foothills
- Suburban Foothills
- Urban Foothills
- Industrial Foothills
- Natural Upper Bajada
- Rural Upper Bajada
- Suburban Upper Bajada
- Urban Upper Bajada
- Industrial Upper Bajada
- Natural Lower Bajada
- Rural Lower Bajada
- Suburban Lower Bajada
- Urban Lower Bajada
- Industrial Lower Bajada
- Natural Moutains
- Rural Moutains
- Suburban Moutains
- Urban Moutains
- Industrial Moutains

Reference Features

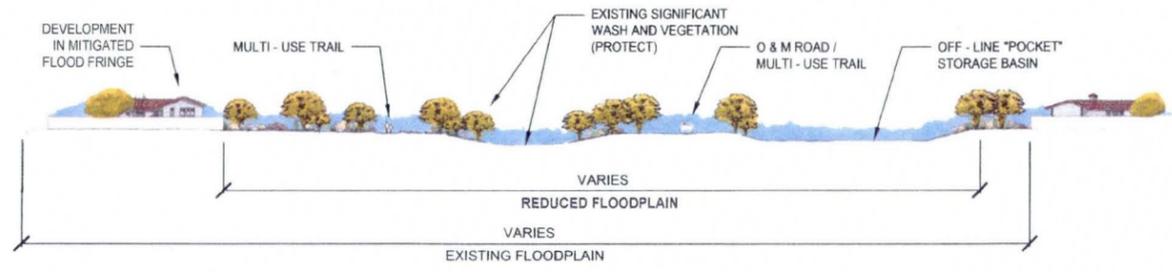
- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Planning Unit Boundary

Data Sources

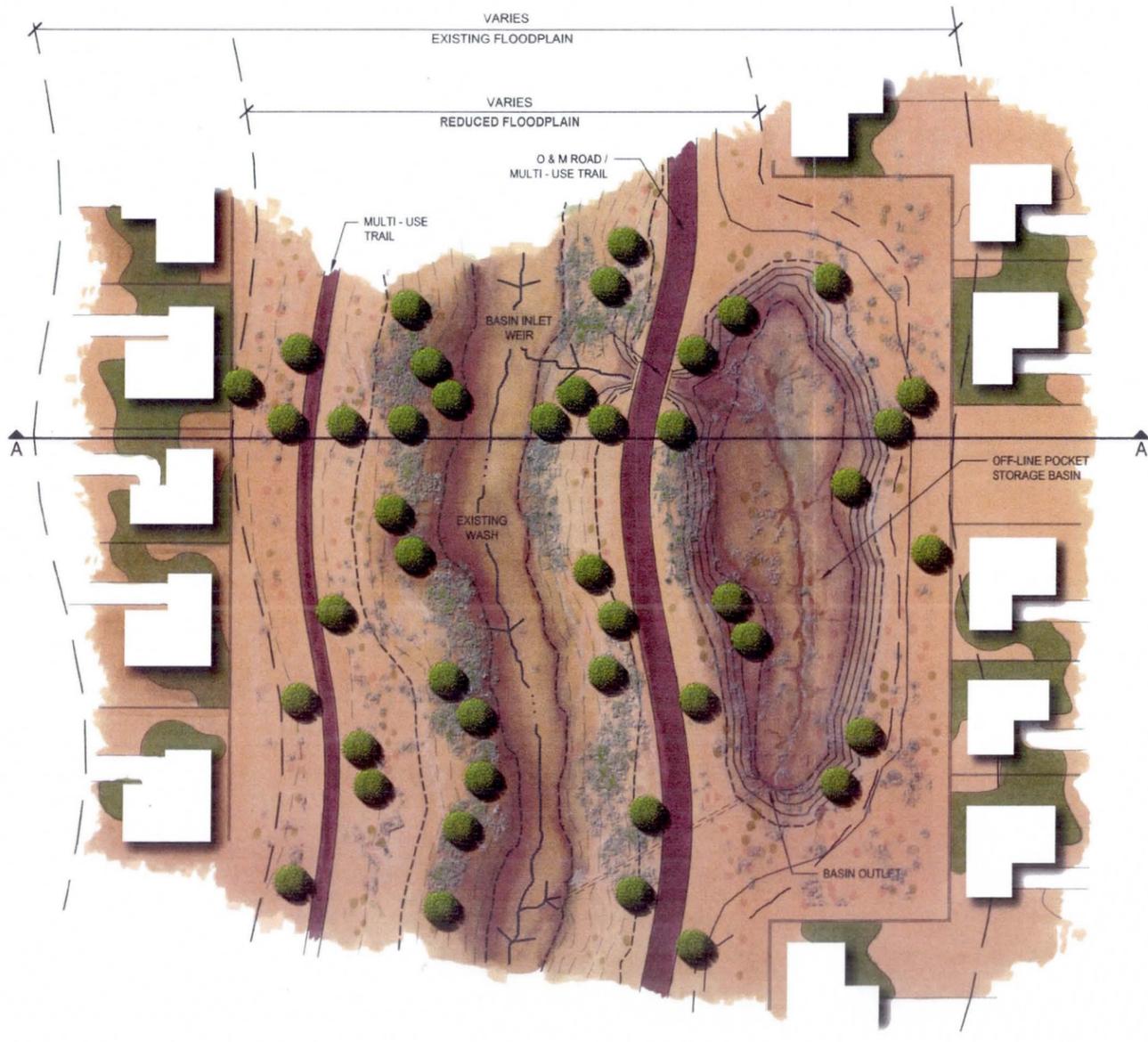
- Landscape Inventory & Analysis (LIA), 2008
- Flood Control District of Maricopa County
- Future Landscape Character Cultural Settings Map, 2008
- Landscape Character Physical Settings Map, 2008
- URS Corporations Alternative Data, 2009



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SECTION A-A



TYPICAL PLAN VIEW

Rainbow Valley
Area Drainage Master Plan
Alternative 6 - Pocket Basins:
Typical Plan and Section

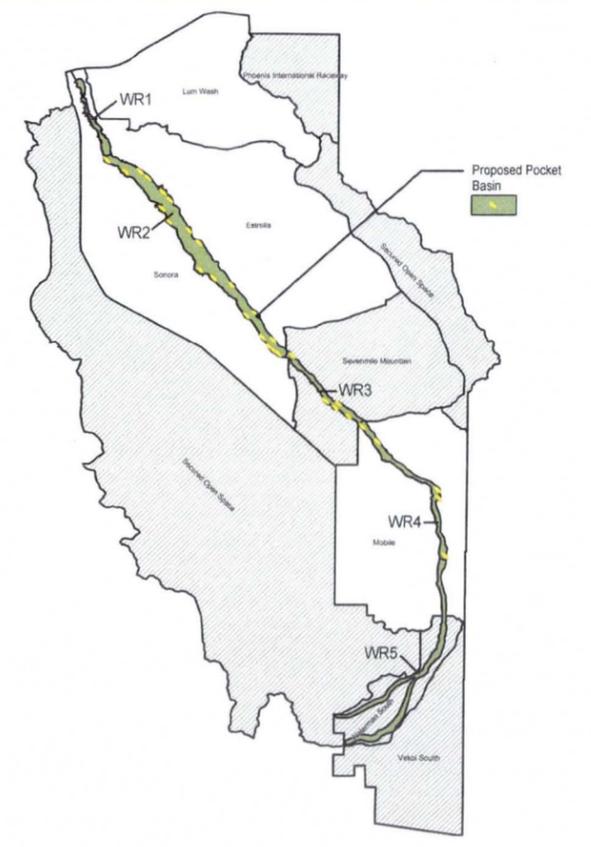


Figure 4-32

Proposed Flood Protection Method:
Non-Structural, Soft-Structural, Semi-Soft Structural

Compatible Landscape Design Themes:
Natural Lower Sonoran Desert
Natural Lower Sonoran Desert Riparian

KEY MAP

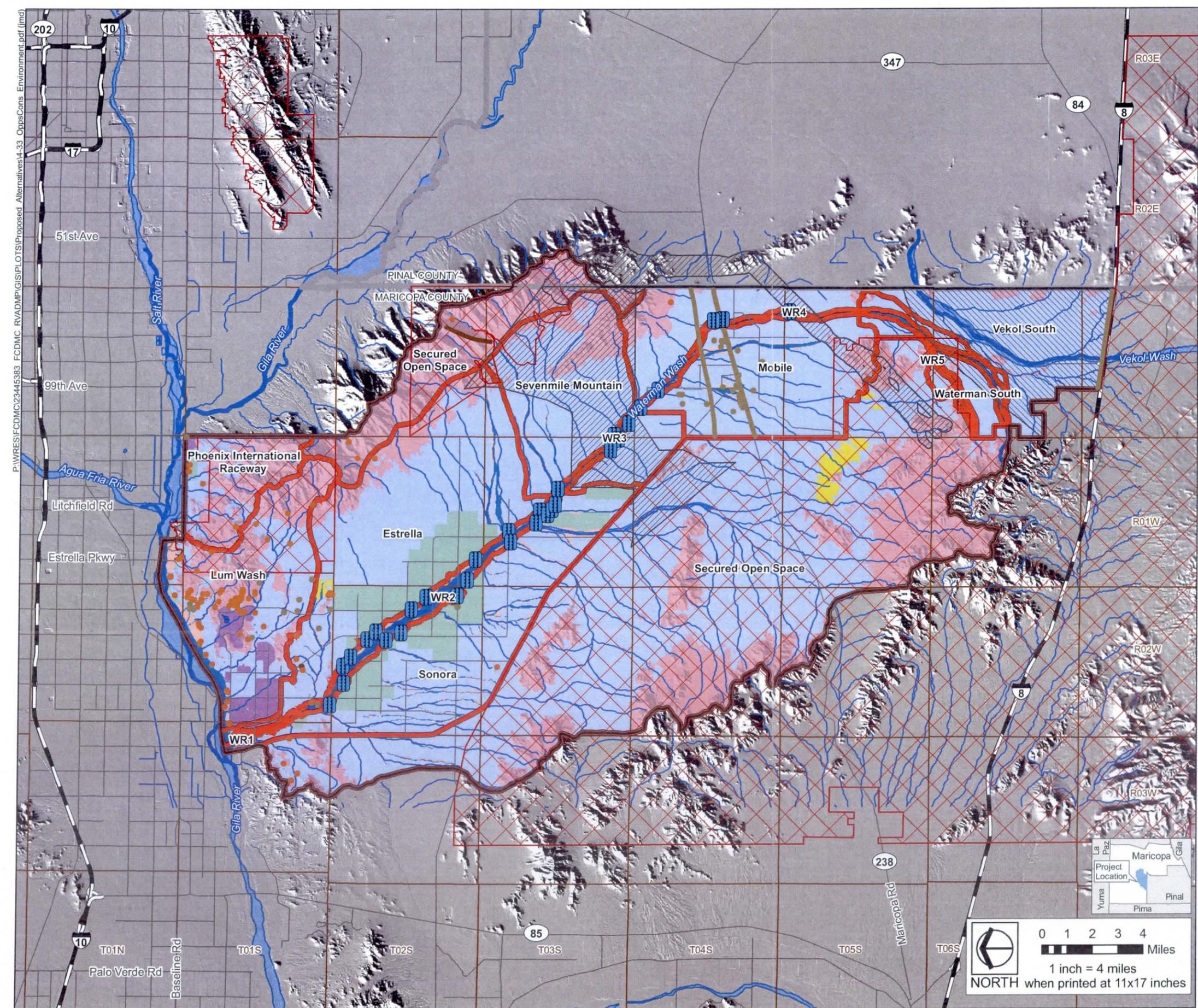


-  Planning Unit where Flood Hazard Mitigation is achieved through Land Use Management or Existing Regulations
-  Pocket Basins not applicable in this Planning Unit
-  Flood Hazard Mitigation achieved through implementation of updated Waterman Wash Guidelines

Rainbow Valley
Area Drainage Master Plan
Alternative 6 – Pocket Basins:
Environmental Resources



Figure 4-33



Project Features

- Pocket Basin

Cultural Resources

- Historic Site
- Prehistoric-Historic Site
- Prehistoric Site

Ecological Units

- Agriculture
- Developed
- Floodway Fringe
- Mixed Creosote Scrub
- Mixed Salt Desert Scrub
- Mixed Upland Desert Scrub
- Mountain Woodland
- Open Water
- Riparian

Overlay Areas

- Secured Open Space
- Vekol Valley Grassland Species Habitat
- Wildlife Corridor

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/ Freeway
- Major Road
- Planning Unit Boundary

Data Sources

Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
Arizona Department of Game and Fish
Wildlife Corridors, 2008
URS Corporation
Cultural Resources, Ecological Units, Alternative Data, 2009

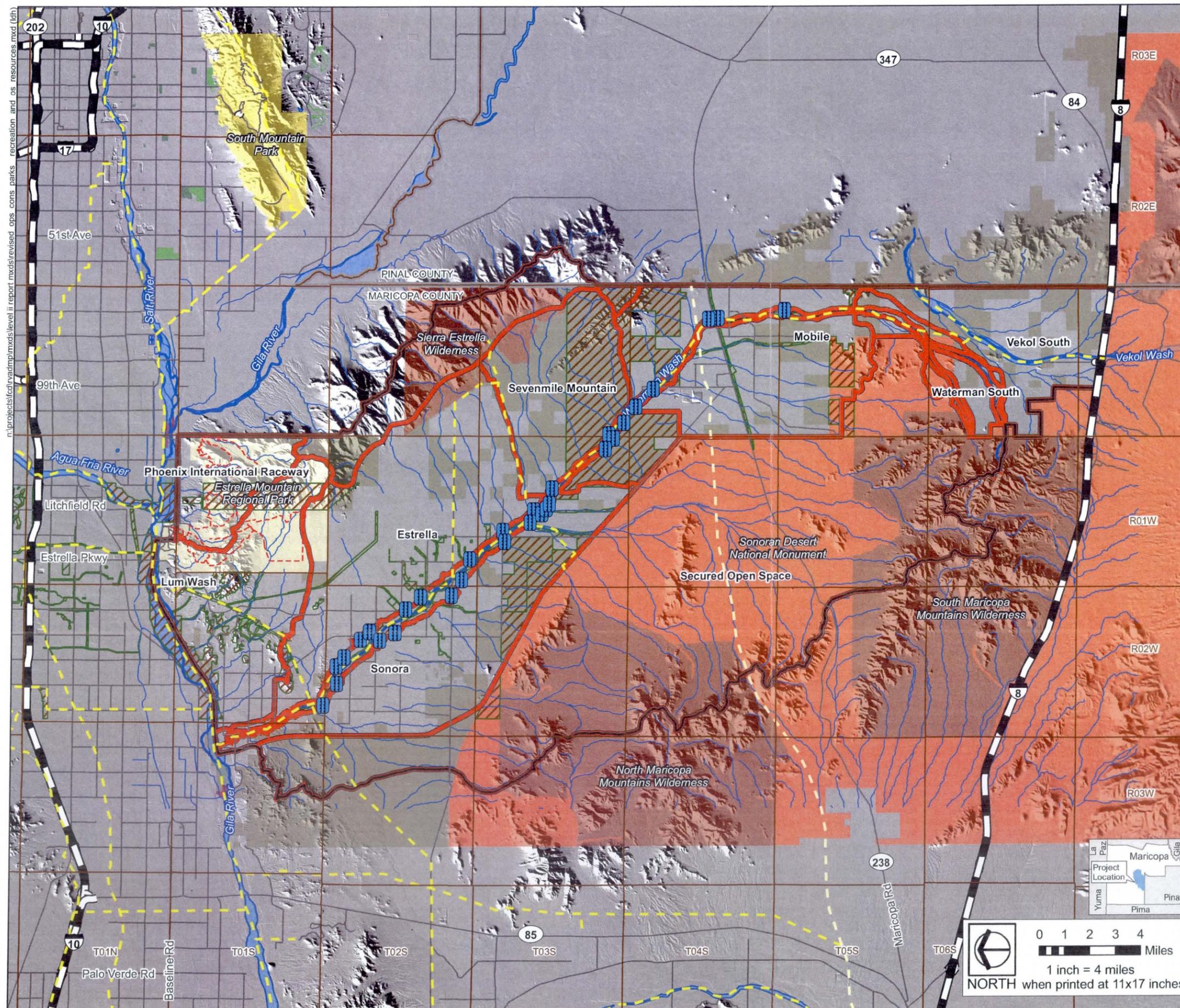
0 1 2 3 4 Miles
1 inch = 4 miles
NORTH when printed at 11x17 inches

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Rainbow Valley
Area Drainage Master Plan
Alternative 6 – Pocket Basins:
Parks, Recreation
& Open-Space Resources



Figure 4-34



Project Features

- Pocket Basin

Parks and Recreation Resources

Federal

- Wilderness Area
- National Monument
- Bureau of Land Management
- Juan Bautista de Anza National Historic Trail

State

- Wildlife Area

Regional

- County Regional Park
- City Regional Park
- Maricopa County Regional Trail System

Local

- City Park
- Planned City Park
- Golf Course
- Community Trail

Other Open-Space Resources

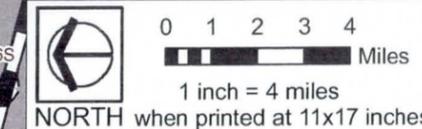
- City of Goodyear Planned Open-Space

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Planning Unit Boundary

Data Sources

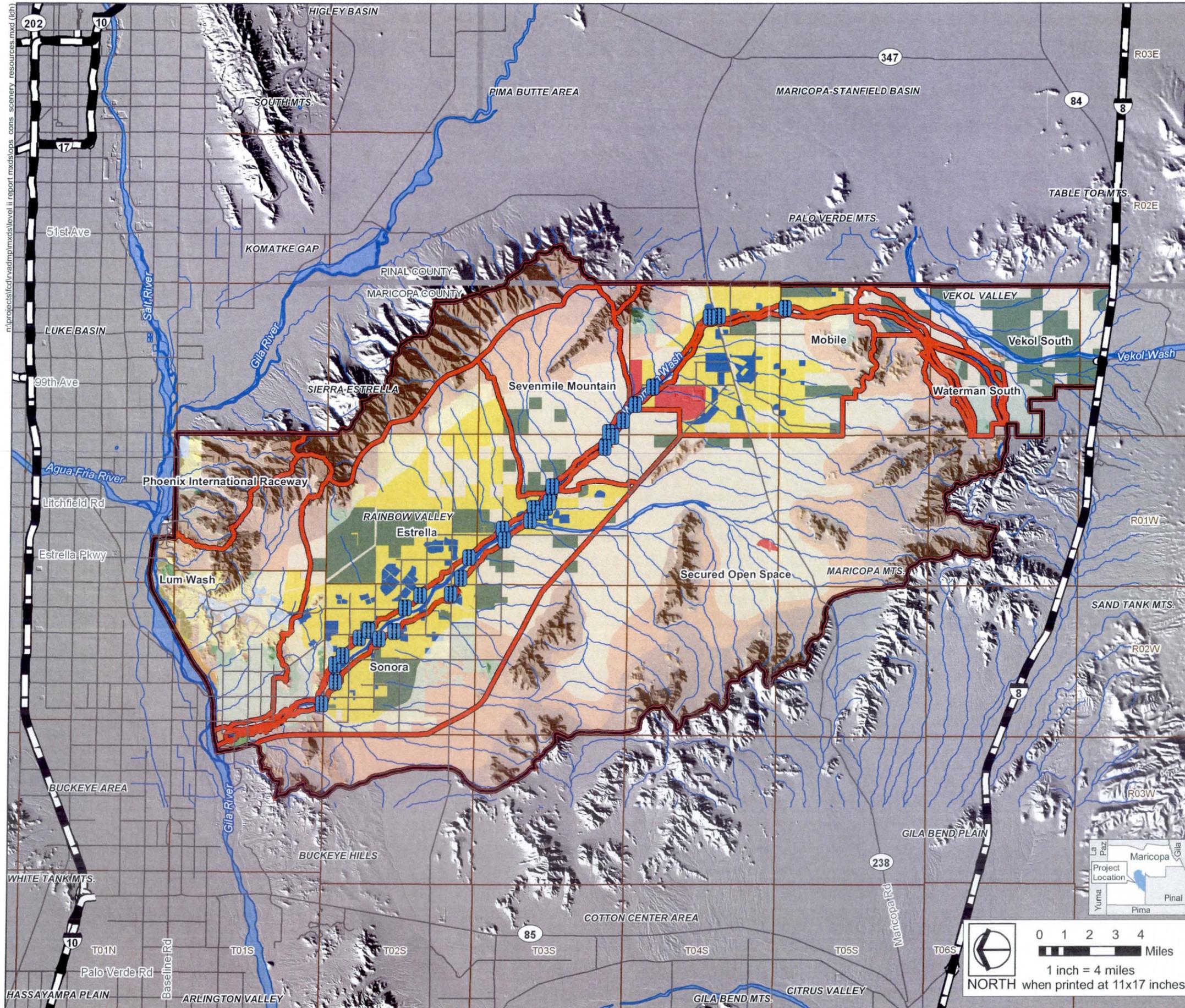
Flood Control District of Maricopa County
Landscape Inventory & Analysis (LIA), 2008
Future Landscape Character Cultural Settings Map, 2008
Landscape Character Physical Settings Map, 2008
City of Goodyear Land Use Plan, 2008
URS Corporations Alternative Data, 2009



Rainbow Valley
Area Drainage Master Plan
Alternative 6 – Pocket Basins:
Scenery Resources



Figure 4-35



Pocket Basin

Sonoran River Lands Subtype

- | | |
|--------------------------|--------------------------|
| Natural River Channel | Natural River Terrace |
| Rural River Channel | Rural River Terrace |
| Suburban River Channel | Suburban River Terrace |
| Urban River Channel | Urban River Terrace |
| Industrial River Channel | Industrial River Terrace |

Sonoran Valley Lands Subtype

- | | |
|--------------------------|------------------------|
| Natural Valley Plains | Natural Valley Wash |
| Rural Valley Plains | Rural Valley Wash |
| Suburban Valley Plains | Suburban Valley Wash |
| Urban Valley Plains | Urban Valley Wash |
| Industrial Valley Plains | Industrial Valley Wash |

Sonoran Mountain Lands Subtype

- | | |
|-----------------------|-------------------------|
| Natural Arroyo | Urban Upper Bajada |
| Rural Arroyo | Industrial Upper Bajada |
| Suburban Arroyo | Natural Lower Bajada |
| Urban Arroyo | Rural Lower Bajada |
| Industrial Arroyo | Suburban Lower Bajada |
| Natural Foothills | Urban Lower Bajada |
| Rural Foothills | Industrial Lower Bajada |
| Suburban Foothills | Natural Moutains |
| Urban Foothills | Rural Moutains |
| Industrial Foothills | Suburban Moutains |
| Natural Upper Bajada | Urban Moutains |
| Rural Upper Bajada | Industrial Moutains |
| Suburban Upper Bajada | |

Reference Features

- County Boundary
- Rainbow Valley
- ADMP Boundary
- Township and Range Boundary
- Planning Unit Boundary

Data Sources

Landscape Inventory & Analysis (LIA), 2008
Flood Control District of Maricopa County
Future Landscape Character Cultural Settings Map, 2008
Landscape Character Physical Settings Map, 2008
URS Corporations Alternative Data, 2009

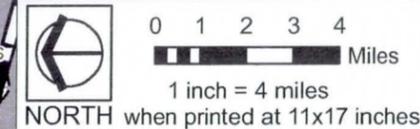
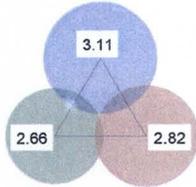


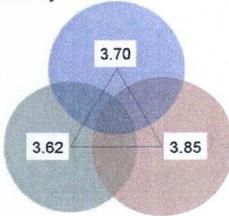
Figure 4-39 Evaluation Results – Waterman South Planning Unit

Alternative 1
0% Context
Sensitivity

CONTEXT
SENSITIVITY RATING



Alternative 2
17% Context
Sensitivity



EVALUATION SCORES

PLANNING UNIT F - WATERMAN SOUTH			
Alternative 1 No New Action		Alternative 2 New Regs.	
Sub-score	TOTAL	Sub-score	TOTAL
	31.1		42.4
25		41.5	
22.5		37.5	
22		37.5	
38.5		45.5	
37		42.5	
35		44.5	
38		47.5	
	29.3		39.9
27.5		39	
30		39	
28		36	
23		32	
22		31	
31		43	
33		43	
32		43	
33		43	
26		43	
32		43	
32		41	
32		42.6	
	34.2		40.7
37		42.5	
37		42.5	
33		41.5	
31		39.5	
33		37.5	
	35.6		38.7
32		32.5	
33		37.5	
32		39.5	
43		41.5	
38		42.5	
	130.2		161.7

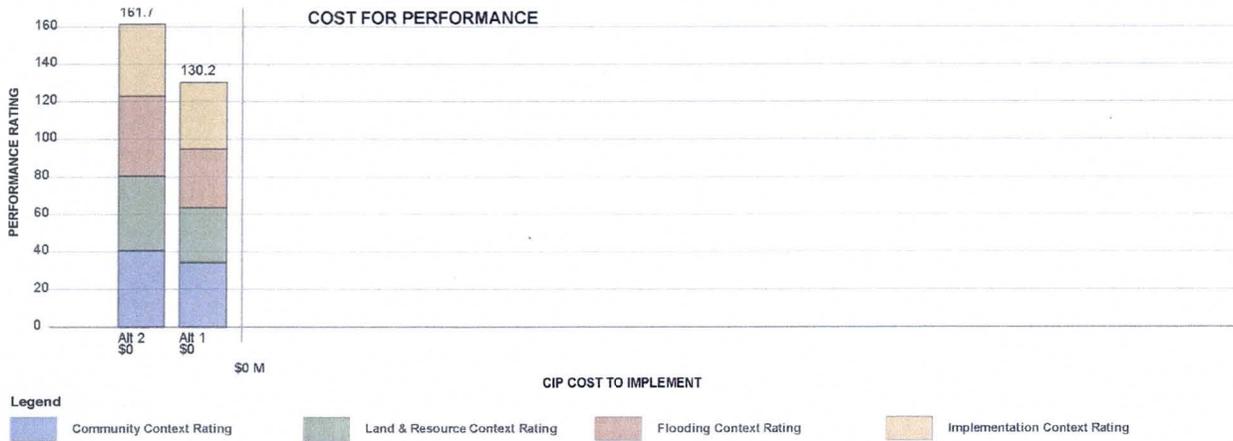
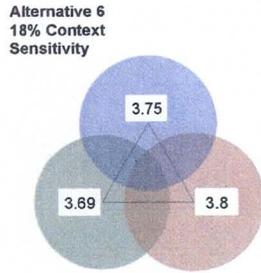
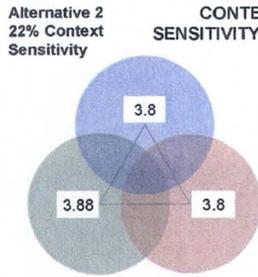


Figure 4-41 Evaluation Results – WR123 Planning Unit

CONTEXT SENSITIVITY RATING



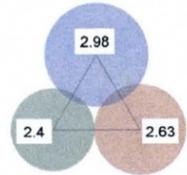
EVALUATION SCORES

Alternative 2 New Regs.		Alternative 6 Pocket Basins	
Sub-score	TOTAL	Sub-score	TOTAL
	41.9		41.9
40.5		43.1	
37.5		45.1	
37.5		43.1	
45		37.1	
41		38.6	
45.5		43.1	
46.5		43.1	
	42.7		40.6
46		41.9	
42.5		41.4	
40.5		42.4	
32.5		31.4	
36.5		34.4	
44.5		42.4	
44.5		41.4	
45.5		42.4	
45.5		42.4	
44		40.4	
45.5		42.4	
43		40.9	
44.6		43.9	
	41.9		41.3
41.5		42	
43.5		39.5	
40.5		41	
41.5		42	
42.5		42	
	39.6		38.3
33		31.5	
39		40.5	
42		39.5	
42		42.5	
42		37.5	
	166.1		162.1

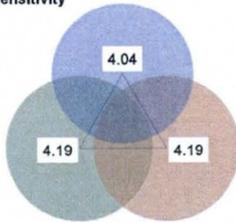


Figure 4-42 Evaluation Results – WR45 Planning Unit

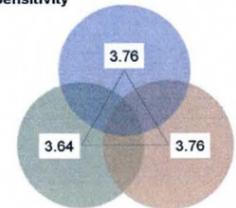
Alternative 1
0% Context Sensitivity



Alternative 2
37% Context Sensitivity

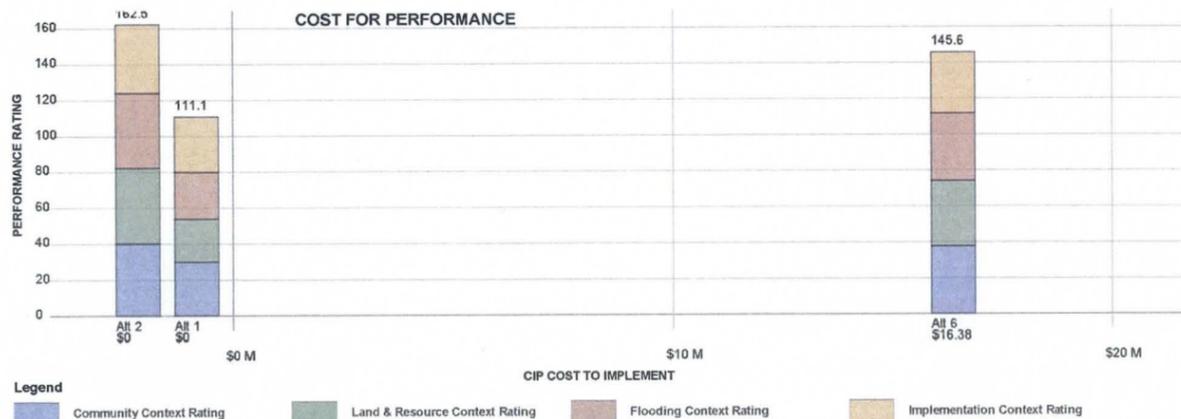


Alternative 6
17% Context Sensitivity



EVALUATION SCORES

PLANNING UNIT WR45 - WATERMAN WASH 4-5						PROJECT GOALS AND OBJECTIVES
Alternative 1 No New Action		Alternative 2 New Regs.		Alternative 6 Pocket Basins		DESCRIPTION
Sub-score	TOTAL	Sub-score	TOTAL	Sub-score	TOTAL	
	26.3	41.9	41.9	37.6	37.6	FLOODING CONTEXT
20		40		39		Resolve or manage existing identified flooding problems
17		37		40		Prevent development in floodplains and floodprone areas not identified as floodplains
17		37.5		39		Maximize the area receiving flood protection from the plan
34		45		33		Minimize or eliminate reliance on mechanized or human intervention for operation during a storm event
30		41.5		34		Provide capacity in channels for anticipated mature vegetation requiring realistic levels of maintenance
33		45.5		39		Preserve or replace natural channel storage capacity to attenuate discharges.
33		46.5		39		Maintain natural flow-paths and drainage patterns
	24	41.9	41.9	36.4	36.4	COMMUNITY CONTEXT
24.5		45.5		37.5		Provide opportunities to implement the Maricopa Regional Trail
23.5		44		39.5		Provide opportunities to implement other local trail systems (i.e., City of Goodyear trails, Juan Bautista Historic Trail, stakeholder-identified trails)
23.5		40		38.5		Provide opportunities to implement local municipal and other stakeholder-identified recreation objectives and facilities (i.e., City of Goodyear planned parks, Estrella Development's park along Waterman wash)
18.5		33.5		28.5		Establish an east-west recreation/open space connection between the Sierra-Estrella Mountains and the Maricopa Mountains/Sonoran Desert National Monument
17.5		30		24.5		Provide opportunity to implement a recreation/open space feature at the confluence of the Gila River and Waterman Wash
26.5		44		38.5		Protect or enhance natural resources
28.5		44		37.5		Protect or enhance cultural resources
28.5		45		38.5		Preserve wildlife movement corridor
26.5		44.5		39		Preserve and complement the desired visual character of future natural, rural, suburban, and urban cultural settings
22.5		44		36.5		Extend the natural scenic character of Waterman Wash to the south in areas where it currently is not well defined
26.5		44		37.5		Maintain and enhance sensitive views (i.e., considering flood protection influence on the views from the mountain recreation areas into the Valley as it develops and from the valley to the mountain lands)
23.5		43		37		Improve and restore the areas containing visually discordant features, particularly along Waterman Wash
22.5		43.6		40.5		Maximize the creation/preservation of open-space consistent with the MAG Desert Spaces Plan (i.e., AGF wildlife corridor, establish habitat areas along washes)
	29.8	40.4	40.4	37.7	37.7	LAND & RESOURCE CONTEXT
31		41.5		39.5		Utilize best available General Plan data for planning
33		42.5		36.5		Coordinate with development plans
29		39.5		38		Recognize and support planned transportation corridors in planning
27		38.5		37		Coordinate with adjacent planning areas for regional connectivity
29		40		37.5		Coordinate with other agency plans in the study area
	31	38.3	38.3	33.9	33.9	IMPLEMENTATION & SUSTAINABILITY
28		31		27		Gain plan support of potential funding partners
29		38		36		Identify multiple partnering opportunities
29		40.5		35.5		Develop a phased plan for implementation to spread expenditures over time
37		41		38		Encourage implementation by others
32		41		33		Meet clean water act requirements for protecting waters of the US
	111.1	162.5	162.5	145.6	145.6	





5.0 RECOMMENDED ALTERNATIVE

5.1 INTRODUCTION

The proposed alternatives analysis followed a path that led to recommended non-District improvement projects to mitigate flood hazards in Rainbow Valley. This outcome in some ways could be predicted because of the present physical nature of the study area, lack of specific identified flood problems, early stages of development, and financial climate at the time of the study. Three alternatives predominated as the preferred alternatives for the planning units (Figure 5-1 and Table 4-10). No new actions were selected for the Phoenix International Raceway, Sevenmile Mountain, Vekol South, and Secured Open Space planning units. New regulations were selected for Waterman South, and Waterman Wash sections 1 through 5, while protecting significant wash corridors were selected for the Estrella, Sonora, Mobile, and Lum Wash planning units. In reviewing the results, the project team noted that for the Estrella Planning Unit and possibly the Sonora Planning Unit there is a lack of significant wash corridors that were identified in the sheet flow, disturbed lands along Waterman Wash, and distributary flow landform areas adjacent to Waterman Wash. As a result, the inclusion of new regulations is also recommended in these planning units (a "hybrid" alternative). It should be noted that the implementation for protecting significant wash corridors will require new regulations for implementation. It should be considered that there is a cost in the development, approval, and implementation of new regulations and protecting significant wash corridors although no capital improvement project costs. There could be some cooperative projects when implementing the protection of significant wash corridors as discussed later in this section.

5.2 RECOMMENDED ALTERNATIVES

New Regulations are recommended to be developed and implemented in the study area in flow characteristic areas where existing regulations do not adequately mitigate flood hazards. These environments occur where flow paths are uncertain so that predicting and controlling flood flows is not dependable. Present regulations were not developed with these conditions in mind and therefore do not adequately address the unique hazards which could create significant downstream impacts to property and health and safety. Landforms that can cause these conditions include alluvial fans, distributary flow, sheetflow, and disturbed areas. The flow characteristics associated with these landforms are prevalent in many of the Rainbow Valley Planning Units.

New regulations may also be needed when implementing the **Protection of Significant Wash Corridors** alternative. There will need to be a means for development to cooperate, coordinate, use, and implement these wash corridors including incentives because of the cost imparted on development to convey flows to them. Development adjacent to the wash corridors may need to provide flow easements and/or rights-of-way for this alternative to be successful.

Development of new regulations and methods for implementing them will be further evaluated in the Level III analysis and use the tools and road map provided as we look at new policies, guidelines, and ordinances in Task 12.8.3 of the scope of work. Goals that we are striving for are to maintain the natural character and beneficial function while minimizing impacts to the landform. Many of the likely regulations could include the development of design guidelines, special policies and ordinances, and/or the formation of Drainage Improvement Districts. The regulations could include rules of development, modification of existing on-site flow attenuation

requirements, revisions to floodplain ordinances, mitigation banking for both wetlands and flows (regional facilities), and land swapping.

A brief discussion of the recommended alternative for each planning unit is presented below.

5.2.1 Phoenix International Raceway (PIR)

No New Action is the recommended alternative for the PIR Planning Unit. Existing land development and floodplain regulations should be adequate to mitigate flood hazards in this planning unit. Additional floodplains are being delineated as part of this project along washes entering the Gila River to protect citizens by delineating floodprone areas that will be used to regulate development along these washes.

5.2.2 Sevenmile Mountain

No New Action is the recommended alternative for the Sevenmile Mountain Planning Unit. This planning unit is presently comprised of public land predominantly owned by the BLM with some private and State Trust Land. Due to BLM control, development is not expected to take place in this planning unit. It has been identified as a proposed wildlife corridor that connects the Sierra Estrella Mountains and the Sonoran Desert National Monument.

5.2.3 Vekol South

No New Action is the recommended alternative for the Vekol South Planning Unit. Early in the project it was determined that there is no surface flow diversion from the Vekol Wash watershed to the Waterman Wash watershed so it was excluded from both the hydrologic model and alternatives analysis.

5.2.4 Secured Open Space

No New Action is the recommended alternative for this Planning Unit. Land areas in this planning unit have special designation such as the Sonoran Desert National Monument and Sierra Estrella Wilderness that will regulate land use as well as make it difficult to implement flood hazard mitigation strategies that alter the existing environment. It is not expected that development will occur in this planning unit so new regulations are not needed.

5.2.5 Waterman South

The flow characteristics in this planning unit include alluvial fans and Piedmont distributary flow landforms. The privately owned land is in Unincorporated Maricopa County where existing regulations do not adequately account for flood hazards with these flow characteristics so developing and implementing **New Regulations** is recommended to protect development from flooding.

5.2.6 Waterman Wash

Waterman Wash is the major environmental/watercourse corridor of the Watershed. Maintaining and enhancing the beneficial uses of its floodway and floodplain for flood hazard mitigation, a wildlife corridor, scenic amenities, and recreation is a key goal for the community for attaining a desired quality of life. **New Regulations** such as those being developed by the City of Goodyear

for the corridor from Williams Field Road on the north to SR 238 to the south is the recommended alternative for all 5 segments of Waterman Wash (WR123 and WR45)

5.2.7 Lum Wash

Protection of the Corgett Wash and Lum Wash corridors to provide development outfalls for flood waters to the Gila River were selected as the recommended alternative for the Lum Wash Planning Unit. The washes provide a link between developable land and the Gila River. Protection of these wash corridors so they maintain their beneficial floodplain value while having the capacity to convey flood flows is vital in mitigating flood hazards. Though there may be costs to protecting the corridor, there is an expectation that development will be responsible as it is part of their cost of developing the land. Structural solutions in lieu of this alternative would have high capital expenditures that would be partially, if not entirely, the responsibility of government agencies.

5.2.8 Estrella

Protection of Significant Wash Corridors is the recommended alternative for the Estrella Planning Unit. Performance and context sensitivity were important factors in selecting this alternative. The selection of this alternative was reinforced because the capital cost of structural conveyance and structural storage are comparatively high. The flow characteristics of this planning unit only provide adequate wash corridors for the northern and southern portions. Therefore, a hybrid recommendation would be more effective in attaining comprehensive flood hazard mitigation, especially for the area approximately one-quarter mile north of Germann Road to approximately one-half mile south of Riggs Road (disturbed, sheet flow, and alluvial fan predominate). In this area, **New Regulations** is the recommended alternative. Further evaluation of the limits for the hybrid alternative will be developed during the next phase of the project.

5.2.9 Sonora

Protection of Significant Wash Corridors is the recommended alternative for the Sonora Planning Unit for similar performance and context sensitive reasons to the Estrella Planning Unit. The capital cost of structural alternatives provided further justification for selecting this alternative. Four wash corridors were identified in the planning unit as shown in Figure 5-1. As in Estrella, it may be difficult for development to convey flows to these facilities. Therefore, a hybrid solution is being recommended for specific areas where disturbed and Piedmont tributary flow characteristics predominate. The hybrid solution includes **New Regulations** as part of the recommendation. The most appropriate means of mitigating flood hazards will probably take the form of implementing new regulations throughout the planning unit that include the use of wash corridors and collaborating with development adjacent to the identified wash corridors for implementing this function. Further detail on the physical extent and land ownerships that could utilize the wash corridors will be evaluated in the next phase of the project.

5.2.10 Mobile

Protection of Significant Wash Corridors is the recommended alternative for the Mobile Planning Unit. One wash corridor was identified for protection. It is a tributary of Waterman Wash east of the Butterfield Landfill and is crossed by SR 238 and the UPRR (Figure 5-1).

Presently, a significant portion of the Planning Unit is part of a major development that includes a drainage master plan. The cost of structural conveyance or structural storage related to SR 238 and the UPRR were deemed high and no increase was identified in function or benefits to the Planning Unit. Context sensitivity and performance were used in selecting the alternative with cost supporting the decision.

5.3 VALUE ANALYSIS

5.3.1 Introduction

The Recommended Alternative was reviewed as part of an independent VA to identify opportunities to increase the value of the recommended plan by improving plan performance or reducing costs. The review was conducted at the conclusion of the alternatives analysis to allow opportunity to incorporate any recommended plan changes during the final detailed plan development. The VA review took place on February 8-10, 2010. The VA process and results are documented in detail in the *Value Analysis Study Final Report*, February 2010, provided under separate cover and summarized in the following sections. The general process used in the VA study was for the study participants to identify and evaluate alternative creative ideas in an attempt to test and recommend potential value enhancements for the project. The best ideas were then presented to the District and Consultant team members for consideration to be incorporated into the plan.

5.3.2 Value Analysis Recommendations

During the VA study, 43 creative ideas were identified. Thirty-four of these ideas were developed into VA design comments with cost implications where applicable. Many of the ideas represent refinements in design approach, reconsideration of criteria, and in some cases, modification of the recommended plan. In general, the ideas evaluated took into account the economic impact, other benefits obtained, and the effect on the overall project objectives. Table 5-1 presents a summary of the ideas developed into recommendations and design comments. The reader is directed to the complete VA report for detailed descriptions of the recommendations.

Table 5-1 Summary of Value Analysis Recommendations

Rec #	Recommendation Title / Description
VA-1	Define and explain the intended "Protect Significant Wash Corridors" to clarify specific meaning of "Protect," "Enhanced," and "Significant Wash."
VA-2	Ensure the regulations address both large and small developers.
VA-3	Define a vision for stormwater management to protect people and property consistent with the values of the community and supportive of responsible and context sensitive development.
VA-4	Utilize a scheme of stormwater flow characteristics and watershed identification to address challenges, opportunities, and performance criteria. Suggested stormwater flow characteristics include: Waterman Wash, significant washes, non-significant washes, alluvial fans, sheet flow, and disturbed. The ability to apply for a variance is critical to maintain flexibility in implementation of the stormwater management program. This framework should also include performance measures for the overall stormwater management program and a periodic re-evaluation and adjustment process to make sure the vision is being achieved.
VA-5	Utilize a variety of options and alternatives such as new regulations (Alternative 2), structural conveyances (Alternative 3), structural storage integrated with transportation facilities (Alternative 4), preservation and protection of wash corridors (Alternative 5) to develop an appropriate stormwater management solution.

Rec #	Recommendation Title / Description
VA-6	Test new regulations for sustainability.
VA-7	Test proposed drainage solutions for sustainability.
VA-8	Establish consistent bases for economic analysis of drainage facilities, land provided for the facilities, and the benefits of the facilities.
VA-9	Create an Intergovernmental Agreement between County, Goodyear, and the District to ensure consistent regulations throughout entire project footprint.
VA-10	As the City of Goodyear Parks Plan is developed, consider utilizing park areas additional stormwater storage, and vice-versa.
VA-11	Develop a realistic cost and benefit analysis for all Alternative solutions to include all costs (i.e., right-of-way, environmental, erosion protection, loss of revenue stream, implementation, etc.) and further develop the "Alternative 2: New Regulations" term to identify and show non-CIP improvements and facilities that are likely to be developed.
VA-12	In the formulation of the Rules of Development (ROD), invite critical discussion and attempt to identify the regulatory body (or bodies), document type and adoption method early in the process. Seek legal counsel as needed at key decision milestones.
VA-13	Add new regional floodplain and floodways for city administration for non-delineated wash corridors.
VA-14	Identify transportation corridors for wash corridors types and crossing types.
VA-15	Evaluate alternative funding mechanism (i.e., bonds, incorporating improvement districts, lighting and landscape districts, etc.).
VA-16	Enable environmental subdivisions for sale to others for mitigation purposes.
VA-17	Ensure the master plan hydrology data are complete and detailed enough to be utilized by a developer.
VA-18	Allow stakeholders to develop local area plans for complete hydrology solutions that will be consistent and contiguous.
VA-19	Develop a clear template for modeling and managing sediment transport to ensure consistency throughout planning units.
VA-20	Define and regulate lateral erosion so that cost can be calculated and balanced.
VA-21	Implement flexible multi-use drainage corridors with identified inlet and outlet points with connectivity.
VA-22	Identify sensitive (Biological, Cultural, etc.) areas and coordinate regional drainage solutions to buffer these areas.
VA-23	Research other flood districts and municipalities for regulation best practices.
VA-24	Allow for early right-of-way acquisition for corridors.
VA-25	Allow developers to dedicate drainage easement or donate right-of-way for drainage corridors in exchange for benefit of regional improvement projects.
VA-26	Research how to define and regulate the edge buffer conditions.
VA-27	Define a percentage of floodplain fringe that should be maintained to limit amount of floodplain infringement.
VA-28	Allow linear retention in floodplain fringe in lieu of providing of on-site retention.
VA-29	Allow developer to utilize 100 year-2 hour flood retention in lieu of 100 year-6 hour flood retention in exchange for preservation of floodplain.
VA-30	Allow for first flush only retention for drainage corridors.
VA-31	Allow infringement on floodplain if compensatory storage is replaced.
VA-32	Allow mixed density within the subdivision parcels.
VA-33	Develop a clear template for managing and modeling vegetation to ensure consistency throughout planning units.
VA-34	Develop a clear operations and maintenance plan.

The VA process progressed differently than a more typical VA session due to the non-structural nature of the recommended plan coupled with the plan being at a conceptual level of development with minimal detail about what the regulations would actually include. As a result, the VA recommendations tended to focus on recommendations for developing the details of the plan and considerations for project implementation.

The 34 VA recommendations were reviewed by the consultant team and grouped into 4 general categories as follows:

- Recommendations on the plan development **process** that should be followed as the plan is developed
- Recommended **modifications** to the plan as presented
- Recommended **plan enhancements** or refinements that should be considered or incorporated into the plan as it is further developed
- Recommendations for successful plan **implementation**

The plan development **process** recommendations included defining a vision for stormwater management to capture the desired outcome and then using the vision as a measure of the success of the plan. Other process recommendations included testing regulations and drainage solutions for sustainability. Recommendations were made for additional research from other flood control districts and municipalities for examples of similar approaches as well as seeking legal counsel in development of the plan to help ensure adoptability of proposed regulations.

VA items recommending **modifications** to the plan stated that more of the flood mitigation alternatives should be combined into a hybrid plan that would include structural measures as a means to establish the location of flow conveyance from the mountain slopes to the valley floor. This would facilitate coordination of flood control planning between multiple potential developments to address runoff generated upstream of their project which must be passed through the development and discharged down slope onto adjoining private or public property.

Recommended **plan enhancements** or refinements focused primarily on impacts to the community and developers and on the technical basis of the regulations. Those addressing impacts to developers emphasized allowing maximum flexibility for the developer by allowing a range of options to be incorporated into the development plans. Those addressing the technical basis of the regulations emphasized utilizing the flow characteristic and watershed areas as a geographic focus for regulation, and addressing the sediment transport and scour issues within the area.

Recommendations for plan **implementation** included establishing a consistent basis for economic evaluation of alternatives for use in project planning and implementation; developing IGAs for implementation and enforcement; joint-use of parks for storm water storage; evaluation of various funding mechanisms; mitigation banking options; and early right-of-way acquisition.

5.3.3 Recommended Plan Development

The following approach will be used to develop the recommended plan based on the VA planning process recommendations.

Each planning unit will be evaluated on an individual basis to identify the performance objectives to be achieved by the recommended plan implementation for that planning unit. This will be based on the unique landform and flow characteristics, jurisdictions and surface management, as well as land use and development trends within the unit. This will result in

identification of key factors that will influence flood mitigation along with development of specific, quantifiable outcomes (criteria) that will result in development practices that, when applied on a cumulative basis within the planning unit, will mitigate the potential flood hazards. By identifying performance objectives and criteria rather than requiring specific actions, the development community is left with maximum flexibility in determining how the requirements will be met.

Based on the identified performance criteria, typical designs will be developed and analyzed as a means to validate the effectiveness of the requirements. Best practices for site layout and grading may be included along with acceptable structural options with plans, profiles, and details illustrating the intended concepts for design performance, aesthetics, and multi-use. These practices, once developed, will be modeled and adjusted as needed, to validate their effectiveness. There may be challenges in balancing potentially conflicting forces from each of the three planning contexts. For example, development requirements that would be effective for flood hazard mitigation may be perceived as too restrictive by the development community and therefore may not be acceptable. Alternatively, soft structural approaches that would be aesthetically compatible with the area, may present an unacceptable risk from natural geomorphic processes of scour and sedimentation that would compromise their effectiveness. These competing interests must be resolved at this stage of the project to allow successful implementation of the plan.

Once the key performance factors are identified and the design criteria and typical designs are developed and validated, regulatory tools for implementation will be selected. Collaboration with stakeholders and developers will be key in establishing a framework for implementation that could include:

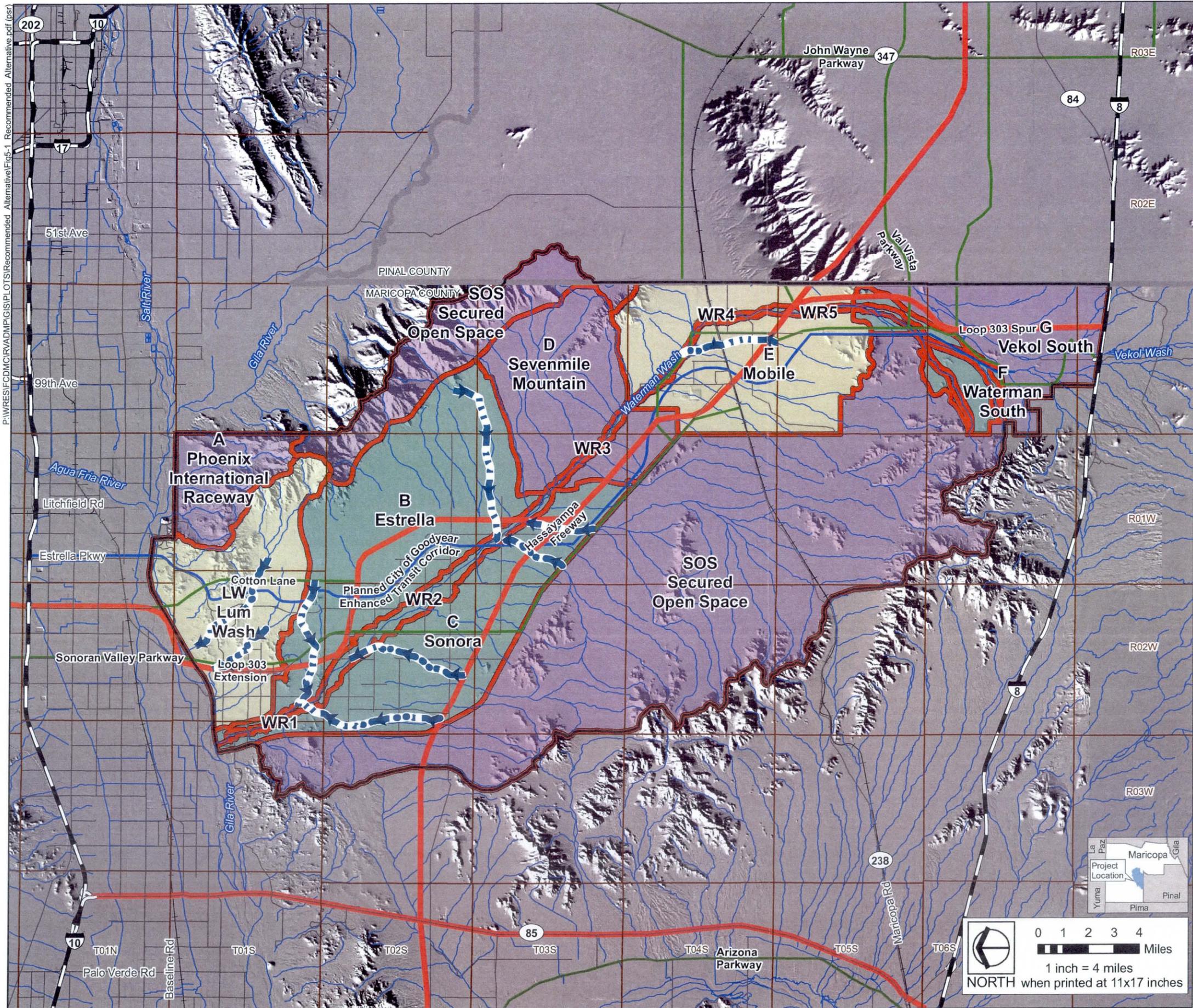
- Ordinances/Rules for Development/Land Use Plan updates
- Engineering criteria/Guidelines/Standards
- Developer Incentives
- Partnering/IGAs

Depending on the level of regulation within the hierarchy of government (i.e., federal, state, county, or city), jurisdictions and land management agencies may require differing regulatory tools. A substantial portion of the developable portions of the study area are within the City of Goodyear. As such, the City will be a key participant in identifying tools for implementation. There is also a significant amount of State Trust Land that will require participation from the Arizona State Land Department.

Rainbow Valley
Area Drainage Master Plan
Recommended Alternative



Figure 5-1



Project Features

- Planning Unit Boundary
- No New Action
- Protected Wash Corridor
- New Regulations
- Protected Wash
- Freeway
- Parkway
- Transit Corridor

Label

Label	Planning Unit
A	Phoenix International Raceway
B	Estrella
C	Sonora
D	Sevenmile Mountain
E	Mobile
F	Waterman South
G	Vekol South
LW	Lum Wash
SOS	Secured Open Space
WR1 to WR5	Waterman Wash Reaches

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/ Freeway
- Major Road
- Railroad
- River/Stream

Data Sources

Flood Control District of Maricopa County
Base Vector and Hillshade Data, 2008
URS Corporation
Flood Hazard Rating and Alternative Data 2009

0 1 2 3 4 Miles
1 inch = 4 miles
NORTH when printed at 11x17 inches

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6.0 REFERENCES

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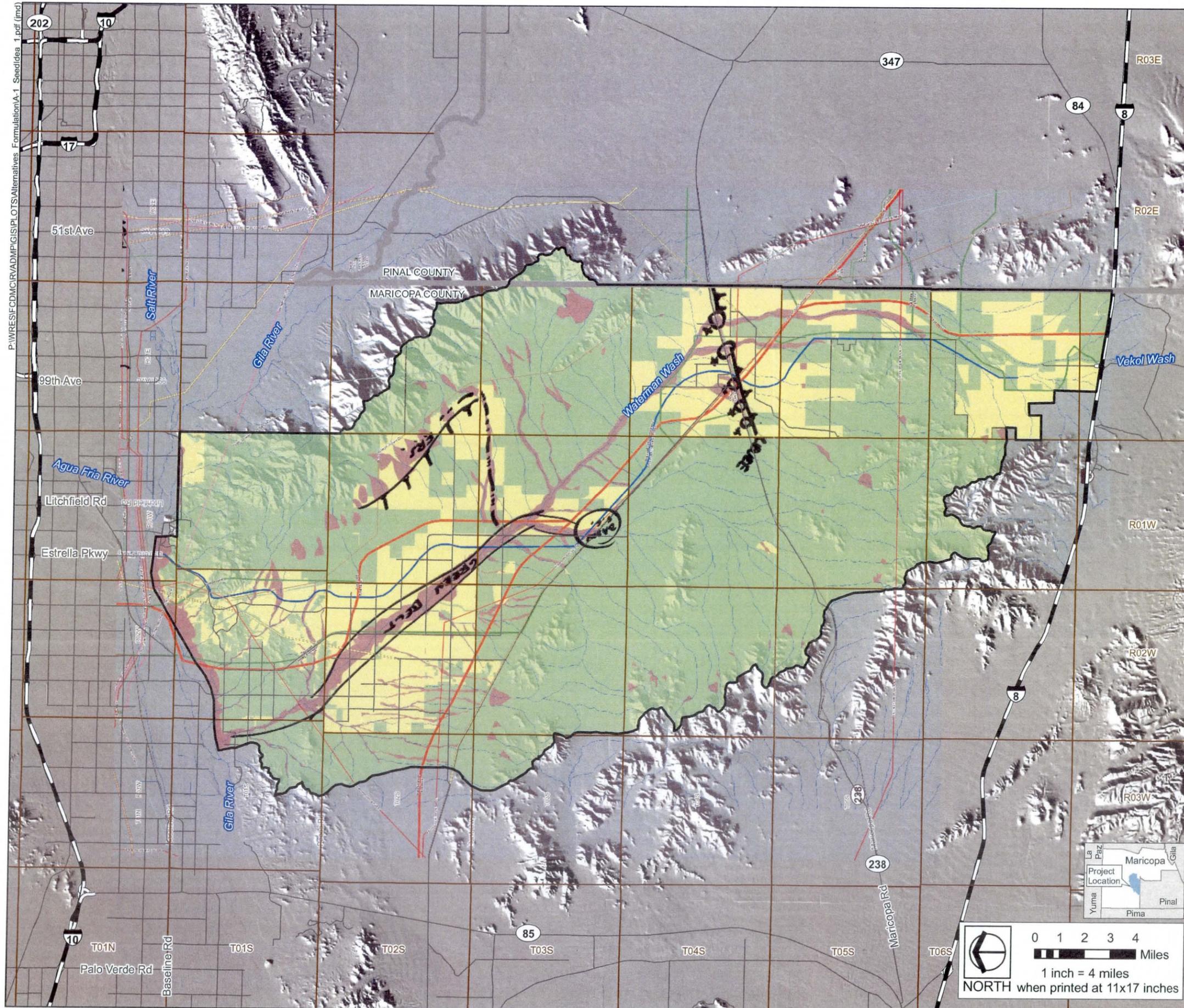
APPENDIX A

SEED IDEAS AND STAKEHOLDER IDEAS FIGURES

Rainbow Valley
Area Drainage Master Plan
Seed Idea 1



Figure A-1



Project Features

Transmission Line Owner and Location

- Arizona Public Service Co., Overhead
- - - Arizona Public Service Co., Underground
- Public Service Co. of New Mexico, Overhead
- Salt River Project, Overhead
- Tucson Electric Power Co., Overhead
- Western Area Power Administration, Overhead
- Unknown, Overhead

Gas Pipeline Owner and Status

- El Paso Corporation, Active
- - - El Paso Corporation, Abandoned
- Kinder Morgan Inc., Active

Flood Hazard Rating

- Low
- Medium
- High

Reference Features

- County Boundary
- Interstate Highway/Freeway
- Rainbow Valley ADMP Boundary
- Major Road
- Township and Range Boundary
- River/Stream

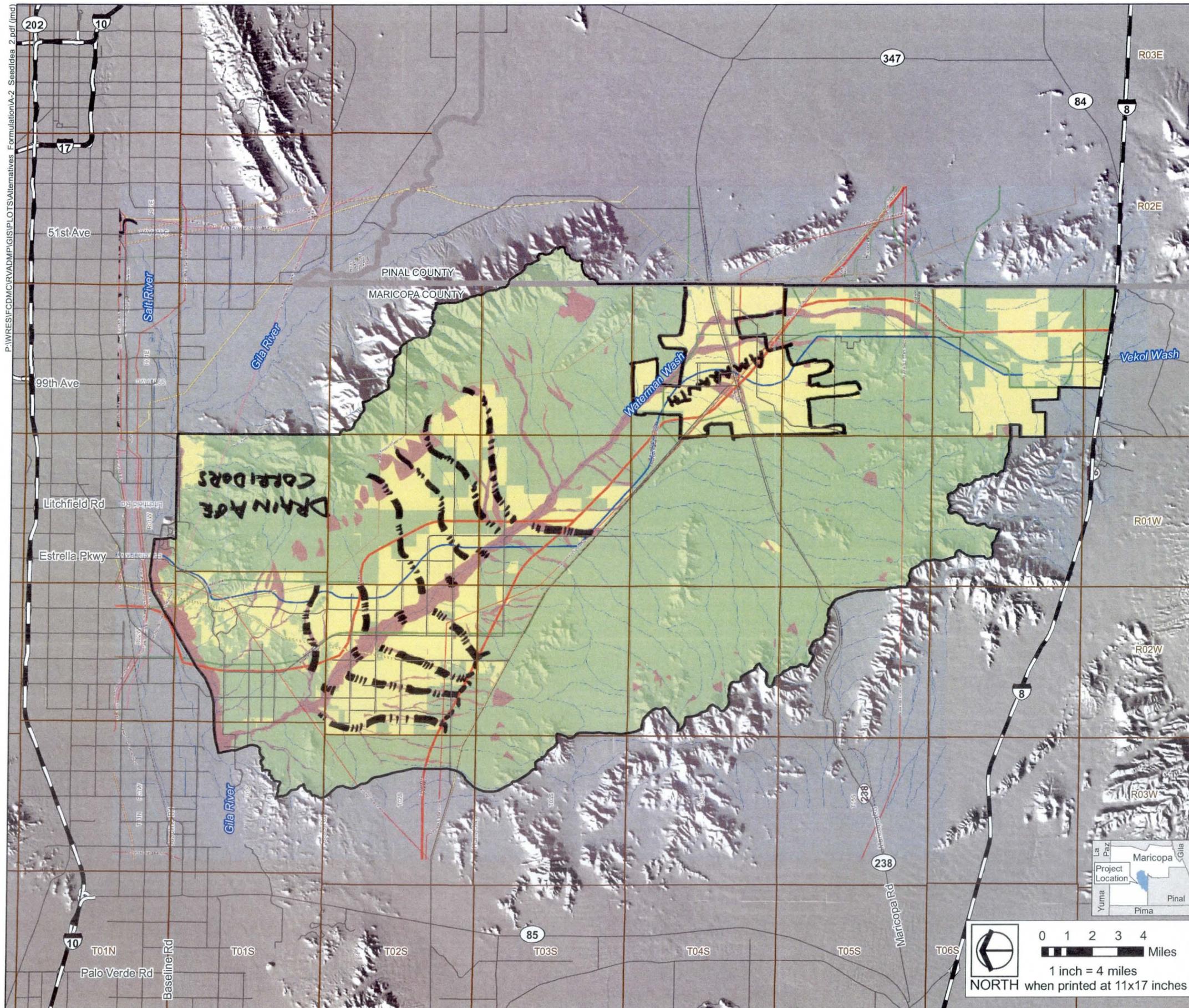
Data Sources

Flood Control District of Maricopa County
Base Vector Data, 2008
Arizona State Cartographer's Office
NAIP Imagery, 2007

Rainbow Valley
Area Drainage Master Plan
Seed Idea 2



Figure A-2



Project Features

Transmission Line Owner and Location

- Arizona Public Service Co., Overhead
- - Arizona Public Service Co., Underground
- Public Service Co. of New Mexico, Overhead
- Salt River Project, Overhead
- Tucson Electric Power Co., Overhead
- Western Area Power Administration, Overhead
- Unknown, Overhead

Gas Pipeline Owner and Status

- El Paso Corporation, Active
- - El Paso Corporation, Abandoned
- Kinder Morgan Inc., Active

Flood Hazard Rating

- Low
- Medium
- High

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/Freeway
- Major Road
- River/Stream

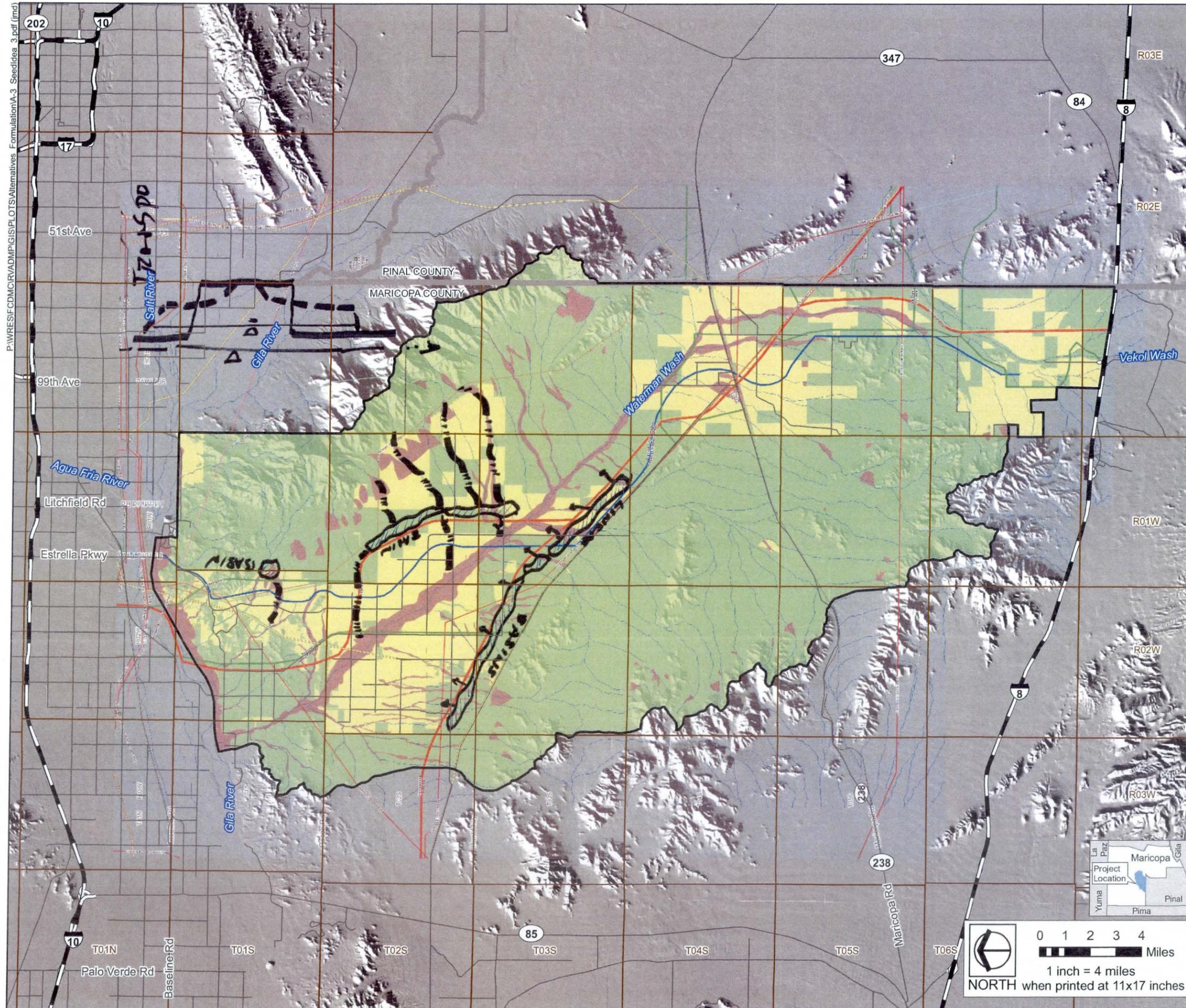
Data Sources

- Flood Control District of Maricopa County
- Base Vector Data, 2008
- Arizona State Cartographer's Office
- NAIP Imagery, 2007

Rainbow Valley
Area Drainage Master Plan
Seed Idea 3



Figure A-3



Project Features

Transmission Line Owner and Location

- Arizona Public Service Co., Overhead
- - - Arizona Public Service Co., Underground
- Public Service Co. of New Mexico, Overhead
- Salt River Project, Overhead
- Tucson Electric Power Co., Overhead
- Western Area Power Administration, Overhead
- Unknown, Overhead

Gas Pipeline Owner and Status

- El Paso Corporation, Active
- - - El Paso Corporation, Abandoned
- Kinder Morgan Inc., Active

Flood Hazard Rating

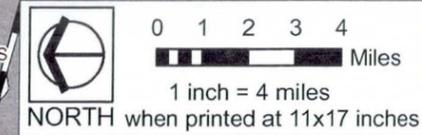
- Low
- Medium
- High

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/Freeway
- Major Road
- River/Stream Boundary

Data Sources

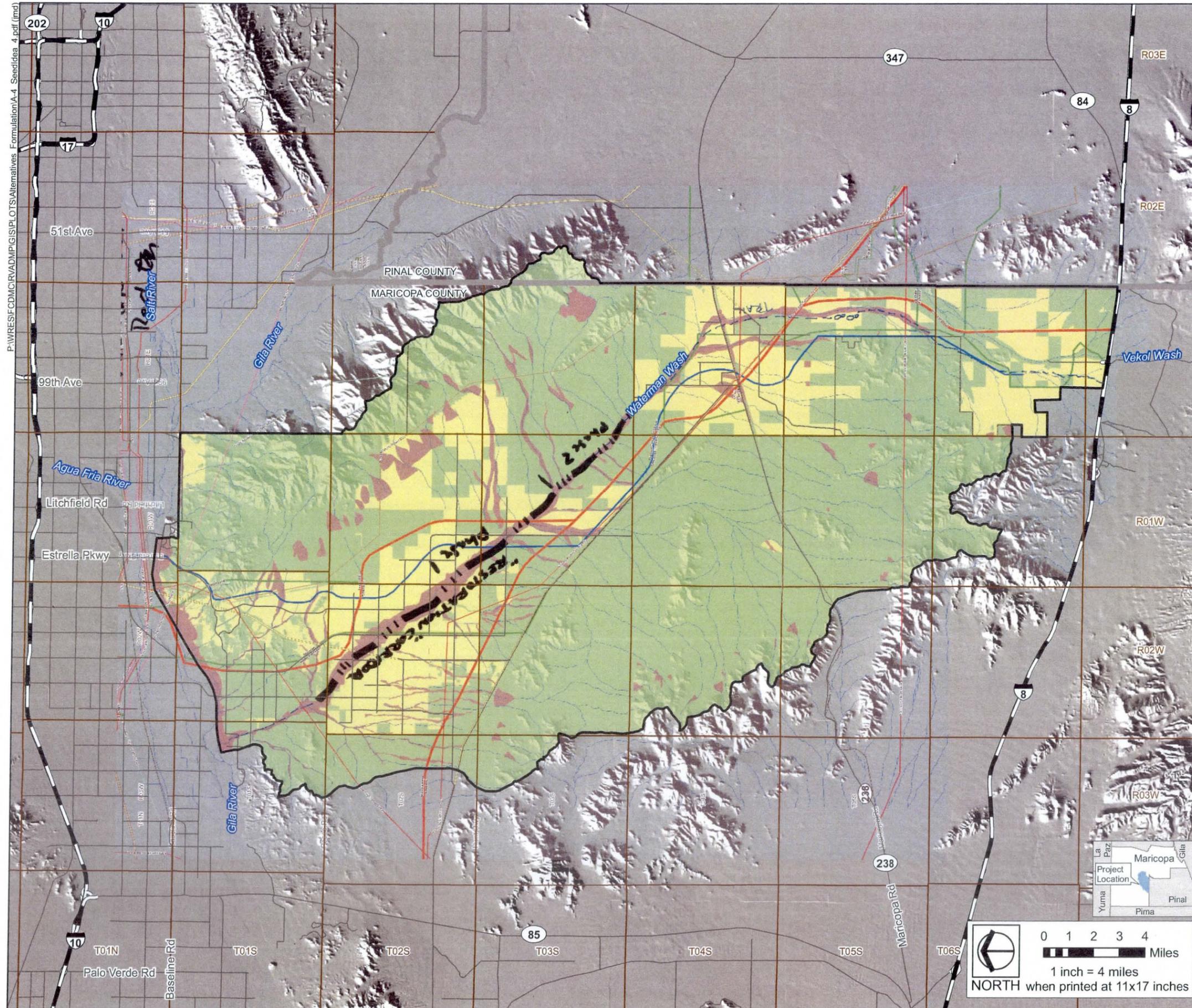
Flood Control District of Maricopa County
Base Vector Data, 2008
Arizona State Cartographer's Office
NAIP Imagery, 2007



Rainbow Valley
Area Drainage Master Plan
Seed Idea 4



Figure A-4



Project Features

Transmission Line Owner and Location

- Arizona Public Service Co., Overhead
- - Arizona Public Service Co., Underground
- Public Service Co. of New Mexico, Overhead
- Salt River Project, Overhead
- Tucson Electric Power Co., Overhead
- Western Area Power Administration, Overhead
- Unknown, Overhead

Gas Pipeline Owner and Status

- El Paso Corporation, Active
- - El Paso Corporation, Abandoned
- Kinder Morgan Inc., Active

Flood Hazard Rating

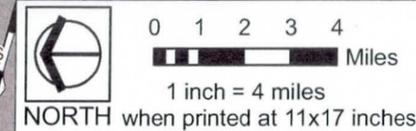
- Low
- Medium
- High

Reference Features

- County Boundary
- Interstate Highway/Freeway
- Rainbow Valley ADMP Boundary
- Major Road
- Township and Range Boundary
- River/Stream

Data Sources

Flood Control District of Maricopa County
Base Vector Data, 2008
Arizona State Cartographer's Office
NAIP Imagery, 2007

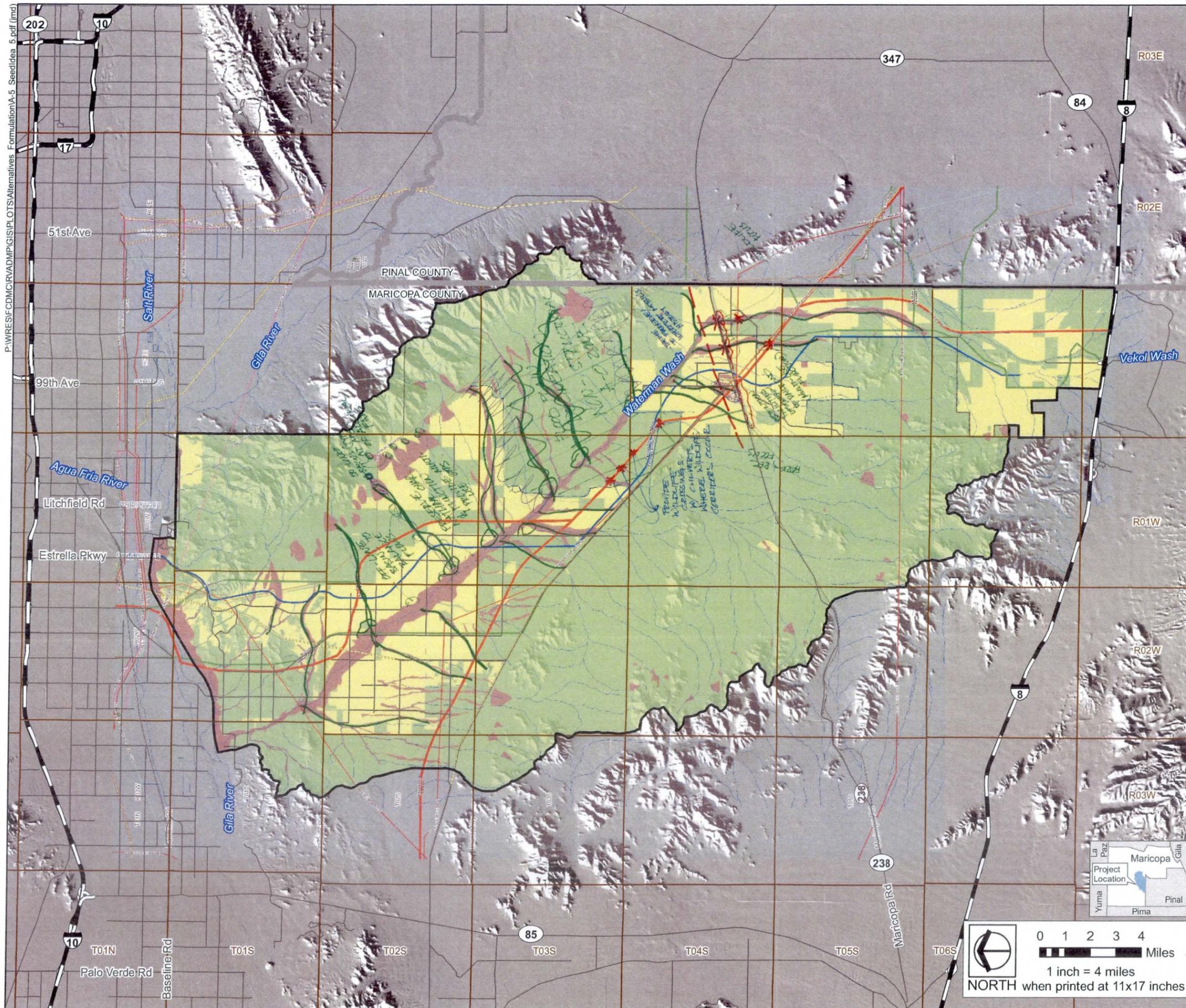


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Rainbow Valley
Area Drainage Master Plan
Seed Idea 5



Figure A-5



Project Features

Transmission Line Owner and Location

- Arizona Public Service Co., Overhead
- - - Arizona Public Service Co., Underground
- Public Service Co. of New Mexico, Overhead
- Salt River Project, Overhead
- Tucson Electric Power Co., Overhead
- Western Area Power Administration, Overhead
- Unknown, Overhead

Gas Pipeline Owner and Status

- El Paso Corporation, Active
- - - El Paso Corporation, Abandoned
- Kinder Morgan Inc., Active

Flood Hazard Rating

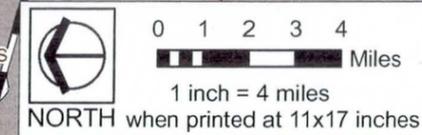
- Low
- Medium
- High

Reference Features

- County Boundary
- Interstate Highway/Freeway
- Rainbow Valley ADMP Boundary
- Major Road
- Township and Range Boundary
- River/Stream

Data Sources

Flood Control District of Maricopa County
Base Vector Data, 2008
Arizona State Cartographer's Office
NAIP Imagery, 2007

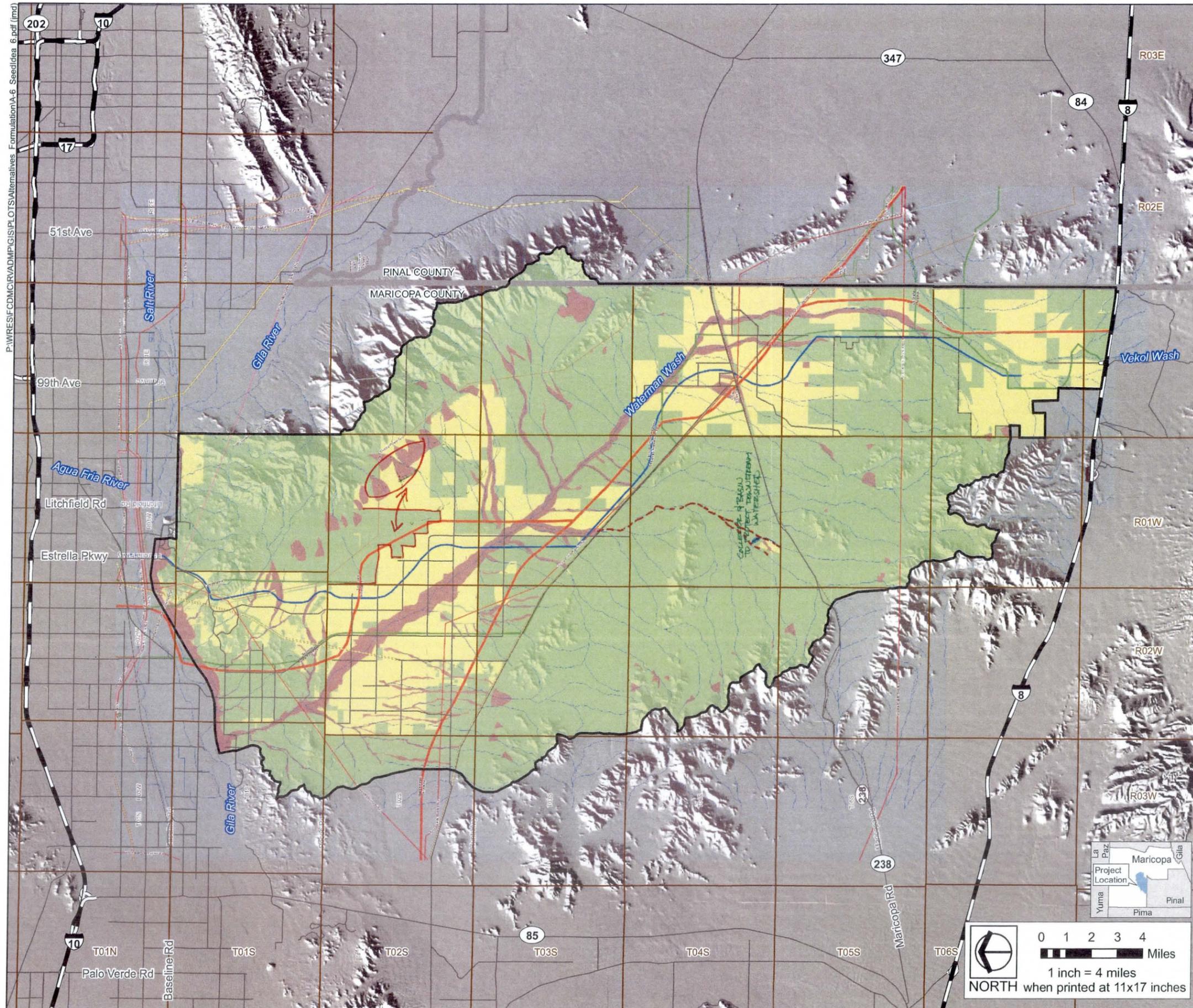


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Rainbow Valley
Area Drainage Master Plan
Seed Idea 6



Figure A-6



Project Features

Transmission Line Owner and Location

- Arizona Public Service Co., Overhead
- - - Arizona Public Service Co., Underground
- Public Service Co. of New Mexico, Overhead
- Salt River Project, Overhead
- Tucson Electric Power Co., Overhead
- Western Area Power Administration, Overhead
- Unknown, Overhead

Gas Pipeline Owner and Status

- El Paso Corporation, Active
- - - El Paso Corporation, Abandoned
- Kinder Morgan Inc., Active

Flood Hazard Rating

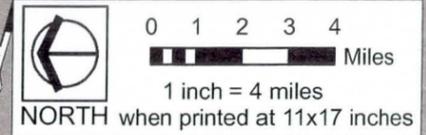
- Low
- Medium
- High

Reference Features

- County Boundary
- Interstate Highway/Freeway
- Rainbow Valley ADMP Boundary
- Major Road
- Township and Range Boundary
- River/Stream Boundary

Data Sources

Flood Control District of Maricopa County
Base Vector Data, 2008
Arizona State Cartographer's Office
NAIP Imagery, 2007

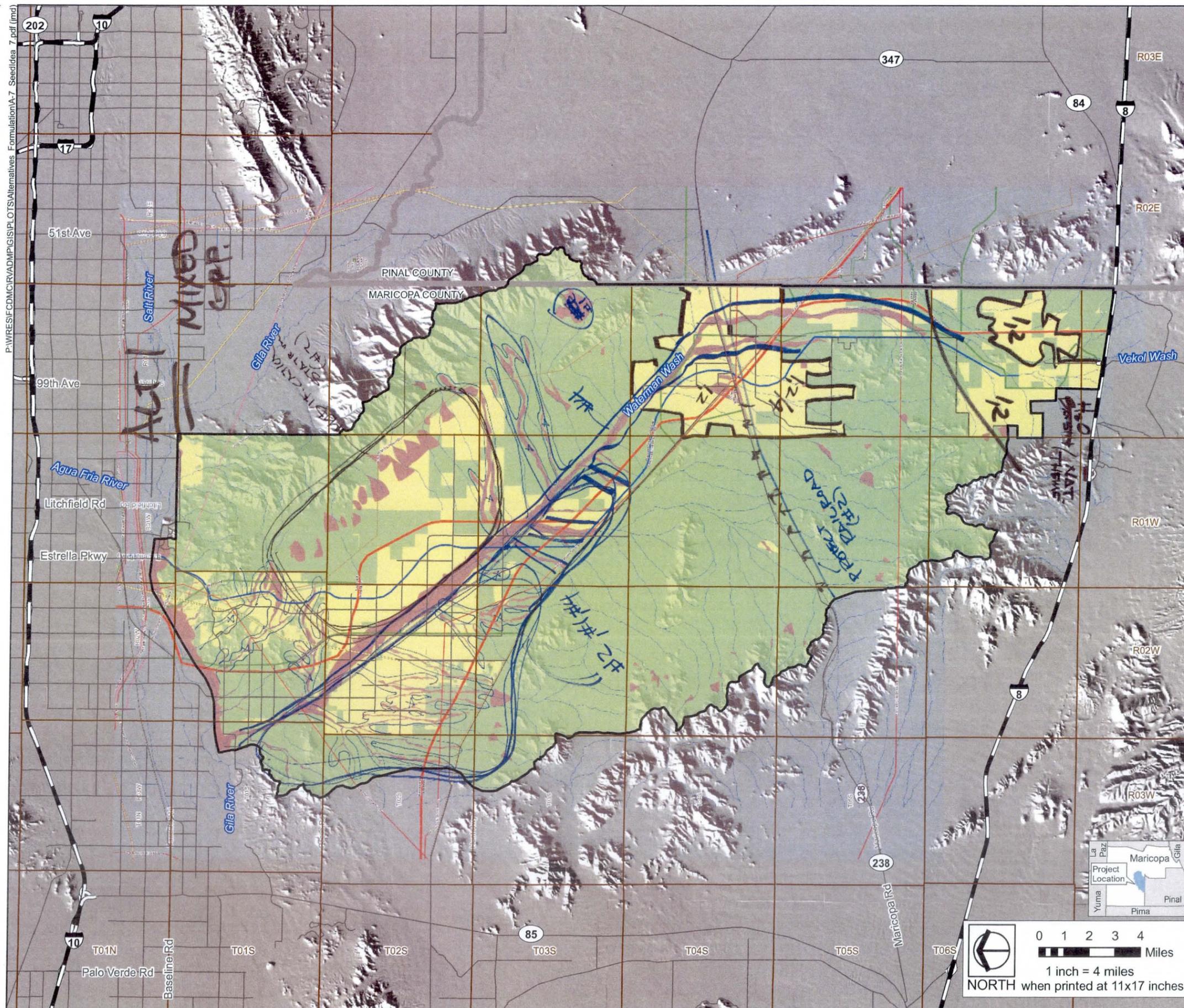


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Rainbow Valley
Area Drainage Master Plan
Seed Idea 7



Figure A-7



Project Features

Transmission Line Owner and Location

- Arizona Public Service Co., Overhead
- - - Arizona Public Service Co., Underground
- Public Service Co. of New Mexico, Overhead
- Salt River Project, Overhead
- Tucson Electric Power Co., Overhead
- Western Area Power Administration, Overhead
- Unknown, Overhead

Gas Pipeline Owner and Status

- El Paso Corporation, Active
- El Paso Corporation, Abandoned
- Kinder Morgan Inc., Active

Flood Hazard Rating

- Low
- Medium
- High

Reference Features

- County Boundary
- Interstate Highway/Freeway
- Rainbow Valley ADMP Boundary
- Major Road
- Township and Range Boundary
- River/Stream Boundary

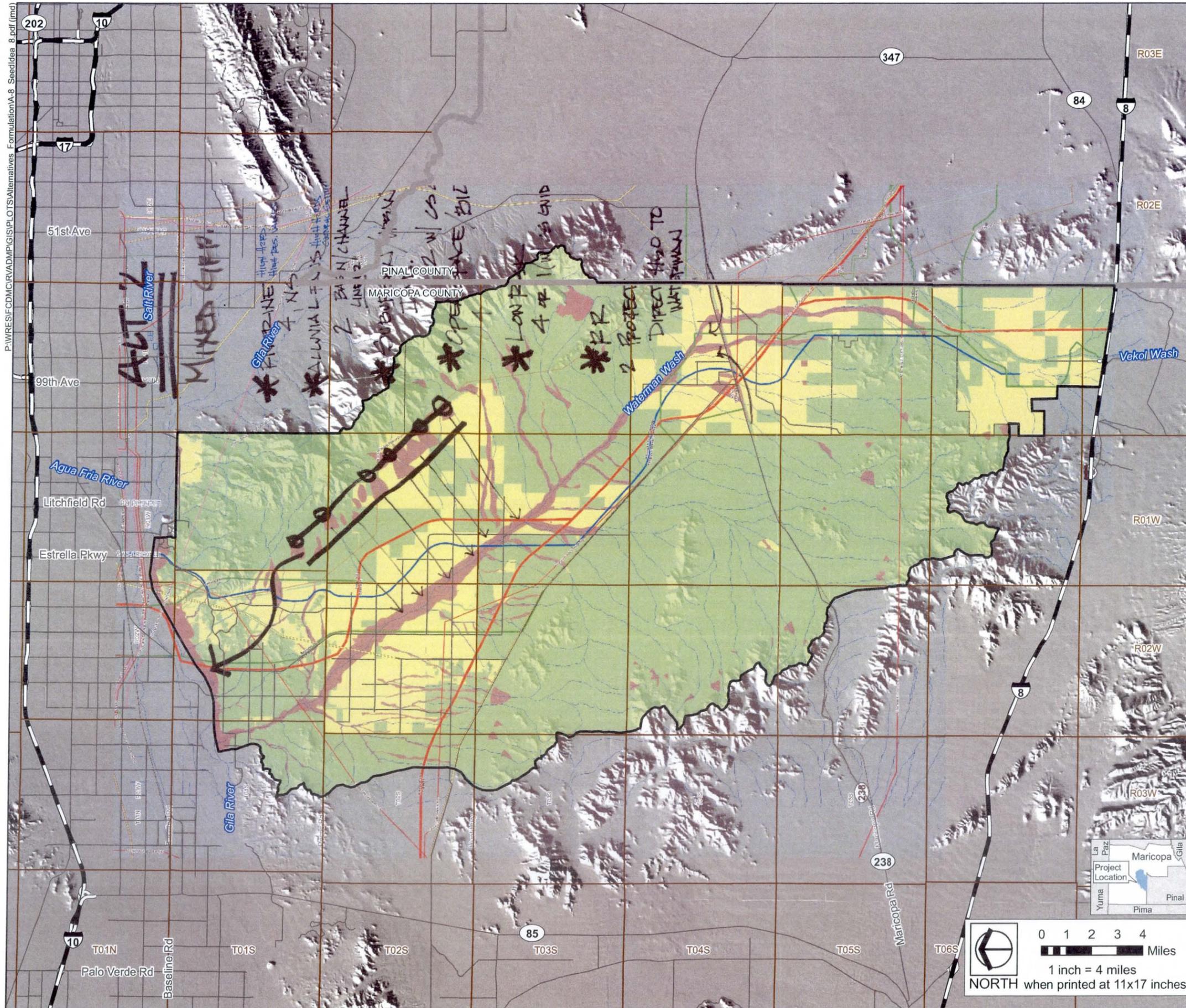
Data Sources

Flood Control District of Maricopa County
Base Vector Data, 2008
Arizona State Cartographer's Office
NAIP Imagery, 2007

Rainbow Valley
Area Drainage Master Plan
Seed Idea 8



Figure A-8



Project Features

Transmission Line Owner and Location

- Arizona Public Service Co., Overhead
- - - Arizona Public Service Co., Underground
- Public Service Co. of New Mexico, Overhead
- Salt River Project, Overhead
- Tucson Electric Power Co., Overhead
- Western Area Power Administration, Overhead
- Unknown, Overhead

Gas Pipeline Owner and Status

- El Paso Corporation, Active
- - - El Paso Corporation, Abandoned
- Kinder Morgan Inc., Active

Flood Hazard Rating

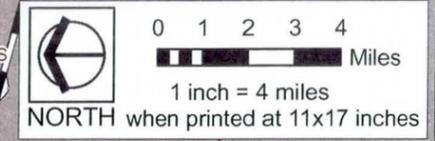
- Low
- Medium
- High

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/Freeway
- Major Road
- River/Stream Boundary

Data Sources

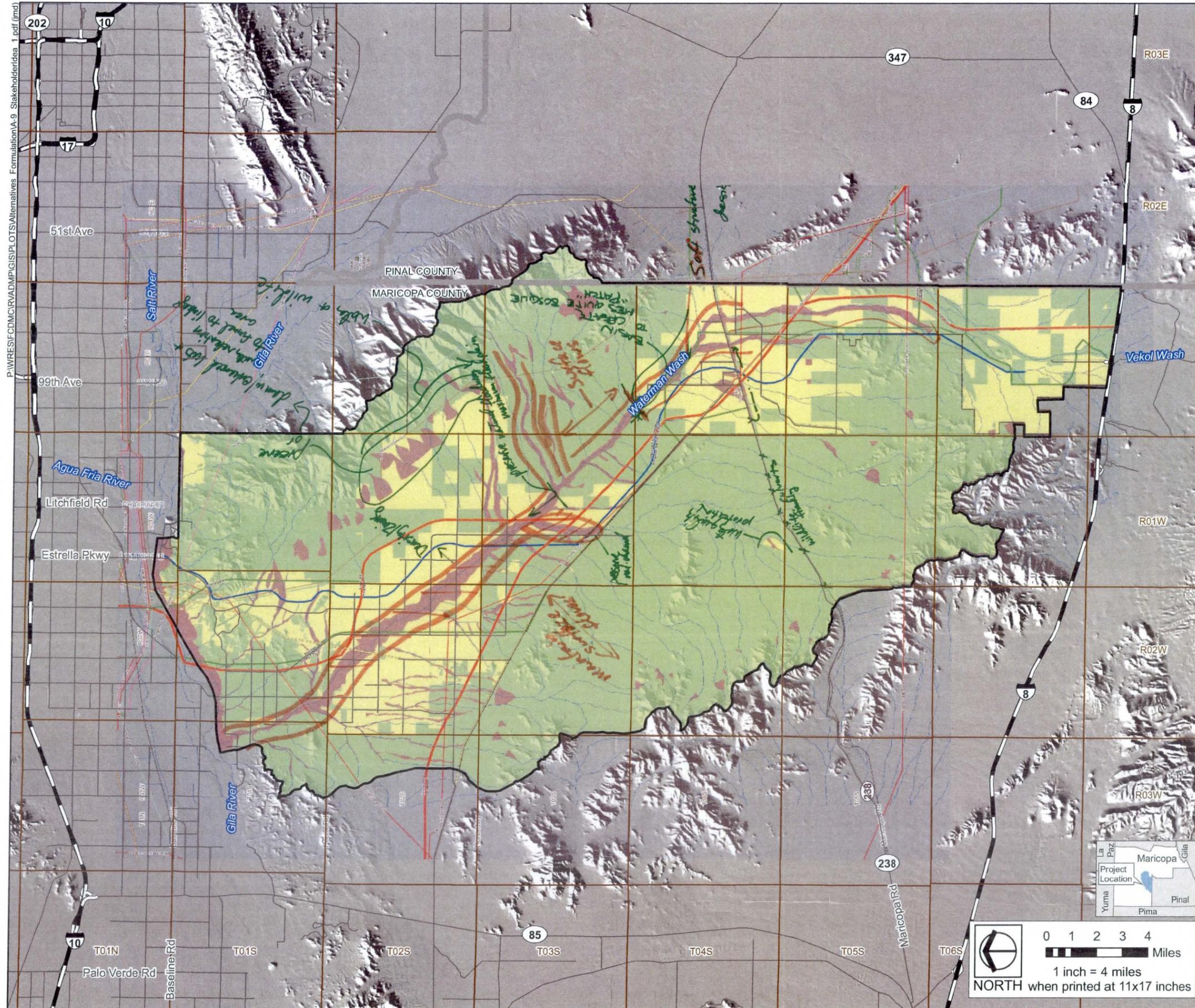
Flood Control District of Maricopa County
Base Vector Data, 2008
Arizona State Cartographer's Office
NAIP Imagery, 2007



Rainbow Valley
Area Drainage Master Plan
Stakeholder Idea 1



Figure A-9



Project Features

Transmission Line Owner and Location

- Arizona Public Service Co., Overhead
- - - Arizona Public Service Co., Underground
- Public Service Co. of New Mexico, Overhead
- Salt River Project, Overhead
- Tucson Electric Power Co., Overhead
- Western Area Power Administration, Overhead
- Unknown, Overhead

Gas Pipeline Owner and Status

- El Paso Corporation, Active
- - - El Paso Corporation, Abandoned
- Kinder Morgan Inc., Active

Flood Hazard Rating

- Low
- Medium
- High

Reference Features

- County Boundary
- Interstate Highway/Freeway
- Rainbow Valley ADMP Boundary
- Major Road
- Township and Range Boundary
- River/Stream

Data Sources

Flood Control District of Maricopa County
Base Vector Data, 2008
Arizona State Cartographer's Office
NAIP Imagery, 2007

0 1 2 3 4
Miles
 1 inch = 4 miles
 NORTH when printed at 11x17 inches

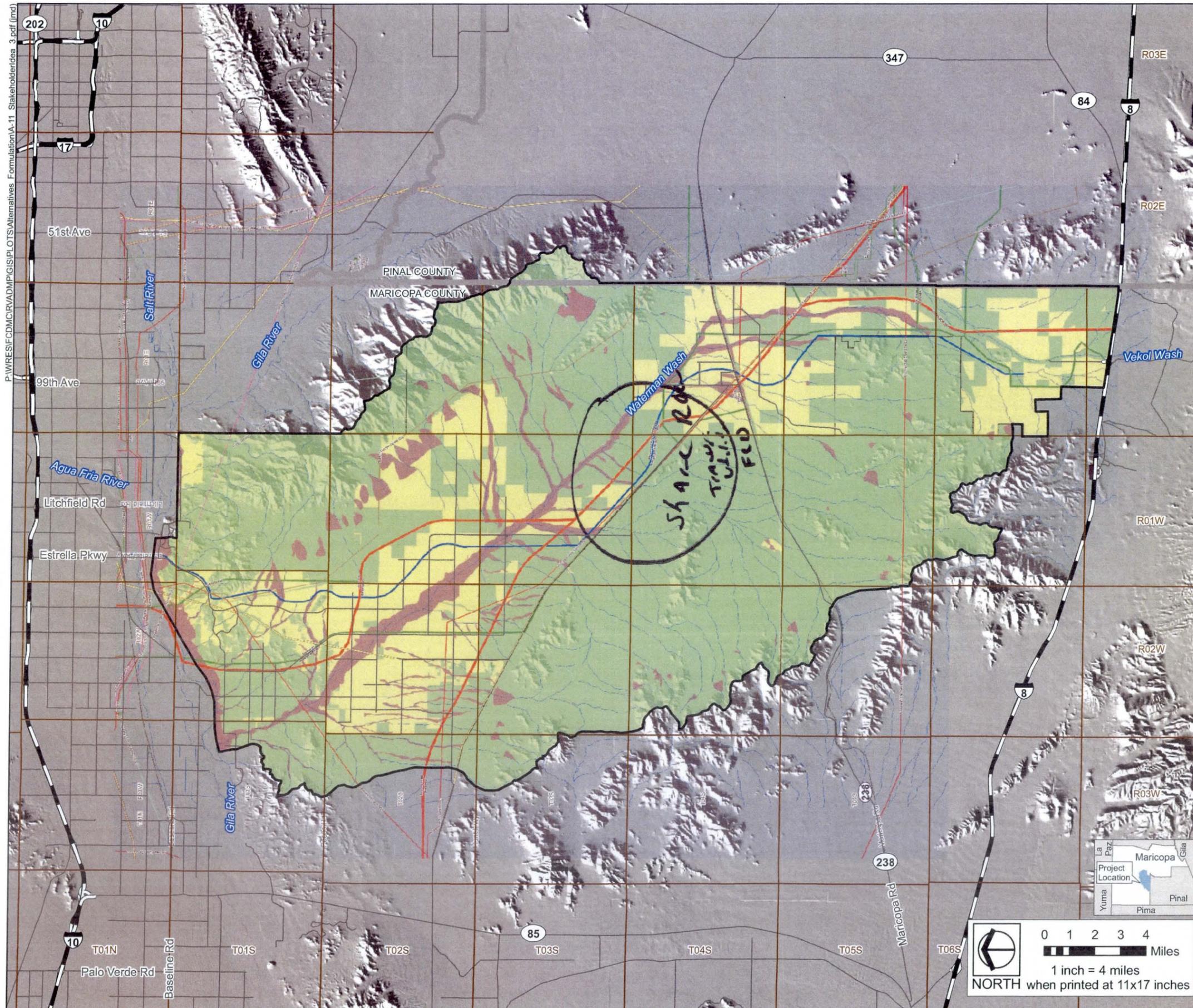


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Rainbow Valley
Area Drainage Master Plan
Stakeholder Idea 3



Figure A-11



Project Features

Transmission Line Owner and Location

- Arizona Public Service Co., Overhead
- - - Arizona Public Service Co., Underground
- Public Service Co. of New Mexico, Overhead
- Salt River Project, Overhead
- Tucson Electric Power Co., Overhead
- Western Area Power Administration, Overhead
- Unknown, Overhead

Gas Pipeline Owner and Status

- El Paso Corporation, Active
- - - El Paso Corporation, Abandoned
- Kinder Morgan Inc., Active

Flood Hazard Rating

- Low
- Medium
- High

Reference Features

- County Boundary
- Interstate Highway/Freeway
- Rainbow Valley ADMP Boundary
- Major Road
- Township and Range Boundary
- River/Stream

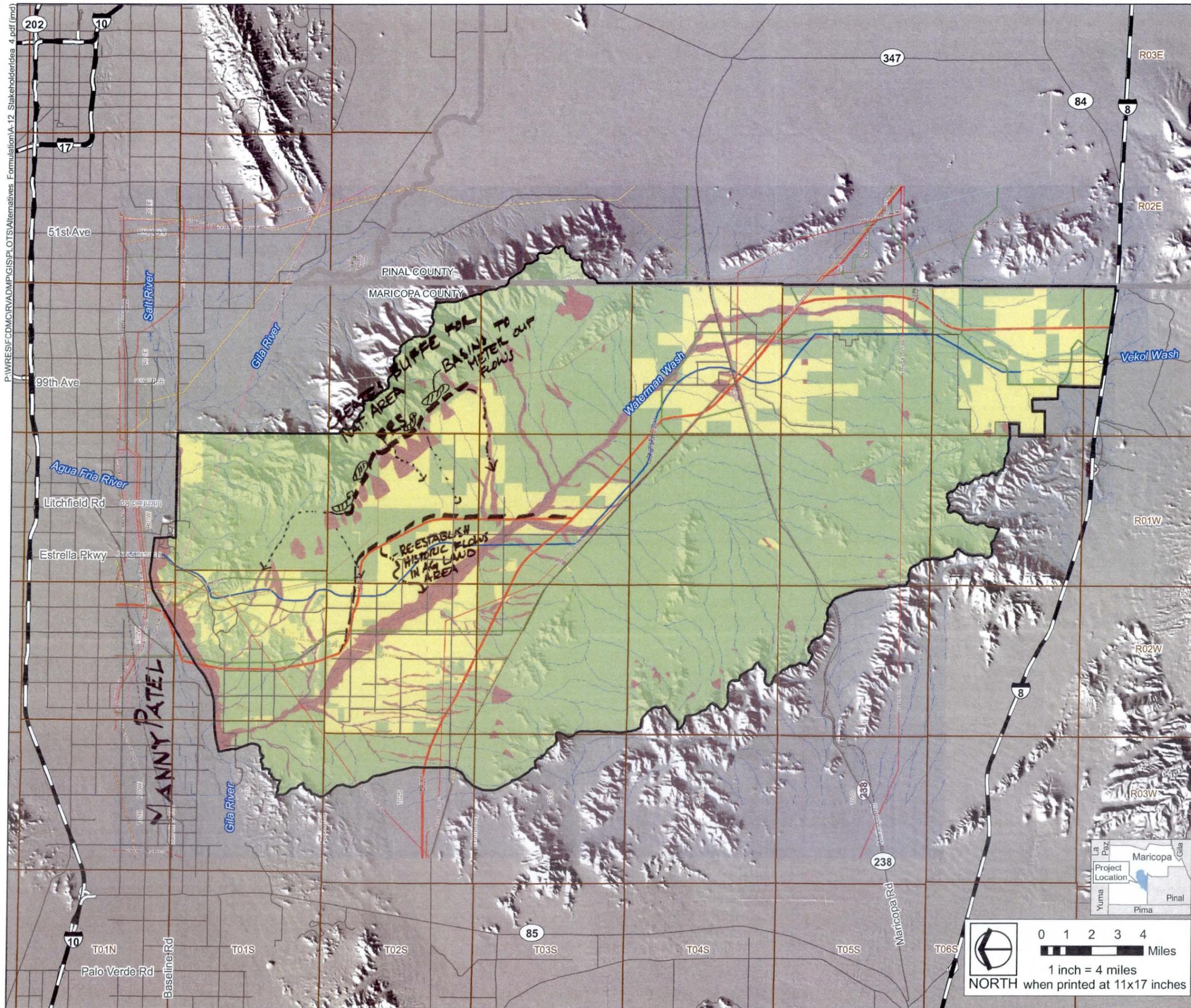
Data Sources

Flood Control District of Maricopa County
Base Vector Data, 2008
Arizona State Cartographer's Office
NAIP Imagery, 2007

Rainbow Valley
Area Drainage Master Plan
Stakeholder Idea 4



Figure A-12



Project Features

Transmission Line Owner and Location

- Arizona Public Service Co., Overhead
- - - Arizona Public Service Co., Underground
- Public Service Co. of New Mexico, Overhead
- Salt River Project, Overhead
- Tucson Electric Power Co., Overhead
- Western Area Power Administration, Overhead
- Unknown, Overhead

Gas Pipeline Owner and Status

- El Paso Corporation, Active
- - - El Paso Corporation, Abandoned
- Kinder Morgan Inc., Active

Flood Hazard Rating

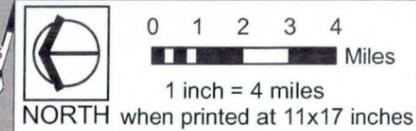
- Low
- Medium
- High

Reference Features

- County Boundary
- Interstate Highway/ Freeway
- Rainbow Valley ADMP Boundary
- Major Road
- Township and Range Boundary
- River/Stream

Data Sources

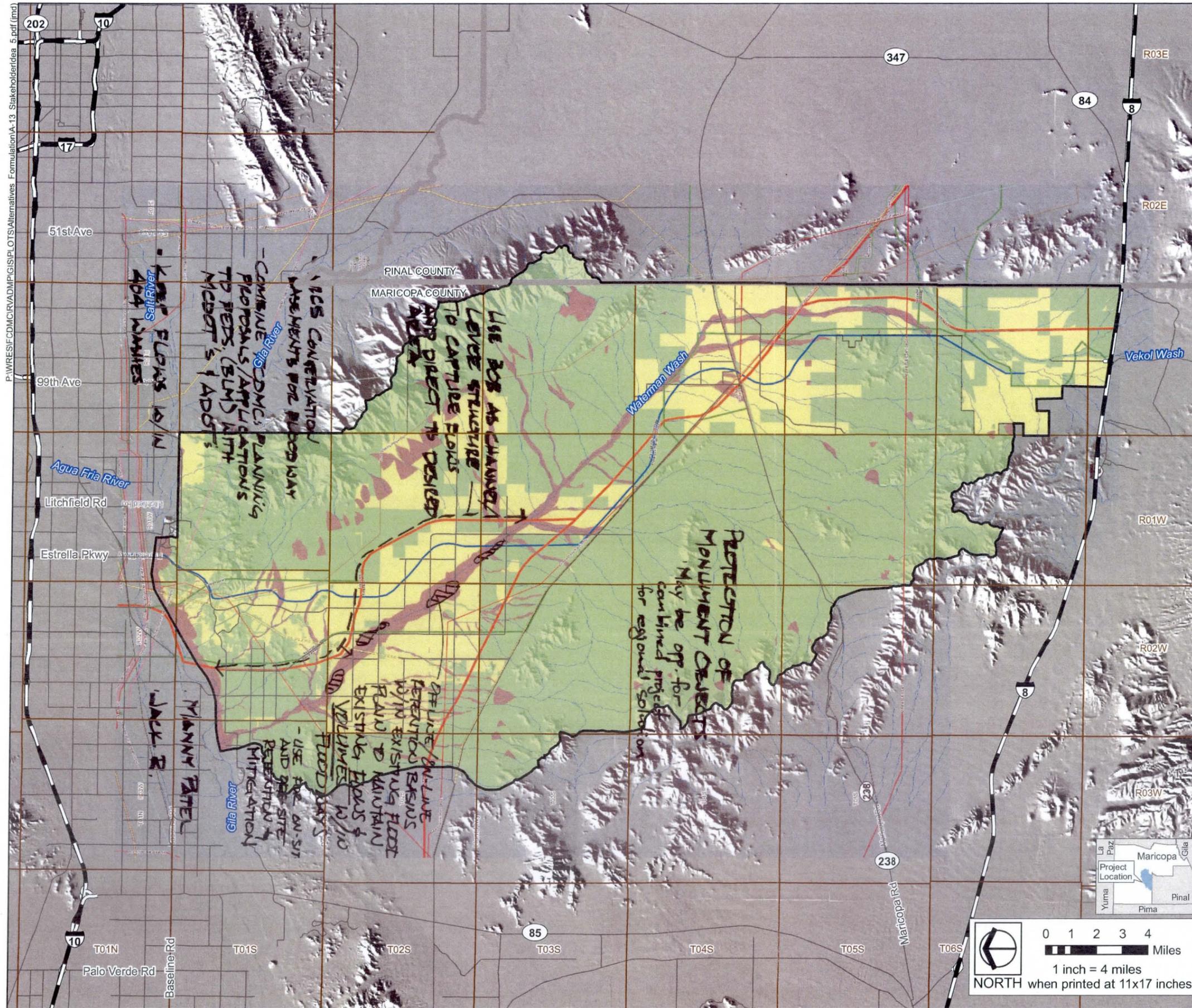
Flood Control District of Maricopa County
Base Vector Data, 2008
Arizona State Cartographer's Office
NAIP Imagery, 2007



Rainbow Valley
Area Drainage Master Plan
Stakeholder Idea 5



Figure A-13



Project Features

Transmission Line Owner and Location

- Arizona Public Service Co., Overhead
- - - Arizona Public Service Co., Underground
- Public Service Co. of New Mexico, Overhead
- Salt River Project, Overhead
- Tucson Electric Power Co., Overhead
- Western Area Power Administration, Overhead
- Unknown, Overhead

Gas Pipeline Owner and Status

- El Paso Corporation, Active
- - - El Paso Corporation, Abandoned
- Kinder Morgan Inc., Active

Flood Hazard Rating

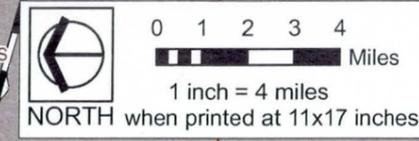
- Low
- Medium
- High

Reference Features

- County Boundary
- Interstate Highway/Freeway
- Rainbow Valley ADMP Boundary
- Major Road
- Township and Range Boundary
- River/Stream Boundary

Data Sources

Flood Control District of Maricopa County
Base Vector Data, 2008
Arizona State Cartographer's Office
NAIP Imagery, 2007

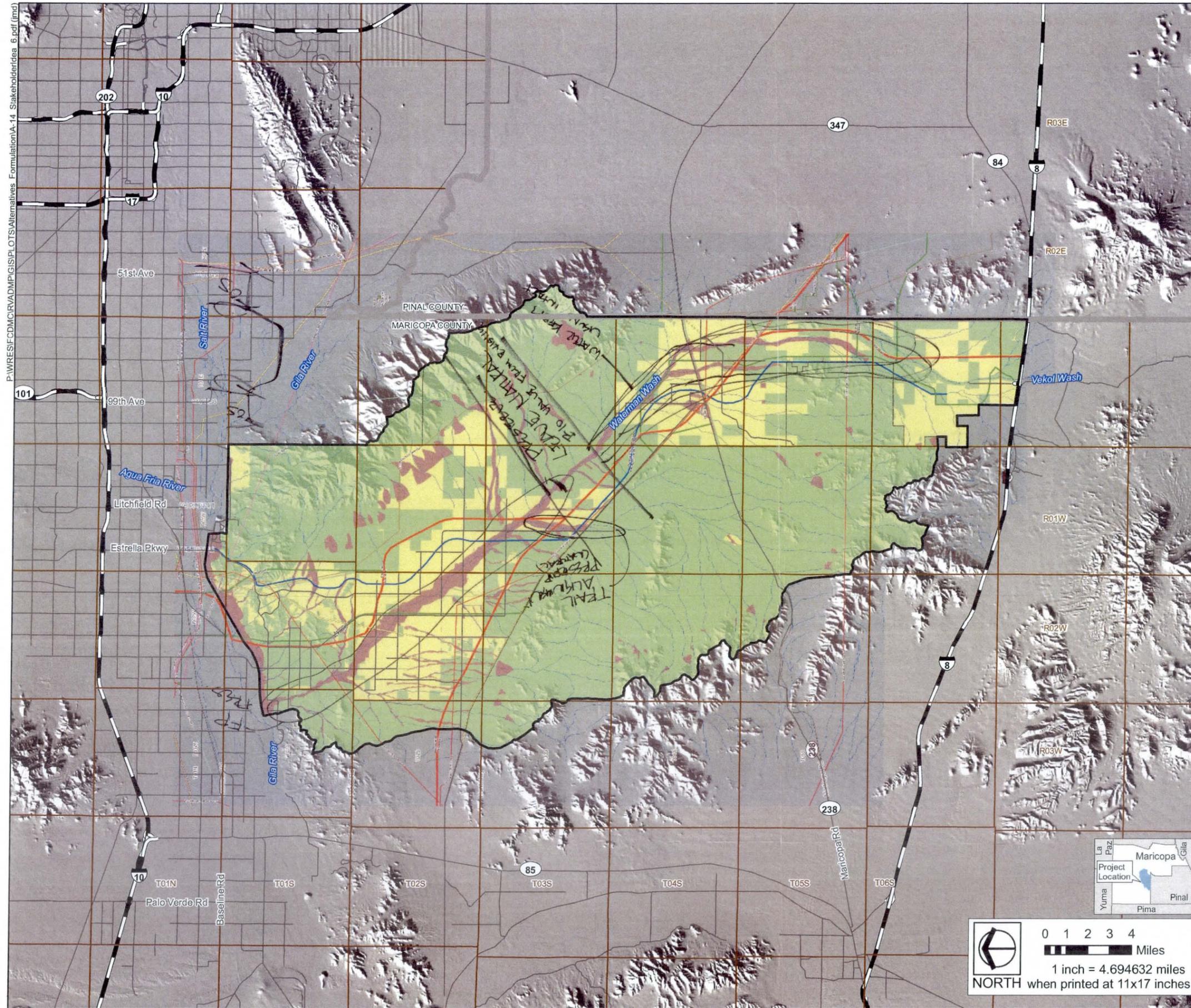


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Rainbow Valley
Area Drainage Master Plan
Stakeholder Idea 6



Figure A-14



Project Features

Transmission Line Owner and Location

- Arizona Public Service Co., Overhead
- - - Arizona Public Service Co., Underground
- Public Service Co. of New Mexico, Overhead
- Salt River Project, Overhead
- Tucson Electric Power Co., Overhead
- Western Area Power Administration, Overhead
- Unknown, Overhead

Gas Pipeline Owner and Status

- El Paso Corporation, Active
- - - El Paso Corporation, Abandoned
- Kinder Morgan Inc., Active

Flood Hazard Rating

- Low
- Medium
- High

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/Freeway
- Major Road
- River/Stream Boundary

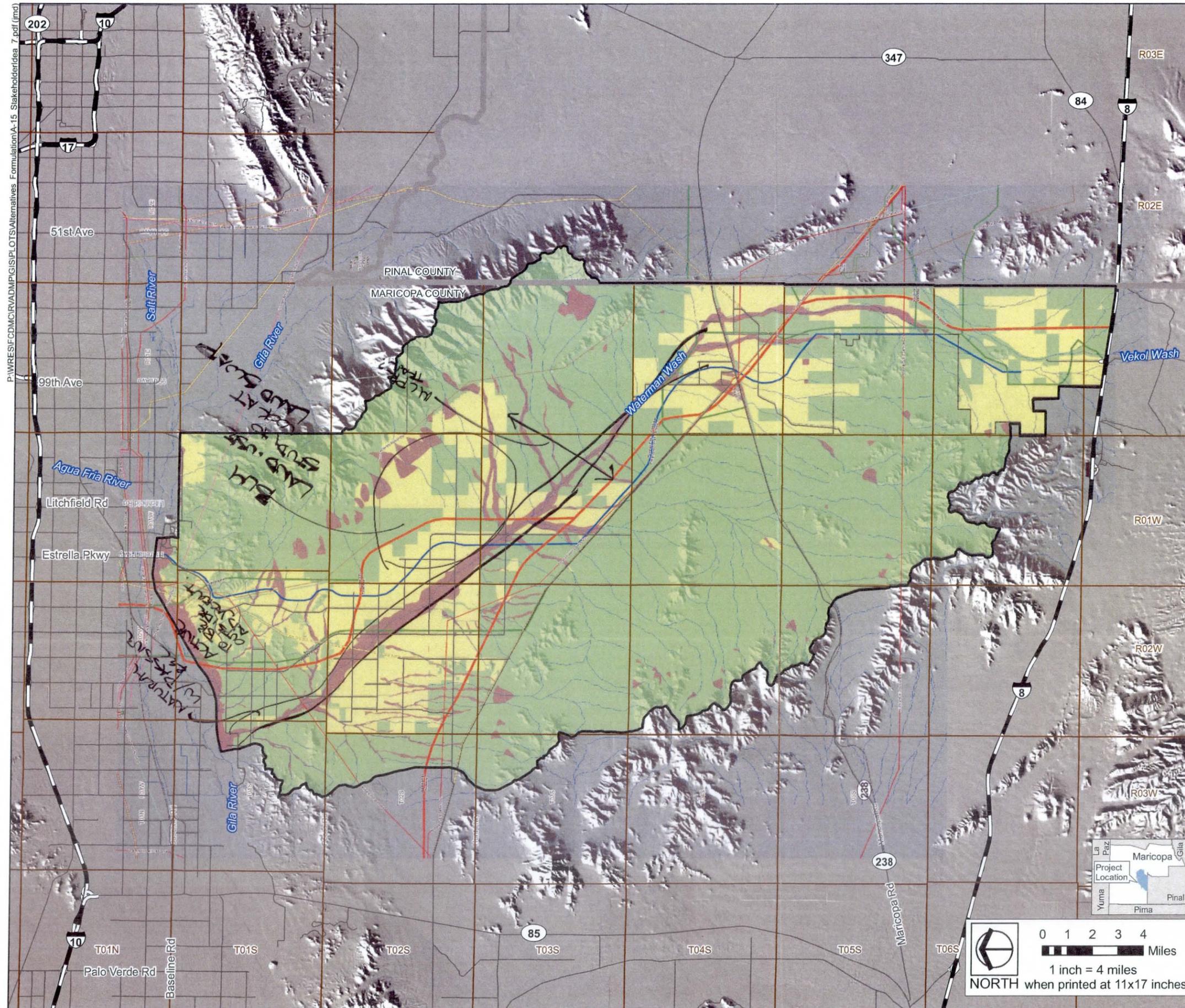
Data Sources

Flood Control District of Maricopa County
Base Vector Data, 2008
Arizona State Cartographer's Office
NAIP Imagery, 2007

Rainbow Valley
Area Drainage Master Plan
Stakeholder Idea 7



Figure A-15



Project Features

Transmission Line Owner and Location

- Arizona Public Service Co., Overhead
- - - Arizona Public Service Co., Underground
- Public Service Co. of New Mexico, Overhead
- Salt River Project, Overhead
- Tucson Electric Power Co., Overhead
- Western Area Power Administration, Overhead
- Unknown, Overhead

Gas Pipeline Owner and Status

- El Paso Corporation, Active
- - - El Paso Corporation, Abandoned
- Kinder Morgan Inc., Active

Flood Hazard Rating

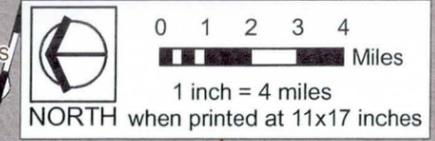
- Low
- Medium
- High

Reference Features

- County Boundary
- Rainbow Valley ADMP Boundary
- Township and Range Boundary
- Interstate Highway/Freeway
- Major Road
- River/Stream

Data Sources

Flood Control District of Maricopa County
Base Vector Data, 2008
Arizona State Cartographer's Office
NAIP Imagery, 2007





APPENDIX B
DETAILED COST ESTIMATES

ALTERNATIVE 3 DETAILED COST ESTIMATE

URS Corporation

Planning Unit	Item Description	Quantity	Channel Bottom Width, ft	Channel Top Width, ft	Length	Unit	Unit Cost	Excavation Cost	ROW Width, ft	ROW Area, acres	ROW cost per acre	ROW Cost	Landscaping Cost*	Total Cost	
LUM WASH	RCPJ04		20	80	1639	LF	\$ 38.00	\$ 62,282.00	110	7.15	\$35,000	\$250,215	\$15,205	\$327,701	
	RCPJ08		20	80	1685	LF	\$ 38.00	\$ 64,030.00	110	7.35	\$35,000	\$257,237	\$15,632	\$336,899	
	RCPJ07B		20	80	6342	LF	\$ 38.00	\$ 240,996.00	110	27.66	\$35,000	\$968,189	\$58,834	\$1,268,019	
	RCPJ07		20	80	3967	LF	\$ 38.00	\$ 150,746.00	110	17.30	\$35,000	\$605,614	\$36,801	\$793,161	
	RCPJ11		20	80	5114	LF	\$ 38.00	\$ 194,332.00	110	22.31	\$35,000	\$780,719	\$47,442	\$1,022,492	
	TOTAL							\$ 712,386.00							\$3,748,272
MOBILE	RCPE32		50	110	1424	LF	\$ 60.00	\$ 85,440.00	110	7.19	\$35,000	\$251,717	\$18,114	\$355,271	
	RCPE53		50	110	1724	LF	\$ 60.00	\$ 103,440.00	110	8.71	\$35,000	\$304,747	\$21,930	\$430,117	
	RCPE31		50	110	571	LF	\$ 60.00	\$ 34,260.00	110	2.88	\$35,000	\$100,934	\$7,263	\$142,458	
	RCPE30		50	110	2859	LF	\$ 60.00	\$ 171,540.00	110	14.44	\$35,000	\$505,379	\$36,968	\$713,286	
	RCPE38		100	160	2723	LF	\$ 97.00	\$ 264,131.00	110	16.88	\$35,000	\$590,733	\$50,265	\$905,130	
	RCPE25		100	160	1886	LF	\$ 97.00	\$ 182,942.00	110	11.69	\$35,000	\$409,153	\$34,815	\$626,910	
	RCPE36		150	210	1425	LF	\$ 134.00	\$ 199,500.00	110	10.47	\$35,000	\$366,391	\$34,483	\$591,824	
	RCPE54		200	260	1000	LF	\$ 171.00	\$ 171,000.00	110	8.49	\$35,000	\$297,291	\$29,938	\$498,229	
	RCPF26		100	160	2300	LF	\$ 97.00	\$ 223,100.00	110	14.26	\$35,000	\$498,967	\$42,457	\$764,524	
	RCPF25		100	160	1544	LF	\$ 97.00	\$ 149,768.00	110	9.57	\$35,000	\$334,959	\$28,502	\$513,228	
	RCPF28		50	110	2363	LF	\$ 60.00	\$ 141,780.00	110	11.93	\$35,000	\$417,702	\$30,058	\$589,540	
	RCPF27		150	210	9440	LF	\$ 134.00	\$ 1,264,960.00	110	69.35	\$35,000	\$2,427,181	\$228,437	\$3,920,578	
	RCPF36		50	110	2700	LF	\$ 60.00	\$ 162,000.00	110	13.64	\$35,000	\$477,273	\$34,345	\$673,618	
	RCPF20		50	110	2900	LF	\$ 60.00	\$ 174,000.00	110	14.65	\$35,000	\$512,626	\$36,889	\$723,515	
	TOTAL							\$ 3,319,311.00							\$11,448,229
	SONORA	RCPB50		50	110	1660	LF	\$ 60.00	\$ 99,600.00	110	8.38	\$35,000	\$293,434	\$21,116	\$414,150
		RCPB52		50	110	1204	LF	\$ 60.00	\$ 72,240.00	110	6.08	\$35,000	\$212,828	\$15,315	\$300,384
		RCPB53		50	110	925	LF	\$ 60.00	\$ 55,500.00	110	4.67	\$35,000	\$163,510	\$11,766	\$230,776
RCPB18			50	110	387	LF	\$ 60.00	\$ 23,220.00	110	1.95	\$35,000	\$68,409	\$4,923	\$96,552	
RCPB39			50	110	1240	LF	\$ 60.00	\$ 74,400.00	110	6.26	\$35,000	\$219,192	\$15,773	\$309,365	
RCPB54			100	160	1622	LF	\$ 97.00	\$ 157,334.00	110	10.05	\$35,000	\$351,880	\$29,941	\$539,156	
RCPB38			100	160	1220	LF	\$ 97.00	\$ 118,340.00	110	7.56	\$35,000	\$264,669	\$22,521	\$405,530	
RCPB26			100	160	3315	LF	\$ 97.00	\$ 321,555.00	110	20.55	\$35,000	\$719,163	\$61,194	\$1,101,912	
RCPB30			20	80	3010	LF	\$ 38.00	\$ 114,380.00	110	13.13	\$35,000	\$459,516	\$27,923	\$601,819	
RCPB29			20	80	1360	LF	\$ 38.00	\$ 51,680.00	110	5.93	\$35,000	\$207,622	\$12,617	\$271,918	
RCPB34			20	80	1600	LF	\$ 38.00	\$ 60,800.00	110	6.98	\$35,000	\$244,261	\$14,843	\$319,904	
RCPB65			100	160	5663	LF	\$ 97.00	\$ 549,311.00	110	35.10	\$35,000	\$1,228,543	\$104,537	\$1,882,391	
RCPB60			100	160	5018	LF	\$ 97.00	\$ 486,746.00	110	31.10	\$35,000	\$1,088,616	\$92,630	\$1,667,992	
RCPA11			50	110	5283	LF	\$ 97.00	\$ 512,451.00	110	26.68	\$35,000	\$933,864	\$67,202	\$1,513,516	
RCPA10			150	210	2870	LF	\$ 134.00	\$ 384,580.00	110	21.08	\$35,000	\$737,925	\$69,451	\$1,191,955	
RCPA18			100	160	4600	LF	\$ 97.00	\$ 446,200.00	110	28.51	\$35,000	\$997,934	\$84,914	\$1,529,048	
RCPA21			100	160	5832	LF	\$ 97.00	\$ 565,704.00	110	36.15	\$35,000	\$1,265,207	\$107,656	\$1,938,567	
RCPA20			100	160	5832	LF	\$ 97.00	\$ 565,704.00	110	36.15	\$35,000	\$1,265,207	\$107,656	\$1,938,567	
RCPA32			100	160	1192	LF	\$ 97.00	\$ 115,624.00	110	7.39	\$35,000	\$258,595	\$22,004	\$396,223	
SUB-TOTAL								\$ 2,590,263.00							\$16,649,725

ALTERNATIVE 3 DETAILED COST ESTIMATE

URS Corporation

Planning Unit	Item Description	Quantity	Channel Bottom Width, ft	Channel Top Width, ft	Length	Unit	Unit Cost	Excavation Cost	ROW Width ¹ , ft	ROW Area ¹ , acres	ROW cost per acre	ROW Cost	Landscaping Cost ¹	Total Cost
ESTRELLA ALT 1	MC3A01	20	80	80	552	LF	\$ 38.00	\$ 20,976.00	110	2.41	\$35,000	\$84,270	\$5,121	\$110,367
	MC3A02	20	80	80	3701	LF	\$ 38.00	\$ 140,638.00	110	16.14	\$35,000	\$565,006	\$34,334	\$739,977
	MC3A03	20	80	80	1409	LF	\$ 38.00	\$ 53,542.00	110	6.15	\$35,000	\$215,102	\$13,071	\$281,715
	MC3A04	20	80	80	1354	LF	\$ 38.00	\$ 51,452.00	110	5.91	\$35,000	\$206,706	\$12,561	\$270,719
	MC3A05	20	80	80	2183	LF	\$ 38.00	\$ 82,954.00	110	9.52	\$35,000	\$333,263	\$20,251	\$436,469
	MC3A06	20	80	80	1270	LF	\$ 38.00	\$ 48,260.00	110	5.54	\$35,000	\$193,862	\$11,762	\$253,924
	MC3A07	20	80	80	2283	LF	\$ 38.00	\$ 86,754.00	110	9.96	\$35,000	\$348,530	\$21,179	\$456,463
	MC3A08	20	80	80	1520	LF	\$ 38.00	\$ 57,760.00	110	6.63	\$35,000	\$232,048	\$14,101	\$303,909
	MC3A09	20	80	80	1473	LF	\$ 38.00	\$ 55,974.00	110	6.42	\$35,000	\$224,873	\$13,665	\$294,511
	MC3A10	20	80	80	3020	LF	\$ 38.00	\$ 114,760.00	110	13.17	\$35,000	\$461,042	\$28,016	\$603,818
	MC3A11	20	80	80	1639	LF	\$ 38.00	\$ 62,282.00	110	7.15	\$35,000	\$250,215	\$15,205	\$327,701
	MC3A12	20	80	80	1103	LF	\$ 38.00	\$ 41,914.00	110	4.81	\$35,000	\$168,387	\$10,232	\$220,534
	MC3A13	20	80	80	2622	LF	\$ 38.00	\$ 99,636.00	110	11.44	\$35,000	\$400,282	\$24,324	\$524,242
	MC3A14	20	80	80	2429	LF	\$ 38.00	\$ 92,302.00	110	10.59	\$35,000	\$370,818	\$22,533	\$485,654
	MC3A15	20	80	80	1488	LF	\$ 38.00	\$ 56,544.00	110	6.49	\$35,000	\$227,163	\$13,804	\$297,511
	MC3A16	20	80	80	353	LF	\$ 38.00	\$ 13,414.00	110	1.54	\$35,000	\$53,890	\$3,275	\$70,579
	MC3A17	20	80	80	100	LF	\$ 38.00	\$ 3,800.00	110	0.44	\$35,000	\$15,266	\$928	\$19,994
	MC3A18	20	80	80	444	LF	\$ 38.00	\$ 16,872.00	110	1.94	\$35,000	\$67,782	\$4,119	\$88,773
	MC3A19	20	80	80	1902	LF	\$ 38.00	\$ 72,276.00	110	8.30	\$35,000	\$290,365	\$17,645	\$380,286
	MC3A20	20	80	80	2171	LF	\$ 38.00	\$ 82,498.00	110	9.47	\$35,000	\$331,431	\$20,140	\$434,069
	MC3A21	20	80	80	1406	LF	\$ 38.00	\$ 53,428.00	110	6.13	\$35,000	\$214,644	\$13,043	\$281,115
	MC3A22	20	80	80	410	LF	\$ 38.00	\$ 15,580.00	110	1.79	\$35,000	\$62,592	\$3,804	\$81,975
	MC3A23	20	80	80	3887	LF	\$ 38.00	\$ 147,706.00	110	16.95	\$35,000	\$593,401	\$36,059	\$777,166
	MC3A25	20	80	80	1400	LF	\$ 38.00	\$ 53,200.00	110	6.11	\$35,000	\$213,728	\$12,988	\$279,916
	MC3A25	20	80	80	1400	LF	\$ 38.00	\$ 53,200.00	110	6.11	\$35,000	\$213,728	\$12,988	\$279,916
	MC3A25	20	80	80	1400	LF	\$ 38.00	\$ 53,200.00	110	6.11	\$35,000	\$213,728	\$12,988	\$279,916
	MC3A26	40	100	100	1228	LF	\$ 52.00	\$ 63,856.00	110	5.92	\$35,000	\$207,204	\$14,211	\$285,271
	MC3A26	20	80	80	1228	LF	\$ 38.00	\$ 46,664.00	110	5.36	\$35,000	\$187,470	\$11,392	\$245,526
	MC3A27	40	100	100	527	LF	\$ 52.00	\$ 27,404.00	110	2.54	\$35,000	\$88,922	\$6,099	\$122,425
	MC3A27	20	80	80	527	LF	\$ 38.00	\$ 20,026.00	110	2.30	\$35,000	\$80,453	\$4,889	\$105,368
	MC3A28	40	100	100	956	LF	\$ 52.00	\$ 49,712.00	110	4.61	\$35,000	\$161,309	\$11,063	\$222,084
	MC3A29	40	100	100	5642	LF	\$ 52.00	\$ 293,384.00	110	27.20	\$35,000	\$951,990	\$65,292	\$1,310,667
	MC3A30	20	80	80	1147	LF	\$ 38.00	\$ 43,586.00	110	5.00	\$35,000	\$175,104	\$10,641	\$229,331
	MC3A32	20	80	80	2345	LF	\$ 38.00	\$ 89,110.00	110	10.23	\$35,000	\$357,995	\$21,754	\$468,859
	MCH15A	20	80	80	7638	LF	\$ 38.00	\$ 290,244.00	110	33.32	\$35,000	\$1,166,040	\$70,857	\$1,527,141
	MCH18	20	80	80	15850	LF	\$ 38.00	\$ 602,300.00	110	69.13	\$35,000	\$2,419,708	\$147,038	\$3,169,047
	MCH22	60	120	120	5127	LF	\$ 67.00	\$ 343,509.00	110	27.07	\$35,000	\$947,483	\$71,102	\$1,362,094
	MCH23	60	120	120	6299	LF	\$ 67.00	\$ 422,033.00	110	33.26	\$35,000	\$1,164,071	\$87,356	\$1,673,460
	MCH33	20	80	80	5482	LF	\$ 38.00	\$ 208,316.00	110	23.91	\$35,000	\$836,899	\$50,856	\$1,096,070
	MCH35	20	80	80	5238	LF	\$ 38.00	\$ 199,044.00	110	22.85	\$35,000	\$799,649	\$48,592	\$1,047,285
	MCH35A	20	80	80	3391	LF	\$ 38.00	\$ 128,858.00	110	14.79	\$35,000	\$517,680	\$31,458	\$677,996
	MCH35A	20	80	80	3391	LF	\$ 38.00	\$ 128,858.00	110	14.79	\$35,000	\$517,680	\$31,458	\$677,996
	MCH37	20	80	80	7700	LF	\$ 38.00	\$ 292,600.00	110	33.59	\$35,000	\$1,175,505	\$71,432	\$1,539,537
	MCH42	20	80	80	5959	LF	\$ 38.00	\$ 226,442.00	110	25.99	\$35,000	\$909,719	\$55,281	\$1,191,442
	MCH47	20	80	80	5618	LF	\$ 38.00	\$ 213,484.00	110	24.50	\$35,000	\$857,661	\$52,117	\$1,123,262
	MCH53B	40	100	100	4227	LF	\$ 52.00	\$ 219,804.00	110	20.38	\$35,000	\$713,233	\$48,917	\$981,955
	MCH54	40	100	100	2624	LF	\$ 52.00	\$ 136,448.00	110	12.65	\$35,000	\$442,755	\$30,366	\$609,569
	MCH62	40	100	100	3967	LF	\$ 52.00	\$ 206,284.00	110	19.12	\$35,000	\$669,363	\$45,908	\$921,555
	MCH63	40	100	100	6006	LF	\$ 52.00	\$ 312,312.00	110	28.95	\$35,000	\$1,013,409	\$69,505	\$1,395,226
MCH73	40	100	100	5311	LF	\$ 52.00	\$ 276,172.00	110	25.60	\$35,000	\$896,140	\$61,462	\$1,233,774	
MCH75	20	80	80	5356	LF	\$ 38.00	\$ 203,528.00	110	23.36	\$35,000	\$817,663	\$49,687	\$1,070,878	
MCH76	20	80	80	871	LF	\$ 38.00	\$ 33,098.00	110	3.80	\$35,000	\$132,969	\$8,080	\$174,148	
MCI04	20	80	80	1317	LF	\$ 38.00	\$ 50,046.00	110	5.74	\$35,000	\$201,057	\$12,218	\$263,321	
MCI04A	20	80	80	2187	LF	\$ 38.00	\$ 83,106.00	110	9.54	\$35,000	\$333,874	\$20,288	\$437,268	
MCI05	20	80	80	3786	LF	\$ 38.00	\$ 143,868.00	110	16.51	\$35,000	\$577,982	\$35,122	\$756,972	
MCI06	20	80	80	6105	LF	\$ 38.00	\$ 231,990.00	110	26.63	\$35,000	\$932,008	\$56,635	\$1,220,633	
MCI08	20	80	80	5225	LF	\$ 38.00	\$ 198,550.00	110	22.79	\$35,000	\$797,664	\$48,472	\$1,044,686	
MCI10	20	80	80	5266	LF	\$ 38.00	\$ 200,108.00	110	22.97	\$35,000	\$803,923	\$48,852	\$1,052,883	
MCI12	20	80	80	5222	LF	\$ 38.00	\$ 198,436.00	110	22.78	\$35,000	\$797,206	\$48,444	\$1,044,086	
MCI13	20	80	80	2549	LF	\$ 38.00	\$ 96,862.00	110	11.12	\$35,000	\$389,138	\$23,647	\$509,647	
MCI25	20	80	80	2772	LF	\$ 38.00	\$ 105,336.00	110	12.09	\$35,000	\$423,182	\$25,715	\$554,233	
MCI26A	20	80	80	5177	LF	\$ 38.00	\$ 196,726.00	110	22.58	\$35,000	\$790,336	\$48,026	\$1,035,089	
MCI28	20	80	80	4592	LF	\$ 38.00	\$ 174,496.00	110	20.03	\$35,000	\$701,028	\$42,599	\$918,124	
MCI30	20	80	80	5276	LF	\$ 38.00	\$ 200,488.00	110	23.01	\$35,000	\$805,450	\$48,945	\$1,054,883	
MCI32	20	80	80	5291	LF	\$ 38.00	\$ 201,058.00	110	23.08	\$35,000	\$807,740	\$49,084	\$1,057,882	
MCI34	20	80	80	965	LF	\$ 38.00	\$ 36,670.00	110	4.21	\$35,000	\$147,320	\$8,952	\$192,942	
MCI38	20	80	80	5144	LF	\$ 38.00	\$ 195,472.00	110	22.44	\$35,000	\$785,298	\$47,720	\$1,028,491	
MCI40	20	80	80	5154	LF	\$ 38.00	\$ 195,852.00	110	22.48	\$35,000	\$786,825	\$47,813	\$1,030,490	
MCI41	20	80	80	5252	LF	\$ 38.00	\$ 199,576.00	110	22.91	\$35,000	\$801,786	\$48,722	\$1,050,084	
MCI42	20	80	80	5329	LF	\$ 38.00	\$ 202,502.00	110	23.24	\$35,000	\$813,541	\$49,436	\$1,065,479	
MCI43	20	80	80	2760	LF	\$ 38.00	\$ 104,880.00	110	12.04	\$35,000	\$421,350	\$25,604	\$551,834	
MCI49	20	80	80	4255	LF	\$ 38.00	\$ 161,690.00	110	18.56	\$35,000	\$649,581	\$39,473	\$850,744	
	SUB-TOTAL						ALT 3A	\$ 9,885,710.00						\$49,762,953

ALTERNATIVE 3 DETAILED COST ESTIMATE

URS Corporation

Planning Unit	Item Description	Quantity	Channel Bottom Width, ft	Channel Top Width, ft	Length	Unit	Unit Cost	Excavation Cost	ROW Width, ft	ROW Area, acres	ROW cost per acre	ROW Cost	Landscaping Cost*	Total Cost
ESTRELLA ALT 2	MC3A01		20	80	552	LF	\$ 38.00	\$ 20,976.00	110	2.41	\$35,000	\$84,270	\$5,121	\$110,367
	MC3A02		20	80	3701	LF	\$ 38.00	\$ 140,838.00	110	16.14	\$35,000	\$565,006	\$34,334	\$739,977
	MC3A03		20	80	1409	LF	\$ 38.00	\$ 53,542.00	110	6.15	\$35,000	\$215,102	\$13,071	\$281,715
	MC3A04		20	80	1354	LF	\$ 38.00	\$ 51,452.00	110	5.91	\$35,000	\$205,706	\$12,561	\$270,719
	MC3A05		20	80	2183	LF	\$ 38.00	\$ 82,954.00	110	9.52	\$35,000	\$333,263	\$20,251	\$436,469
	MC3A06		20	80	1270	LF	\$ 38.00	\$ 48,260.00	110	5.54	\$35,000	\$193,882	\$11,782	\$253,924
	MC3A07		20	80	2283	LF	\$ 38.00	\$ 86,754.00	110	9.96	\$35,000	\$348,530	\$21,179	\$456,463
	MC3A08		20	80	1520	LF	\$ 38.00	\$ 57,760.00	110	6.63	\$35,000	\$232,048	\$14,101	\$303,909
	MC3A09		20	80	1473	LF	\$ 38.00	\$ 55,974.00	110	6.42	\$35,000	\$224,873	\$13,665	\$294,511
	MC3A10		20	80	3020	LF	\$ 38.00	\$ 114,760.00	110	13.17	\$35,000	\$461,042	\$28,016	\$603,818
	MC3A11		20	80	1639	LF	\$ 38.00	\$ 62,282.00	110	7.15	\$35,000	\$250,215	\$15,205	\$327,701
	MC3A12		20	80	1103	LF	\$ 38.00	\$ 41,914.00	110	4.81	\$35,000	\$168,387	\$10,232	\$220,534
	MC3A13		20	80	2622	LF	\$ 38.00	\$ 99,636.00	110	11.44	\$35,000	\$400,282	\$24,324	\$524,242
	MC3A14		20	80	2429	LF	\$ 38.00	\$ 92,302.00	110	10.59	\$35,000	\$370,818	\$22,533	\$485,654
	MC3A15		20	80	1488	LF	\$ 38.00	\$ 56,544.00	110	6.49	\$35,000	\$227,163	\$13,804	\$297,511
	MC3A16		20	80	353	LF	\$ 38.00	\$ 13,414.00	110	1.54	\$35,000	\$53,890	\$3,275	\$70,579
	MC3A17		20	80	100	LF	\$ 38.00	\$ 3,800.00	110	0.44	\$35,000	\$15,266	\$928	\$19,994
	MC3A18		20	80	444	LF	\$ 38.00	\$ 16,872.00	110	1.94	\$35,000	\$67,782	\$4,119	\$88,773
	MC3A19		20	80	1902	LF	\$ 38.00	\$ 72,276.00	110	8.30	\$35,000	\$290,365	\$17,645	\$380,286
	MC3A20		20	80	2171	LF	\$ 38.00	\$ 82,498.00	110	9.47	\$35,000	\$331,431	\$20,140	\$434,069
	MC3A21		20	80	1406	LF	\$ 38.00	\$ 53,428.00	110	6.13	\$35,000	\$214,644	\$13,043	\$281,115
	MC3A22		20	80	410	LF	\$ 38.00	\$ 15,580.00	110	1.79	\$35,000	\$62,592	\$3,804	\$81,975
	MC3A23		20	80	3887	LF	\$ 38.00	\$ 147,706.00	110	16.95	\$35,000	\$593,401	\$36,059	\$777,166
	MC3A25		20	80	1400	LF	\$ 38.00	\$ 53,200.00	110	6.11	\$35,000	\$213,728	\$12,988	\$279,916
	MC3A25		20	80	1400	LF	\$ 38.00	\$ 53,200.00	110	6.11	\$35,000	\$213,728	\$12,988	\$279,916
	MC3A25		20	80	1400	LF	\$ 38.00	\$ 53,200.00	110	6.11	\$35,000	\$213,728	\$12,988	\$279,916
	MC3A26		40	100	1228	LF	\$ 52.00	\$ 63,856.00	110	5.92	\$35,000	\$207,204	\$14,211	\$285,271
	MC3A26		20	80	1228	LF	\$ 38.00	\$ 46,664.00	110	5.36	\$35,000	\$187,470	\$11,392	\$245,526
	MC3A27		40	100	527	LF	\$ 52.00	\$ 27,404.00	110	2.54	\$35,000	\$88,922	\$6,099	\$122,425
	MC3A27		20	80	527	LF	\$ 38.00	\$ 20,026.00	110	2.30	\$35,000	\$80,453	\$4,889	\$105,368
	MC3A28		40	100	956	LF	\$ 52.00	\$ 49,712.00	110	4.61	\$35,000	\$161,309	\$11,063	\$222,084
	MC3A29		40	100	5642	LF	\$ 52.00	\$ 293,384.00	110	27.20	\$35,000	\$951,990	\$65,292	\$1,310,667
	MC3A30		20	80	1147	LF	\$ 38.00	\$ 43,586.00	110	5.00	\$35,000	\$175,104	\$10,641	\$229,331
	MC3A32		20	80	2345	LF	\$ 38.00	\$ 89,110.00	110	10.23	\$35,000	\$357,995	\$21,754	\$468,859
	MCH15A		20	80	7638	LF	\$ 38.00	\$ 290,244.00	110	33.32	\$35,000	\$1,166,040	\$70,857	\$1,527,141
	MCH18		20	80	15850	LF	\$ 38.00	\$ 602,300.00	110	69.13	\$35,000	\$2,419,708	\$147,038	\$3,169,047
	MCH22		60	120	5127	LF	\$ 67.00	\$ 343,509.00	110	27.07	\$35,000	\$947,483	\$71,102	\$1,362,094
	MCH23		60	120	6299	LF	\$ 67.00	\$ 422,033.00	110	33.26	\$35,000	\$1,164,071	\$87,356	\$1,673,460
	MCH33		20	80	5482	LF	\$ 38.00	\$ 208,316.00	110	23.91	\$35,000	\$836,899	\$50,856	\$1,096,070
	MCH35		20	80	5238	LF	\$ 38.00	\$ 199,044.00	110	22.85	\$35,000	\$799,649	\$48,592	\$1,047,285
	MCH35A		20	80	3391	LF	\$ 38.00	\$ 128,858.00	110	14.79	\$35,000	\$517,680	\$31,458	\$677,996
	MCH35A		20	80	3391	LF	\$ 38.00	\$ 128,858.00	110	14.79	\$35,000	\$517,680	\$31,458	\$677,996
	MCH37		20	80	7700	LF	\$ 38.00	\$ 292,600.00	110	33.59	\$35,000	\$1,175,505	\$71,432	\$1,539,537
	MCH42		20	80	5959	LF	\$ 38.00	\$ 226,442.00	110	25.99	\$35,000	\$909,719	\$55,281	\$1,191,442
	MCH47		20	80	5618	LF	\$ 38.00	\$ 213,484.00	110	24.50	\$35,000	\$857,661	\$52,117	\$1,123,262
	MCH53B		40	100	4227	LF	\$ 52.00	\$ 219,804.00	110	20.38	\$35,000	\$713,233	\$48,917	\$981,955
	MCH54		40	100	2624	LF	\$ 52.00	\$ 136,448.00	110	12.65	\$35,000	\$442,755	\$30,366	\$609,569
	MCH62		40	100	3967	LF	\$ 52.00	\$ 206,284.00	110	19.12	\$35,000	\$669,363	\$921,555	\$921,555
	MCH63		40	100	6006	LF	\$ 52.00	\$ 312,312.00	110	28.95	\$35,000	\$1,013,409	\$69,505	\$1,395,226
MCH73		40	100	5311	LF	\$ 52.00	\$ 276,172.00	110	25.60	\$35,000	\$896,140	\$61,462	\$1,233,774	
MCH75		20	80	5356	LF	\$ 38.00	\$ 203,528.00	110	23.36	\$35,000	\$817,663	\$49,687	\$1,070,878	
MCH76		20	80	871	LF	\$ 38.00	\$ 33,096.00	110	3.80	\$35,000	\$132,969	\$8,080	\$174,148	
MCI04		20	80	1317	LF	\$ 38.00	\$ 50,046.00	110	5.74	\$35,000	\$201,057	\$12,218	\$263,321	
MCI04A		20	80	2187	LF	\$ 38.00	\$ 83,106.00	110	9.54	\$35,000	\$333,874	\$20,288	\$437,268	
MCI05		20	80	3786	LF	\$ 38.00	\$ 143,868.00	110	16.51	\$35,000	\$577,982	\$35,122	\$756,972	
MCI06		20	80	6105	LF	\$ 38.00	\$ 231,990.00	110	26.63	\$35,000	\$932,008	\$56,635	\$1,220,633	
MCI08		20	80	5225	LF	\$ 38.00	\$ 198,550.00	110	22.79	\$35,000	\$797,664	\$48,472	\$1,044,686	
MCI10		20	80	5266	LF	\$ 38.00	\$ 200,108.00	110	22.97	\$35,000	\$803,923	\$48,852	\$1,052,883	
MCI12		20	80	5222	LF	\$ 38.00	\$ 198,436.00	110	22.78	\$35,000	\$797,206	\$48,444	\$1,044,086	
MCI13		20	80	2549	LF	\$ 38.00	\$ 96,862.00	110	11.12	\$35,000	\$389,138	\$23,647	\$509,647	
MCI25		20	80	2772	LF	\$ 38.00	\$ 105,336.00	110	12.09	\$35,000	\$423,182	\$25,715	\$554,233	
MCI26A		20	80	5177	LF	\$ 38.00	\$ 196,726.00	110	22.58	\$35,000	\$790,362	\$48,026	\$1,035,089	
MCI28		20	80	4592	LF	\$ 38.00	\$ 174,496.00	110	20.03	\$35,000	\$701,028	\$42,599	\$918,124	
MCI30		20	80	5276	LF	\$ 38.00	\$ 200,488.00	110	23.01	\$35,000	\$805,450	\$48,945	\$1,054,883	
MCI32		20	80	5291	LF	\$ 38.00	\$ 201,058.00	110	23.08	\$35,000	\$807,740	\$49,084	\$1,057,882	
MCI34		20	80	965	LF	\$ 38.00	\$ 36,670.00	110	4.21	\$35,000	\$147,320	\$8,952	\$192,942	
MCI39		20	80	5144	LF	\$ 38.00	\$ 195,472.00	110	22.44	\$35,000	\$785,298	\$47,720	\$1,028,491	
MCI40		20	80	5154	LF	\$ 38.00	\$ 195,852.00	110	22.48	\$35,000	\$786,825	\$47,813	\$1,030,490	
MCI41		20	80	5252	LF	\$ 38.00	\$ 199,576.00	110	22.91	\$35,000	\$801,786	\$48,722	\$1,050,084	
MCI42		20	80	5329	LF	\$ 38.00	\$ 202,502.00	110	23.24	\$35,000	\$813,541	\$49,436	\$1,065,479	
MCI43		20	80	2760	LF	\$ 38.00	\$ 104,880.00	110	12.04	\$35,000	\$421,350	\$25,604	\$551,834	
MCI49		20	80	4255	LF	\$ 38.00	\$ 161,690.00	110	18.56	\$35,000	\$649,581	\$39,473	\$850,744	
	SUB-TOTAL						ALT 3B	\$ 9,885,710.00						\$49,762,953

ALTERNATIVE 3 DETAILED COST ESTIMATE

URS Corporation

Planning Unit	Item Description	Quantity	Channel Bottom Width, ft	Channel Top Width, ft	Length	Unit	Unit Cost	Excavation Cost	ROW Width ¹ , ft	ROW Area ¹ , acres	ROW cost per acre	ROW Cost	Landscaping Cost ¹	Total Cost
ESTRELLA ALT 3	MC3A01	40	40	100	552	LF	\$ 52.00	\$ 28,704.00	110	2.66	\$35,000	\$93,140	\$6,388	\$128,233
	MC3A02	40	40	100	3701	LF	\$ 52.00	\$ 192,452.00	110	17.84	\$35,000	\$624,480	\$42,830	\$859,762
	MC3A03	40	40	100	1409	LF	\$ 52.00	\$ 73,268.00	110	6.79	\$35,000	\$237,744	\$16,306	\$327,318
	MC3A04	40	40	100	1354	LF	\$ 52.00	\$ 70,408.00	110	6.53	\$35,000	\$228,464	\$15,669	\$314,541
	MC3A05	40	40	100	2183	LF	\$ 52.00	\$ 113,516.00	110	10.52	\$35,000	\$368,344	\$25,263	\$507,123
	MC3A06	40	40	100	1270	LF	\$ 52.00	\$ 66,040.00	110	6.12	\$35,000	\$214,291	\$14,697	\$295,028
	MC3A07	40	40	100	2283	LF	\$ 52.00	\$ 118,716.00	110	11.01	\$35,000	\$385,217	\$26,420	\$530,353
	MC3A08	40	40	100	1520	LF	\$ 52.00	\$ 79,040.00	110	7.33	\$35,000	\$256,474	\$17,590	\$353,104
	MC3A09	40	40	100	1473	LF	\$ 52.00	\$ 76,596.00	110	7.10	\$35,000	\$248,543	\$17,046	\$342,186
	MC3A10	60	120	3020	LF	\$ 67.00	\$ 202,340.00	110	15.95	\$35,000	\$558,104	\$41,882	\$802,326	
	MC3A11	60	120	1639	LF	\$ 67.00	\$ 109,813.00	110	8.65	\$35,000	\$302,891	\$22,730	\$435,434	
	MC3A12	80	140	1103	LF	\$ 82.00	\$ 90,446.00	110	6.33	\$35,000	\$221,562	\$17,829	\$329,837	
	MC3A13	80	140	2622	LF	\$ 82.00	\$ 215,004.00	110	15.05	\$35,000	\$526,687	\$42,382	\$784,073	
	MC3A14	80	140	2429	LF	\$ 82.00	\$ 199,178.00	110	13.94	\$35,000	\$487,919	\$39,262	\$726,359	
	MC3A15	80	140	1488	LF	\$ 82.00	\$ 122,016.00	110	8.54	\$35,000	\$298,898	\$24,052	\$444,966	
	MC3A16	80	140	353	LF	\$ 82.00	\$ 28,946.00	110	2.03	\$35,000	\$70,908	\$5,706	\$105,560	
	MC3A17	80	140	100	LF	\$ 82.00	\$ 8,200.00	110	0.57	\$35,000	\$20,087	\$1,616	\$29,904	
	MC3A18	80	140	444	LF	\$ 82.00	\$ 36,408.00	110	2.55	\$35,000	\$89,187	\$7,177	\$132,772	
	MC3A19	80	140	1902	LF	\$ 82.00	\$ 155,964.00	110	10.92	\$35,000	\$382,059	\$30,744	\$568,767	
	MC3A20	80	140	2171	LF	\$ 82.00	\$ 178,022.00	110	12.46	\$35,000	\$436,094	\$35,092	\$649,208	
	MC3A21	80	140	1406	LF	\$ 82.00	\$ 115,292.00	110	8.07	\$35,000	\$282,427	\$22,726	\$420,445	
	MC3A22	80	140	410	LF	\$ 82.00	\$ 33,620.00	110	2.35	\$35,000	\$82,358	\$6,627	\$122,605	
	MC3A23	80	140	3887	LF	\$ 82.00	\$ 318,734.00	110	22.31	\$35,000	\$780,791	\$62,829	\$1,162,354	
	MC3A25	20	80	1400	LF	\$ 38.00	\$ 53,200.00	110	6.11	\$35,000	\$213,728	\$12,988	\$279,916	
	MC3A25	20	80	1400	LF	\$ 38.00	\$ 53,200.00	110	6.11	\$35,000	\$213,728	\$12,988	\$279,916	
	MC3A25	20	80	1400	LF	\$ 38.00	\$ 53,200.00	110	6.11	\$35,000	\$213,728	\$12,988	\$279,916	
	MC3A26	20	80	1228	LF	\$ 38.00	\$ 46,664.00	110	5.36	\$35,000	\$187,470	\$11,392	\$245,526	
	MC3A26	20	80	1228	LF	\$ 38.00	\$ 46,664.00	110	5.36	\$35,000	\$187,470	\$11,392	\$245,526	
	MC3A27	20	80	527	LF	\$ 38.00	\$ 20,026.00	110	2.30	\$35,000	\$80,453	\$4,889	\$105,368	
	MC3A27	20	80	527	LF	\$ 38.00	\$ 20,026.00	110	2.30	\$35,000	\$80,453	\$4,889	\$105,368	
	MC3A28	60	120	956	LF	\$ 67.00	\$ 64,052.00	110	5.05	\$35,000	\$176,671	\$13,258	\$253,981	
	MC3A29	60	120	5642	LF	\$ 67.00	\$ 378,014.00	110	29.79	\$35,000	\$1,042,656	\$78,245	\$1,498,915	
	MC3A30	20	80	1147	LF	\$ 38.00	\$ 43,586.00	110	5.00	\$35,000	\$175,104	\$10,641	\$229,331	
	MC3A32	20	80	2345	LF	\$ 38.00	\$ 89,110.00	110	10.23	\$35,000	\$357,995	\$21,754	\$468,859	
	MCH15A	20	80	7638	LF	\$ 38.00	\$ 290,244.00	110	33.32	\$35,000	\$1,166,040	\$70,857	\$1,527,141	
	MCH18	20	80	15850	LF	\$ 38.00	\$ 602,300.00	110	69.13	\$35,000	\$2,419,708	\$147,038	\$3,169,047	
	MCH22	80	140	5127	LF	\$ 82.00	\$ 420,414.00	110	29.42	\$35,000	\$1,029,873	\$82,872	\$1,533,159	
	MCH23	80	140	6299	LF	\$ 82.00	\$ 516,518.00	110	36.15	\$35,000	\$1,265,295	\$101,816	\$1,883,629	
	MCH33	20	80	5482	LF	\$ 38.00	\$ 208,316.00	110	23.91	\$35,000	\$836,899	\$50,856	\$1,096,070	
	MCH35	20	80	5238	LF	\$ 38.00	\$ 199,044.00	110	22.85	\$35,000	\$799,649	\$48,592	\$1,047,285	
	MCH35A	20	80	3391	LF	\$ 38.00	\$ 128,858.00	110	14.79	\$35,000	\$517,680	\$31,458	\$677,996	
	MCH35A	20	80	3391	LF	\$ 38.00	\$ 128,858.00	110	14.79	\$35,000	\$517,680	\$31,458	\$677,996	
	MCH37	20	80	7700	LF	\$ 38.00	\$ 292,600.00	110	33.59	\$35,000	\$1,175,505	\$71,432	\$1,539,537	
	MCH42	20	80	5959	LF	\$ 38.00	\$ 226,442.00	110	25.99	\$35,000	\$909,719	\$55,281	\$1,191,442	
	MCH47	20	80	5618	LF	\$ 38.00	\$ 213,484.00	110	24.50	\$35,000	\$857,661	\$52,117	\$1,123,262	
	MCH53B	40	100	4227	LF	\$ 52.00	\$ 219,804.00	110	20.38	\$35,000	\$713,233	\$48,917	\$981,955	
	MCH54	40	100	2624	LF	\$ 52.00	\$ 136,448.00	110	12.65	\$35,000	\$442,755	\$30,366	\$609,569	
	MCH62	80	140	3967	LF	\$ 82.00	\$ 325,294.00	110	22.77	\$35,000	\$796,861	\$64,122	\$1,186,277	
MCH63	40	100	6006	LF	\$ 52.00	\$ 312,312.00	110	28.95	\$35,000	\$1,013,409	\$69,505	\$1,395,226		
MCH73	40	100	5311	LF	\$ 52.00	\$ 276,172.00	110	25.60	\$35,000	\$896,140	\$61,462	\$1,233,774		
MCH75	20	80	5356	LF	\$ 38.00	\$ 203,528.00	110	23.36	\$35,000	\$817,663	\$49,687	\$1,070,878		
MCH76	20	80	871	LF	\$ 38.00	\$ 33,098.00	110	3.80	\$35,000	\$132,969	\$8,080	\$174,148		
MCI04	20	80	1317	LF	\$ 38.00	\$ 50,046.00	110	5.74	\$35,000	\$201,057	\$12,218	\$263,321		
MCI04A	20	80	2187	LF	\$ 38.00	\$ 83,106.00	110	9.54	\$35,000	\$333,874	\$20,288	\$437,268		
MCI05	20	80	3786	LF	\$ 38.00	\$ 143,868.00	110	16.51	\$35,000	\$577,982	\$35,122	\$756,972		
MCI06	20	80	6105	LF	\$ 38.00	\$ 231,990.00	110	26.63	\$35,000	\$932,008	\$56,635	\$1,220,633		
MCI08	20	80	5225	LF	\$ 38.00	\$ 198,550.00	110	22.79	\$35,000	\$797,664	\$48,472	\$1,044,686		
MCI10	20	80	5266	LF	\$ 38.00	\$ 200,108.00	110	22.97	\$35,000	\$803,923	\$48,852	\$1,052,883		
MCI12	20	80	5222	LF	\$ 38.00	\$ 198,436.00	110	22.78	\$35,000	\$797,206	\$48,444	\$1,044,086		
MCI13	20	80	2549	LF	\$ 38.00	\$ 96,862.00	110	11.12	\$35,000	\$389,138	\$23,647	\$509,647		
MCI25	20	80	2772	LF	\$ 38.00	\$ 105,336.00	110	12.09	\$35,000	\$423,182	\$25,715	\$554,233		
MCI26A	20	80	5177	LF	\$ 38.00	\$ 196,726.00	110	22.58	\$35,000	\$790,336	\$48,026	\$1,035,089		

ALTERNATIVE 3 DETAILED COST ESTIMATE

URS Corporation

Planning Unit	Item Description	Quantity	Channel Bottom Width, ft	Channel Top Width, ft	Length	Unit	Unit Cost	Excavation Cost	ROW Width ¹ , ft	ROW Area ² , acres	ROW cost per acre	ROW Cost	Landscaping Cost ³	Total Cost
	MCI28		20	80	4592	LF	\$ 38.00	\$ 174,496.00	110	20.03	\$35,000	\$701,028	\$42,599	\$918,124
	MCI30		20	80	5276	LF	\$ 38.00	\$ 200,488.00	110	23.01	\$35,000	\$805,450	\$48,945	\$1,054,883
	MCI32		20	80	5291	LF	\$ 38.00	\$ 201,058.00	110	23.08	\$35,000	\$807,740	\$49,084	\$1,057,822
	MCI34		20	80	965	LF	\$ 38.00	\$ 36,670.00	110	4.21	\$35,000	\$147,320	\$8,952	\$192,942
	MCI39		20	80	5144	LF	\$ 38.00	\$ 195,472.00	110	22.44	\$35,000	\$785,298	\$47,720	\$1,028,491
	MCI40		20	80	5154	LF	\$ 38.00	\$ 195,852.00	110	22.48	\$35,000	\$786,825	\$47,813	\$1,030,490
	MCI41		20	80	5252	LF	\$ 38.00	\$ 199,576.00	110	22.91	\$35,000	\$801,786	\$48,722	\$1,050,084
	MCI42		20	80	5329	LF	\$ 38.00	\$ 202,502.00	110	23.24	\$35,000	\$813,541	\$49,436	\$1,065,479
	MCI43		20	80	2760	LF	\$ 38.00	\$ 104,880.00	110	12.04	\$35,000	\$421,350	\$25,604	\$551,834
	MCI49		20	80	4255	LF	\$ 38.00	\$ 161,690.00	110	18.56	\$35,000	\$649,581	\$39,473	\$850,744
	SUB-TOTAL						ALT 3C	\$ 11,411,911.00						\$53,203,038

Total w/ ALT 3A	\$ 16,507,670.00													\$81,609,180
Total w/ ALT 3B	\$ 16,507,670.00													\$81,609,180
Total w/ ALT 3C	\$ 18,033,871.00													\$85,049,265

Total w/ ALT 3A and Contingency (30%)														\$106,091,934
Total w/ ALT 3B and Contingency (30%)														\$106,091,934
Total w/ ALT 3C and Contingency (30%)														\$110,564,045

¹ Proposed ROW is based on a 40'-wide landscape setback on each side plus an additional 15' on each side for access roads for a total of 55' per side and 110' total.

² Landscaping Costs- from RVADMP Costing Criteria Narrative 2009, from EPG, date 11-30-2009; Channel \$5000.00/acre, Basins \$4250.00/acre, does not include 30' of access road or the 80' landscape setback required for channels; Channel side slopes to be hydro seeded 5ft depth 6:1 side slope requires a sideslope width of 30.41' plus the channel bottom width (varies).

³ ROW Area includes the top width of the channel and the additional ROW required for access roads and landscaping setback, multiplied by the channel length

ALTERNATIVE 4 DETAILED COST ESTIMATE

URS Corporation

Planning Unit	Item Description	Quantity	Channel Bottom Width, ft	Channel Top Width, ft	Length	Unit	Unit Cost	Excavation Cost	ROW Width ¹ , ft	ROW Area ² , acres	ROW cost per acre	ROW Cost	Landscape Costs ³	Total Cost	
MOBILE	PNDF18	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108	
	RCPF18		20	80	1300	LF	\$38	\$49,400	110	5.67	\$35,000	\$198,462	\$12,060	\$259,922	
	PNDF24	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108	
	RCPF24		10	70	4490	LF	\$30	\$134,700	110	18.55	\$35,000	\$649,380	\$36,499	\$820,579	
	PNDE31	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108	
	RPDE31		10	70	387	LF	\$30	\$11,610	110	1.60	\$35,000	\$55,971	\$3,146	\$70,727	
	PNDE38	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108	
	RPDE38		10	70	900	LF	\$30	\$27,000	110	3.72	\$35,000	\$130,165	\$7,316	\$164,481	
	PNDE25	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108	
	RPDE25		10	70	850	LF	\$30	\$25,500	110	3.51	\$35,000	\$122,034	\$6,910	\$155,344	
	PNDF26	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108	
	RPDF26		10	70	1000	LF	\$30	\$30,000	110	4.13	\$35,000	\$144,628	\$8,129	\$182,757	
	PNDF27	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108	
	SUB-TOTAL							\$4,326,714				\$8,896,540	\$131,750	\$14,219,565	
SONORA	PND34	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108	
	RCPD34		20	80	930	LF	\$38	\$35,340	110	4.06	\$35,000	\$141,977	\$8,627	\$185,944	
	PND38	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108	
	RCPD38		20	80	590	LF	\$38	\$22,420	110	2.57	\$35,000	\$90,071	\$5,473	\$117,965	
	PND37A	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108	
	RCD37A		20	80	1700	LF	\$38	\$64,600	110	7.42	\$35,000	\$259,527	\$15,771	\$339,898	
	PND37	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108	
	RCPD37		20	80	7440	LF	\$38	\$282,720	110	32.45	\$35,000	\$1,135,813	\$69,020	\$1,487,553	
	SUB-TOTAL							\$2,718,511				\$5,967,388	\$131,750	\$9,311,790	
	PND811	1					EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108
	RCPB11		20	80	4700	LF	\$38	\$178,600	110	20.50	\$35,000	\$717,516	\$43,601	\$939,717	
	RCPB21		50	110	3720	LF	\$60	\$223,200	110	18.79	\$35,000	\$657,576	\$47,320	\$928,096	
	PND845	1					EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108
	RCPB45		30	90	3450	LF	\$45	\$155,250	110	15.84	\$35,000	\$554,408	\$35,965	\$745,623	
	SUB-TOTAL							\$1,713,766				\$4,099,500	\$131,750	\$6,203,651	
	PND818	1					EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108
	RCPB18		50	110	641	LF	\$60	\$38,460	110	3.24	\$35,000	\$113,308	\$8,154	\$159,922	
	PND839	1					EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108
	RCPB39		50	110	5673	LF	\$60	\$340,380	110	28.65	\$35,000	\$1,002,803	\$72,163	\$1,415,346	
	PND865	1					EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108
	RCPB65		50	110	600	LF	\$60	\$36,000	110	3.03	\$35,000	\$106,061	\$7,632	\$149,693	
	PND830	1					EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108
	RCPB30		50	110	5049	LF	\$60	\$302,940	110	12.75	\$35,000	\$446,250	\$64,225	\$813,415	
	PND829	1					EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108
	RCPB29		50	110	600	LF	\$60	\$36,000	110	3.03	\$35,000	\$106,061	\$7,632	\$149,693	
	PND834	1					EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108
	RCPB34		50	110	500	LF	\$60	\$30,000	110	2.53	\$35,000	\$88,384	\$6,360	\$124,744	
	PND835	1					EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108
	RCPB35		50	110	500	LF	\$60	\$30,000	110	2.53	\$35,000	\$88,384	\$6,360	\$124,744	
	PND826	1					EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108
	RCPB26		50	110	4276	LF	\$60	\$256,560	110	21.60	\$35,000	\$755,859	\$54,392	\$1,066,811	
	RCPB60		50	110	600	LF	\$60	\$36,000	110	3.03	\$35,000	\$106,061	\$7,632	\$149,693	
	PND838	1					EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108
	SUB-TOTAL							\$6,311,560				\$12,578,169	\$131,750	\$20,310,030	
	PBA11	1					EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108
	RCPA11A		50	110	1302	LF	\$134	\$174,468	110	6.58	\$35,000	\$230,152	\$16,562	\$421,181	
	PBA11B	1					EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108
	RCPA11		50	110	6310	LF	\$60	\$378,600	110	31.87	\$35,000	\$1,115,404	\$80,266	\$1,574,270	
	RCPA14		50	110	6553	LF	\$60	\$393,180	110	33.10	\$35,000	\$1,158,359	\$83,357	\$1,634,895	
	RCPA37		50	110	7098	LF	\$60	\$425,880	110	35.85	\$35,000	\$1,254,697	\$90,289	\$1,770,866	
	SUB-TOTAL							\$2,528,844				\$5,928,611	\$131,750	\$8,991,428	
	PBA10	1					EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108
RCPA10		50	110	750	LF	\$60	\$45,000	110	3.79	\$35,000	\$132,576	\$9,540	\$187,116		
PBA18	1					EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108	
RCPA18		150	210	500	LF	\$134	\$67,000	110	3.67	\$35,000	\$128,558	\$12,099	\$207,658		
PBA19	1					EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108	
RCPA08		150	210	400	LF	\$134	\$53,600	110	2.94	\$35,000	\$102,847	\$9,680	\$166,126		
PBA21	1					EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108	
RCPA21		150	210	750	LF	\$134	\$100,500	110	5.51	\$35,000	\$192,837	\$18,149	\$311,487		
PBA21A	1					EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108	

ALTERNATIVE 4 DETAILED COST ESTIMATE

Planning Unit	Item Description	Quantity	Channel Bottom Width, ft	Channel Top Width, ft	Length	Unit	Unit Cost	Excavation Cost	ROW Width, ft	ROW Area ² , acres	ROW cost per acre	ROW Cost	Landscape Costs ³	Total Cost	
ESTRELLA	RCPA2B		150	210	5800	LF	\$134	\$777,200	110	42.61	\$35,000	\$1,491,276	\$140,353	\$2,408,829	
	RCPA20		150	210	11200	LF	\$134	\$1,500,800	110	82.28	\$35,000	\$2,879,706	\$271,027	\$4,651,533	
	RCPA32		150	210	1800	LF	\$134	\$241,200	110	13.22	\$35,000	\$462,810	\$43,558	\$747,568	
	RCPA52		200	260	1963	LF	\$171	\$335,673	110	16.67	\$35,000	\$583,582	\$58,768	\$978,024	
	RCPA55		200	260	9154	LF	\$171	\$1,565,334	110	77.75	\$35,000	\$2,721,403	\$274,053	\$4,560,789	
	SUB-TOTAL							\$7,578,096				\$14,120,596		\$23,194,668	
	System G														
	RCPH04	1	20	80	1682	LF	\$38	\$63,916		110	7.34	\$35,000	\$256,779	\$15,604	\$336,299
	RCPH17	1	60	120	2441	LF	\$67	\$163,547		110	12.89	\$35,000	\$451,103	\$33,852	\$648,502
	RCH04B	1	20	80	4177	LF	\$38	\$158,726		110	18.22	\$35,000	\$637,673	\$38,749	\$835,149
	RCPH18	1	20	80	15850	LF	\$38	\$602,300		110	69.13	\$35,000	\$2,419,708	\$147,038	\$3,169,047
	RCPH52	1	20	80	4222	LF	\$38	\$160,436		110	18.42	\$35,000	\$644,543	\$39,167	\$844,146
	RCPH54	1	20	80	1368	LF	\$38	\$51,984		110	5.97	\$35,000	\$208,843	\$12,691	\$273,518
	MBH05G	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108	
	MBH04G	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108	
	System F														
	RCPH06	1	20	80	1955	LF	\$38	\$74,290		110	8.53	\$35,000	\$298,456	\$18,136	\$390,882
RCPH16	1	20	80	4914	LF	\$38	\$186,732		110	21.43	\$35,000	\$750,186	\$45,586	\$982,504	
RCPH14	1	20	80	8519	LF	\$38	\$323,722		110	37.16	\$35,000	\$1,300,536	\$79,030	\$1,703,288	
RCPH33	1	20	80	5480	LF	\$38	\$208,240		110	23.90	\$35,000	\$836,593	\$50,837	\$1,095,670	
RCPH47	1	20	80	1545	LF	\$38	\$58,710		110	6.74	\$35,000	\$235,864	\$14,333	\$308,907	
MBH06F	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108		
MBH16F	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108		
System H															
MC4478	1	20	80	801	LF	\$38	\$30,438		110	3.49	\$35,000	\$122,283	\$7,431	\$160,152	
MC7875	1	20	80	802	LF	\$38	\$30,476		110	3.50	\$35,000	\$122,436	\$7,440	\$160,352	
MC7573	1	20	80	804	LF	\$38	\$30,552		110	3.51	\$35,000	\$122,741	\$7,459	\$160,752	
MC7371	1	100	160	803	LF	\$97	\$77,891		110	4.98	\$35,000	\$174,205	\$14,823	\$266,919	
MC7172	1	60	120	4412	LF	\$67	\$295,604		110	23.30	\$35,000	\$815,349	\$61,187	\$1,172,140	
MBH44H	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108		
MBH78H	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108		
MBH75H	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108		
MBH73H	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108		
MBH71H	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108		
System E															
RCPH12	1	20	80	1410	LF	\$38	\$53,580		110	6.15	\$35,000	\$215,255	\$13,080	\$281,915	
RCPH09	1	20	80	3428	LF	\$38	\$130,264		110	14.95	\$35,000	\$523,329	\$31,801	\$685,394	
RCPH08	1	20	80	6985	LF	\$38	\$265,430		110	30.47	\$35,000	\$1,066,351	\$64,799	\$1,396,580	
RCPH35	1	20	80	5239	LF	\$38	\$199,082		110	22.85	\$35,000	\$799,801	\$48,601	\$1,047,485	
RCPH37	1	20	80	4536	LF	\$38	\$172,368		110	19.79	\$35,000	\$692,479	\$42,080	\$906,927	
MBH09E	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108		
MBH08E	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108		
MBH12E	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108		
System D															
RCP103	1	20	80	5416	LF	\$38	\$205,808		110	23.62	\$35,000	\$826,823	\$50,243	\$1,082,874	
RCP104	1	20	80	4365	LF	\$38	\$165,870		110	19.04	\$35,000	\$666,374	\$40,493	\$872,737	
RCP106	1	20	80	5690	LF	\$38	\$216,220		110	24.82	\$35,000	\$868,652	\$52,785	\$1,137,658	
MB103D	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108		
System C															
RCP116	1	20	80	2763	LF	\$38	\$104,994		110	12.05	\$35,000	\$421,808	\$25,632	\$552,434	
RC117C	1	20	80	2050	LF	\$38	\$77,900		110	8.94	\$35,000	\$312,959	\$19,018	\$409,877	
RCP124	1	20	80	5278	LF	\$38	\$200,564		110	23.02	\$35,000	\$805,755	\$48,963	\$1,055,283	
RC126A	1	20	80	2813	LF	\$38	\$106,894		110	12.27	\$35,000	\$429,441	\$26,096	\$562,431	
MB115B	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108		
MB117C	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108		
MB124C	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108		
System A															
RCP138	1	20	80	628	LF	\$38	\$23,864		110	2.74	\$35,000	\$95,872	\$5,826	\$125,562	
RCP123	1	20	80	2212	LF	\$38	\$84,056		110	9.65	\$35,000	\$337,691	\$20,520	\$442,267	
RC125A	1	20	80	1968	LF	\$38	\$74,784		110	8.58	\$35,000	\$300,441	\$18,257	\$393,482	
RC125B	1	20	80	3230	LF	\$38	\$122,740		110	14.09	\$35,000	\$493,101	\$29,964	\$645,806	
RCP139	1	20	80	5144	LF	\$38	\$195,472		110	22.44	\$35,000	\$785,298	\$47,720	\$1,028,491	
MB144B	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108		
MB126B	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108		
MB123A	1				EA	\$578,358	\$578,358		31.00	\$35,000	\$1,085,000	\$131,750	\$1,795,108		

ALTERNATIVE 4 DETAILED COST ESTIMATE

URS Corporation

Planning Unit	Item Description	Quantity	Channel Bottom Width, ft	Channel Top Width, ft	Length	Unit	Unit Cost	Excavation Cost	ROW Width ¹ , ft	ROW Area ⁴ , acres	ROW cost per acre	ROW Cost	Landscape Costs ³	Total Cost
System I														
	RDR40A	1	20	80	1783	LF	\$38	\$67,754	110	7.78	\$35,000	\$272,198	\$16,541	\$356,493
	RRMB29	1	20	80	2730	LF	\$38	\$103,740	110	11.91	\$35,000	\$416,770	\$25,326	\$545,836
	RCP140	1	20	80	3372	LF	\$38	\$128,136	110	14.71	\$35,000	\$514,780	\$31,282	\$674,197
	RCP141	1	20	80	5249	LF	\$38	\$199,462	110	22.90	\$35,000	\$801,328	\$48,694	\$1,049,484
	RCP142	1	20	80	5325	LF	\$38	\$202,350	110	23.23	\$35,000	\$812,930	\$49,399	\$1,064,680
	RCP143	1	20	80	2763	LF	\$38	\$104,994	110	12.05	\$35,000	\$421,808	\$25,632	\$552,434
	RCP149	1	20	80	4255	LF	\$38	\$161,690	110	18.56	\$35,000	\$649,581	\$39,473	\$850,744
	MC4342	1	20	80	800	LF	\$38	\$30,400	110	3.49	\$35,000	\$122,130	\$7,421	\$159,952
	MC4241	1	20	80	800	LF	\$38	\$30,400	110	3.49	\$35,000	\$122,130	\$7,421	\$159,952
	MC4140	1	20	80	801	LF	\$38	\$30,438	110	3.49	\$35,000	\$122,283	\$7,431	\$160,152
	MC4008	1	20	80	801	LF	\$38	\$30,438	110	3.49	\$35,000	\$122,283	\$7,431	\$160,152
	MC0809	1	20	80	801	LF	\$38	\$30,438	110	3.49	\$35,000	\$122,283	\$7,431	\$160,152
	MC0919	1	20	80	803	LF	\$38	\$30,514	110	3.50	\$35,000	\$122,588	\$7,449	\$160,552
	MC1928	1	20	80	813	LF	\$38	\$30,894	110	3.55	\$35,000	\$124,115	\$7,542	\$162,551
	MC2829	1	20	80	810	LF	\$38	\$30,780	110	3.53	\$35,000	\$123,657	\$7,514	\$161,951
	MBH431	1				EA	\$578,358	\$578,358	31.00		\$35,000	\$1,085,000	\$131,750	\$1,795,108
	MBH411	1				EA	\$578,358	\$578,358	31.00		\$35,000	\$1,085,000	\$131,750	\$1,795,108
	MBH411	1				EA	\$578,358	\$578,358	31.00		\$35,000	\$1,085,000	\$131,750	\$1,795,108
	MBH401	1				EA	\$578,358	\$578,358	31.00		\$35,000	\$1,085,000	\$131,750	\$1,795,108
	MBI081	1				EA	\$578,358	\$578,358	31.00		\$35,000	\$1,085,000	\$131,750	\$1,795,108
	MBI091	1				EA	\$578,358	\$578,358	31.00		\$35,000	\$1,085,000	\$131,750	\$1,795,108
	MBI191	1				EA	\$578,358	\$578,358	31.00		\$35,000	\$1,085,000	\$131,750	\$1,795,108
	MBI281	1				EA	\$578,358	\$578,358	31.00		\$35,000	\$1,085,000	\$131,750	\$1,795,108
	MBI291	1				EA	\$578,358	\$578,358	31.00		\$35,000	\$1,085,000	\$131,750	\$1,795,108
System B														
	MC2931	1	20	80	4252	LF	\$38	\$161,576	110	18.55	\$35,000	\$649,123	\$39,445	\$850,144
	MC3133	1	20	80	5316	LF	\$38	\$202,008	110	23.19	\$35,000	\$811,556	\$49,316	\$1,062,880
	MC3335	1	20	80	5310	LF	\$38	\$201,780	110	23.16	\$35,000	\$810,640	\$49,260	\$1,061,681
	MC3537	1	20	80	4061	LF	\$38	\$154,318	110	17.71	\$35,000	\$619,964	\$37,673	\$811,956
	SUB-TOTAL							\$23,043,581				\$57,180,880		\$85,564,386
	TOTAL							\$48,221,071				\$108,771,684		\$167,795,519
	with Contingency (30%)													\$218,134,175

¹ Proposed ROW is based on a 40' -wide landscape setback on each side plus an additional 15' on each side for access roads for a total of 55' per side and 110' total.

² Basins - Additional 30% land acquisition beyond basic engineering need, from the Districts Policy for the Aesthetic treatment and Landscaping of Flood Control features (FCDMC, December 1992) - 20 acre foot print with an additional 30% for landscaping setback (6 acres), and an additional 25% to account for curvature and side slope (5 acres), total ROW area 31acres.

³ Landscaping Costs- from RVADMP Costing Criteria Narrative 2009, from EPG, date 11-30-2009, Channel \$5000.00/acre, Basins \$4250.00/acre, does not include 30' of access road or the 80' landscape setback required for channels, Channel side slopes to be hydro seeded 5ft depth 6:1 side slope requires a sideslope width of 30.41' plus the channel bottom width (varies).

⁴ ROW Area includes the top width of the channel and the additional ROW required for access roads and landscaping setback, multiplied by the channel length

ALTERNATIVE 6 DETAILED COST ESTIMATE

Planning Unit	Item Description	Quantity	Unit	Unit Cost	Excavation Cost	ROW Area ¹ , acres	ROW cost per acre	ROW Cost	Landscaping Costs ²	Total Cost	
WR4	PBF19	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBF29	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBF31	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBF34	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBE45	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBG27	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBE41	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	SUB - TOTAL										\$12,565,754
WR3	PBG30	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBD27	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBD29	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBG40	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	SUB - TOTAL									\$7,180,431	
WR2	PBD40	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBD39	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBB08	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBB08 (#2)	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBG42	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBH70	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBB45	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBH76	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBB61	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBH77	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBB61 (#2)	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBH86	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBB63	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBA42	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBA44	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBI34	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBI37	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBI50	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBI50A	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBA49	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	PBA51	1	EA	\$578,358	\$578,358	31	\$35,000	\$1,085,000.00	\$131,750	\$1,795,108	
	SUB - TOTAL										\$37,697,263
	TOTAL										\$57,443,448
With Contingency (30%)										\$74,676,483	

Basins - Additional 30% land acquisition beyond basic engineering need, from the Districts Policy for the Aesthetic treatment and Landscaping of Flood Control features (FCDMC, December 1992) - 20 acre foot print with an additional 30% for landscaping setback (6 acres), and an additional 25% to account for curvature and side slope (5 acres), total ROW area 31 acres
² Landscaping Costs- from RVADMP Costing Criteria Narrative 2009, from EPG, date 11-30-2009, Basins \$ 4250.00/acre

UNITS COSTS

URS Corporation

Description	Bottom Width, ft	Side Slopes, ft/ft	Depth, ft	Top Width, ft	Cross sectional Area, ft ²	Unit Length, ft	Total Excavation, ft ³	Excavation, yd ³	Cost per yd ³ of Excavation	Cost per Linear Foot
10 foot channel section	10.00	6	5.00	70.00	200.00	100.00	20,000.00	741.00	\$4.00	\$30
6.1 side slopes										
no channel lining considered										
20 foot channel section	20.00	6	5.00	80.00	250.00	100.00	25,000.00	926.00	\$4.00	\$38
6.1 side slopes										
no channel lining considered										
30 foot channel section	30.00	6	5.00	90.00	300.00	100.00	30,000.00	1,112.00	\$4.00	\$45
6.1 side slopes										
no channel lining considered										
40 foot channel section	40.00	6	5.00	100.00	350.00	100.00	35,000.00	1,297.00	\$4.00	\$52
6.1 side slopes										
no channel lining considered										
50 foot channel section	50.00	6	5.00	110.00	400.00	100.00	40,000.00	1,482.00	\$4.00	\$60
6.1 side slopes										
no channel lining considered										
60 foot channel section	60.00	6	5.00	120.00	450.00	100.00	45,000.00	1,667.00	\$4.00	\$67
6.1 side slopes										
no channel lining considered										
80 foot channel section	80.00	6	5.00	140.00	550.00	100.00	55,000.00	2,038.00	\$4.00	\$82
6.1 side slopes										
no channel lining considered										
100 foot channel section	100.00	6	5.00	160.00	650.00	100.00	65,000.00	2,408.00	\$4.00	\$97
6.1 side slopes										
no channel lining considered										
150 foot channel section	150.00	6	5.00	210.00	900.00	100.00	90,000.00	3,334.00	\$4.00	\$134
6.1 side slopes										
no channel lining considered										
200 foot channel section	200.00	6	5.00	260.00	1150.00	100.00	115,000.00	4,260.00	\$4.00	\$171
6.1 side slopes										
no channel lining considered										
250 foot channel section	250.00	6	5.00	310.00	1400.00	100.00	140,000.00	5,186.00	\$4.00	\$208
6.1 side slopes										
no channel lining considered										
300 foot channel section	300.00	6	5.00	360.00	1650.00	100.00	165,000.00	6,112.00	\$4.00	\$245
6.1 side slopes										
no channel lining considered										

UNITS COSTS

URS Corporation

Description	Side Slopes, ft/ft	Depth, ft	Top Cross sectional Area, acre	Excavation Area (from CAD), ft ²	Excavation Area, yd ³	Cost per yd ³	Excavation Cost
20 acre top width footprint	10H:1V	5.00	20.00	3903915	144589	\$4.00	\$578,357.76
10H:1V SS							
1000ft x 871ft							

LANDSCAPE SETBACKS

The 40-foot landscape setback desired for constructed channel projects represents a maximum range of additional land required to achieve the various District landscape architecture objectives as discussed in the District's *Policy for the Aesthetic Treatment and Landscape of Flood Control Projects* (District 1992) and *Aesthetic and Multi-Use Design Guidelines for Flood Control Structures* (District 2005). This need would be reduced in areas where adjacent land uses are providing similar functions or benefits. The table below shows a potential range of land uses and their impact on the reduction on the required landscape setback.

Land-Use	Recommended Landscape Setback
Adjacent Road Right-of-way	Forty-foot minus the right-of-way landscape setback of road (example – a channel adjacent to a road with a 25-foot landscape setback would only require 15 feet of project landscape setback on the road side).
Adjacent Semi-Public Open-Space (Development)	No additional setback is required. Guidelines and regulations governing the mutually beneficial placement of City-required open space in conjunction with the “first-flush” retention benefits developers receive by being able to use the channel in place of onsite retention should be considered.
Adjacent Public Open Space (Secured)	No additional setback is required. Includes public parks, federally protected open-spaces, and facilities with long-term multi-use functions that will serve to provide similar functions as the landscape setback.