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Arizona Water Protection Fund
Application Cover Page
FY 2017

Title of Project:

Type of Project:
- [X] Capital or Other
- [ ] Water Conservation
- [ ] Research

Stream Type:
- [ ] Perennial
- [X] Intermittent
- [ ] Ephemeral

Your level of commitment to maintenance of project benefits and capital improvements:
[ ] < 5 years [X] 5-10 years [ ] 11-15 years [ ] 16-20 years

Applicant Information:
Name/Organization: Flood Control District of Maricopa County
Address 1: 2801 West Durango Street
Address 2:
City: Phoenix
State: Arizona
ZIP Code: 85009
Phone: 602-506-0867
Fax: 602-506-8561
Tax ID No.:

Inside an AMA: Yes [X] No [ ]

If yes, which AMA:
- [X] Phoenix
- [ ] Tucson
- [ ] Prescott
- [ ] Pinal
- [ ] Santa Cruz

Type of Application:
- [X] New
- [ ] Continuation

Contact Person:
Name: Walt Kinsler
Title: Project Manager
Phone: 602-506-0867
Fax: 602-506- 8561
e-mail: waltkinsler@mail.maricopa.gov

Any Previous AWPF Grants:
[ ] Yes [X] No

If yes, please provide Grant #(s):

Arizona Water Protection Fund Grant Amount Requested:

$ 128,237.00

If the application is funded, will the Grantee intend to request an advance:
[ ] **Yes** [X] **No**

Matching Funds Obtained and Secured:

Applicant/Agency/Organization:	Amount ($):
1. Applicant: Flood Control District of Maricopa County	$514,670.00
2.	
3.	
Total:	$514,670.00

Has your legal counsel or contracting authority reviewed and accepted the Grant Award Contract General Provisions?
[ ] Yes [ ] No [X] N/A

Signature of the undersigned certifies understanding and compliance with all terms, conditions and specifications in the attached application. Additionally, signature certifies that all information provided by the applicant is true and accurate. The undersigned acknowledges that intentional presentation of any false or fraudulent information, or knowingly concealing a material fact regarding this application is subject to criminal penalties as provided in A.R.S. Title 13. The Arizona Water Protection Fund Commission may approve Grant Awards with modifications to scope items, methodology, schedule, final products and/or budget.

Walt Kinsler	Project Manager 603-506-0867
Typed Name of Applicant or Applicant's Authorized Representative	**Title and Telephone Number**
Walt Kinsler	October 14, 2016
Signature	**Date Signed**

2) Executive Summary:

The Flood Control District of Maricopa County (District) is pleased to present this proposal to the Arizona Water Protection Fund (AWPF) for a Capital Improvement Pilot Project (Project). The Project will remove non-native saltcedar (*Tamarix* species) and replace with appropriate native riparian vegetation on a 36.70 acre District owned property, located east of SR85 Bridge along the north edge of the Gila River. The Project will improve the health of the riparian system by protecting and restoring critical habitat desired by the Southwestern Willow Flycatcher, Yellow-Bill Cuckoo, Yuma Clapper Rail and other wildlife species at risk from saltcedar defoliation by the pending arrival of the Tamarisk Leaf Beetle (TLB). Saltcedar forests also pose an extreme fire risk that may be mitigated by actively replacing it with high-value native vegetation.

Over the last century nearly 95 percent of native riparian forests in Arizona have been lost, with the introduction of non-native species such as saltcedar acting as a contributing factor. Saltcedar crowds out native plants, increases fire risk, impedes flood flows, impacts the biological health of the floodplain, and limits recreational access to rivers and washes. As a result of the prolific spread of saltcedar the USDA introduced the TLB to control the plant, which is expected to arrive in the Lower Gila River by 2020-21. The TLB will leave dead woody saltcedar biomass along riparian environments, resulting in a change in of micro-climate temperatures and humidity that will increase fire risk and disturbance to wildlife habitat including threated and endangered species.

The District has been working with the cities of Avondale, Goodyear, Buckeye, various stakeholders, and property owners along the El Rio reach of the Gila River, beginning at the confluence of the Agua Fria spanning 17.5 miles downstream to the SR85 Bridge. The District commissioned several studies looking at flood hazard mitigation, sediment transfer, design guidelines, and vegetative management in an effort to understand and restore the Gila. The AWPF grant will provide the necessary resources to begin implementation of these restoration efforts.

The Project will apply a science-based holistic approach to salt cedar replacement with appropriate native riparian vegetation to provide flood and fire risk reduction and biological improvements as outlined in the El Rio Vegetation Management Plan (VMP) (see Supplement). Four of the eight Vegetation Management Units (VMU) identified in the VMP will be incorporated as follows:

- No Action - 10.75 acers: Located on raised cobble islands with little to no saltcedar. Monitor to determine if /when saltcedar removal is warranted.
- Saltcedar Treatment and Riparian Enhancement - 16.50 acres: Located adjacent to existing open water where saltcedar will be replaced by *Populus fremontii* (cottonwood) and *Salix gooddingii* (willow) plantings.
- Saltcedar Treatment Only - 6.75 acres: Removal of saltcedar allowing existing native vegetation to succeed primarily along the north side of the existing wetted channel.
- Bridge Clearance - 2.75 acers: To mitigate fire risk to SR85 Bridge. ADOT requested that all trees within 200 feet of the bridge be removed, specifically saltcedar and not replaced with new plantings.

3) Project Overview:

Background:

Project's Purpose: To restore a 36.7 acre site along the Lower Gila River by removing non-native invasive saltcedar vegetation and replacing it with high-valued, appropriate, native riparian vegetation. This Project will establish replacement habitats for wildlife including threatened and endangered (T&E) species (e.g., Southwest Willow Flycatcher, Yuma Clapper Rail and Yellow-Billed Cuckoo) by mitigating possible loss and damage to their habitat as a result of the tamarisk leaf beetle (TLB) (Diorhabda elongata complex). Studies have shown that saltcedar forests are 10 times more likely to catch fire, while saltcedar defoliation by the TLB could also increase fire risk. This Project will assist in restoring proper hydrologic conditions and functions to the Project area through the removal of prolific saltcedar growths. An Adaptive Management plan will be developed and administered to include long-term maintenance and monitoring for the purposes of documenting the natural succession of the restored environment and its effects on wildlife. Additionally, the knowledge gained will be shared with other land managers throughout the southwest tasked with controlling saltcedar infested areas and the pending effects of the TLB.

The Project's Location: Is just upstream of the SR85 Bridge within the El Rio reach of the Lower Gila River. The site is a 36.70 acre, District owned, triangular-shaped cluster of parcels along the north bank of the Gila River (see Supplemental)

Background and History of the Area: In 1999, a coalition of elected officials from Avondale, Goodyear and Buckeye, along with private landowners, developers, and other interested public agencies worked with the District to articulate a vision to restore and preserve the Gila River. They named this vision El Rio and identified five major themes including: 1) Restore and Maintain the Natural Functions within the Gila River Corridor as a Riparian Habitat, and 2) Maintain, Enhance or Mitigate Flood Control Elements.

The El Rio reach of the Lower Gila River spans 17.5 miles from the confluence of the Agua Fria River downstream to the SR 85 Bridge crossing, is nearly 1 mile wide, and receives runoff from 46,345 square miles of land. Between 2002 and 2006, the El Rio Watercourse Master Plan (WCMP) (see Supplemental) was conducted through a cooperative effort between the District, Avondale, Buckeye, Goodyear, and the County's Parks and Recreation and Planning and Development departments. This comprehensive biological and hydrological study recommended replacing non-native, invasive saltcedar with native, TLB-resilient species as a flood risk alternative to maintain and enhance the Gila River's natural functions. In 2007 a Memorandum of Understanding was executed between the District and the cities of Avondale, Goodyear, and Buckeye committed themselves to work towards implementing the WCMP and adopting a comprehensive saltcedar management plan, which evolved into the El Rio Vegetation Management Plan (VMP) (see Supplement). The VMP is a science-based, holistic approach to active replacement of existing saltcedar with appropriate native riparian and upland vegetation to provide floodplain management and associated benefits for the entire El Rio project area. Implementation will occur through a series of small pilot projects similar to this one, by effected property owners as resources become available.

Goals:

1. To enhance flood and fire protection by restoring non-native invasive saltcedar forests with appropriate native riparian vegetation per the Vegetation Management Units (VMU) outlined in the VMP, while protecting and creating diverse riverine wildlife habitats for the Project area. The VMU's are as follows:
    - No Action - 10.75 acers: Located on raised cobble islands with little to no saltcedar. Monitor to determine if /when saltcedar removal is warranted.
    - Saltcedar Treatment and Riparian Enhancement - 16.50 acres: Located adjacent to existing open water where saltcedar will be replaced with native riparian vegetation.
    - Saltcedar Treatment Only - 6.75 acres: Removal of saltcedar to allow existing native vegetation to grow
    - Bridge Clearance - 2.75 acers: To mitigate fire risk to SR85 Bridge. ADOT requested that all trees within 200 feet of the bridge be removed, specifically saltcedar and not replaced with new plantings.
2. To implement an Adaptive Management program by applying long-term maintenance and monitoring practices to sustain revegetation survival and saltcedar eradication while tracking and documenting the Project's vegetation succession, saltcedar and secondary weed growth suppression, and the habitat effects on existing and future wildlife.

Objectives: Key Objectives:

1. Develop a baseline inventory of existing vegetation and wildlife in the Project area and develop best management practices to protect high-value habitats prior to construction.
2. Develop a science-based, holistic design plan for replacing saltcedar with appropriate native riparian vegetation using the strategies outlined in the VMP, including Cultural Resource and Wildlife Habitat Surveys.
3. Acquire all permits and compliance documents needed from regulatory agencies to construct and maintain the Project.
4. Collect seeds and pole cuttings to propagate to meet the VMU's species and densities as outlined in VMP.
5. Mechanically remove saltcedar from the Pilot Project area and acquire a State Pesticide Permit to safely apply herbicides to kill and stop the spread, Resprout, or re-growth of saltcedar.
6. Install native riparian plant species and densities to meet the appropriate VMU's.
7. Implement adaptive management practices through long-term maintenance and monitoring to sustain the VMU's as functioning habitats that are capable of long-term regeneration and recovery.
8. Share Project knowledge gained for effective saltcedar removal and re-vegetation strategies and their effects on critical habitats with land managers tasked with controlling saltcedar infestation.

Statement of Problems and Causes:

Saltcedar, currently the dominant woody plant species in the El Rio floodway, was introduced in the 1800's for erosion control, wind breaks, and horticultural purposes. Today the dense stands of this non-native plant are the biggest challenge facing the El Rio reach. Saltcedar grows at greater densities than native species due to its tolerance of saline soils and more xeric conditions that can infests areas due to its high seed production and viability; an extended seed dispersal period relative to native cottonwoods and willows. The saltcedar re-sprouts quickly after floods and fires, tolerates high salinities, and excretes salt, limiting desirable vegetation from germinating around its base. Saltcedar is also 10 times more likely to catch fire than native riparian vegetative species.

In an effort to control the spread of saltcedar, the USDA introduced the Tamarisk Leaf Beetle (TLB), which is expected to arrive to the Lower Gila River around 2020. Mortality of saltcedar by the TLB could take several years, but may ultimately result in improved flood conveyance capacity, riparian habitat recovery, and fire risk reduction. The TLB will not remove the resulting dead woody biomass and is likely to increase the potential for wildfires putting existing riparian habitats at risk. This could result in short-term adverse impacts to suitable habitat for T&E species such as the southwestern willow flycatcher (Empidonax traillii extimus), western yellow-billed cuckoo (Coccyzus americanus), and Yuma clapper rail (Rallus longirostris yumanensis) documented to occur in or have potential to occur in the Project area or along El Rio reach of the Gila.

Historically riparian areas have been natural wildfire barriers; however this trend has been reversed by the replacement of fire-resistant native vegetation, such as willows and cottonwoods, with more flammable oily saltcedar. Saltcedar recovers readily from burning to become even more abundant. Fire risk is likely to temporarily increase as a result of saltcedar defoliation and subsequent dieback by the TLB. Efforts now to accelerate active restoration of these saltcedar infested environments is vital to reducing the negative effects associated with the arrival of the TLB and can help to reduce fire risk in critical riparian areas while creating sustainable desirable habitat for wildlife and T&E species.

Statement of Solutions: Project Years of Benefit to the Resource and the General Public

This Project addresses the need for a coordinated strategy to develop a scientifically-supported pragmatic vegetation management plan to demonstrate successful management techniques and establish long-term maintenance and monitoring programs. This Project will create replacement habitat for riparian wildlife and potential T&E species at risk from saltcedar defoliation impacts that when properly managed could provide ecological benefits to the Project area for several generations. In addition, this project will kick-start a series of pilot projects, stimulating economic development and eco-tourism in the Southwest Valley by revitalizing the river and preserving and restoring a part of Arizona's natural heritage. The knowledge gained on effective saltcedar removal and re-vegetation strategies used in the development and implementation of this Pilot Project will assist the District, adjacent jurisdictions, and private property owners along the El Rio responsible for managing saltcedar infestation prior to the TLB's arrival and for years after TLB defoliation occurs.

4) Project Location & Environmental Contaminant Information:

Project Location & Environmental Contaminant Information
FY 2017

Project Location Information

1. County: Maricopa	2. Section: 24	3. Township: 1S	4. Range: 4W

5. Watershed: Lower Gila River
6. 8 or 10 Digit Hydrologic Unit Code (HUC): 150701
7. Name of USGS Topographic Map where project area is located: Buckeye
8. State Legislative District: 3

(Information available at: http://azredistricting.org/districtlocator/

9. Land ownership of project area: Flood Control District of Maricopa County
10. Current land use of project area: Zoned RR and RU 43 - Undeveloped
11. Size of project area (in acres): 36.7 DIRECT
12. Stream Name: Gila River
13. Length of stream through project area: 4,200 linear feet
14. Miles of stream benefited: .795 miles
15. Acres of riparian habitat: 36.7 acres will be:

- ■ Enhanced
- ■ Maintained
- ■ Restored
- ☐ Created

16. General description and/or delineation for the area of impact of the project within the watershed.

The 36.7 ac. project site is made up of three individually deeded parcels all owned by the FCD of Maricopa County. Each parcel is within the Gila River Floodway. The three parcels make up a triangular site with the north Section line 24 is also the north project boundary for each parcel.

17. Provide directions to the project site from the nearest city or town. List any special access requirements:

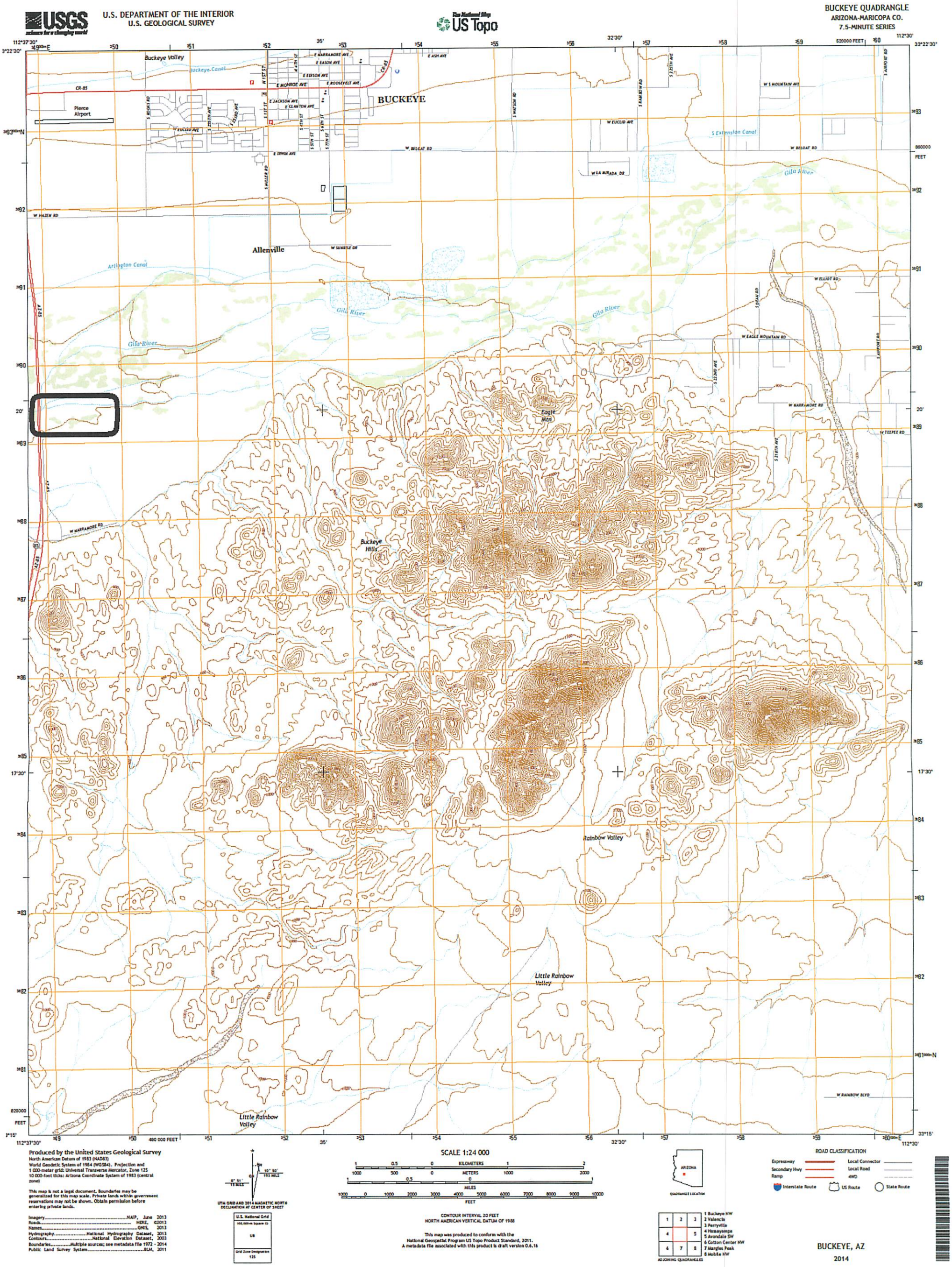
Follow I-10 west approximately 31.6 miles to exit 112 (SR85), Drive south on SR85 for approximately 9 miles. The project site is a 36.70 ac triangular parcel on the east side about 450 feet north of the south SR85 Bridge abutment. Access is from the north bridge abutment on the east side. A dirt road parallels SR 85 along the existing ADOT ROW.

Environmental Contaminant Location Information

1. Does your project site contain known environmental contaminants? ☐YES ■NO If yes, please identify the contaminant(s) and enclose data about the location and levels of contaminants:

2. Are there known environmental contaminants in the project vicinity? ☐YES ■NO If yes, please identify the contaminant(s) and enclose data about the location and levels of contaminants:

3. Are you asking for Arizona Water Protection Fund monies to identify whether or not environmental contaminants are present? ☐YES ■NO



*Black box represents Pilot Project general location

5) Scope of Work:

Work Assignment: Design Phase

Task #1: Permits, Authorizations, Clearances and Agreements

- **Description:** The Grantee must obtain and submit to the Project Manager all permits, authorizations, clearances and agreements, and perform any consultations necessary to complete the tasks listed in this Scope of Work. These may include, but are not limited to:
    - State Historic Preservation Office (SHPO) clearance
    - Endangered Species Act Section 7 consultation with US Fish & Wildlife Service
    - Access agreement(s) between Grantee and Landowner(s) (if different)
    - Clean Water Act Section 401 Certification from Arizona Department of Environmental Quality
    - Clean Water Act Section 404 permit from the Army Corps of Engineers
    - Data Collection permit(s) if necessary
    - City of Buckeye Hydrant Meter Rental permit
    - Arizona Pollutant Discharge Elimination System (AZPDES) Permit including Notice of Intent (NOI) to construct and Notice of Termination (NOT) when completed
    - Arizona Department of Environmental Quality Pesticide General Permit and filing of NOI
    - Maricopa County Floodplain Use Permit
- **Purpose:** To comply with all local, state and federal permit requirements, environmental laws such as NEPA and obtain legal access to project area.
- **Deliverable Description:** Copies of all approved permits, authorizations, clearances and agreements.
- **Responsible personnel:**
    - District
- **Deliverable Due Date:** 18 months after execution of the Water Protection Fund grant contract and prior to any ground disturbing activities.
- **Reimbursable Cost:** **$3,024.00 (Cost includes a 5% Administration Cost. See Detailed Budget Breakdown)**

Task #2: Site Assessment (This task will be done prior to the grant contract execution because the information gathered will help expedite the subsequent tasks needed to obtain permits. It is listed here to provide the reviewer an understanding of the collective tasks that must be accomplished and the sequence, with descriptions of all the tasks required to restore the Pilot Project site. No match is requested, identified, or included in our Project Budget.)

- **Description:** The District will contract with Stillwater Sciences to conduct on-site field assessment of the Project Pilot site.
    - Ground-truth and revise as necessary the vegetation management unit boundaries identified for the Pilot Project area in the Vegetation Management Plan; Map and record saltcedar age, density, and cover;

- Identify specific access routes and accessibility issues for heavy equipment and long-term monitoring and maintenance activities, including landowner access and geographic barriers;
- Map and record notable topographic features, ditches, and other features:
- Map and record cover, density, and diversity of native vegetation to be conserved and to guide planting palettes;
- Map and record cover and diversity of other noxious weeds;
- Evaluate suitable habitat features/characteristics to determine potential for special-status species and nesting birds to occur on site and need for pre-treatment surveys for endangered species and/or whether other protective measures may be needed during project implementation;
- Evaluate channel stability upstream, downstream, and across the channel, to understand potential geomorphic consequences of saltcedar removal and identify the need for a "hydraulic shield" of conserved saltcedar or other measures needed to reduce the risk of habitat enhancement plantings being scoured or damaged from high flow events;
- Document hydrology/water availability, including surface flow patterns and likely depths to groundwater;
- Sample for soil conditions (e.g., texture, salinity, nutrients), to determine the need for soil amendments (collect and submitted for (a fertility) analysis up to 3 samples from each Vegetation Unit type);

- **Purpose:** To evaluate opportunities, constraints, and overall feasibility and sustainability of the specific Vegetation Management Units as defined by the Vegetation Management Plan for the Pilot Project site, and to provide critical information to help inform and direct the Planting Plan.
- **Deliverable Description:** The results of the site assessment will be summarized in a memorandum to help document the basis for the Planting Plan. The memorandum will also provide realistic objectives for the results of the site assessment, budget, and timeline that can be used as the basis for project monitoring and performance evaluation per Task 10.
- **Responsible Personnel:**
  - Stillwater Sciences
  - District
- **Deliverable Due Date:** To expedite the design, permitting (long lead item), and other pre-construction efforts this Task will be initiated and possibly completed prior to the execution of the Water Protection Fund grant contract and will be paid for entirely by the District. As such, this task is not recognized as a match, but is documented in the Scope because of how integral it is to the overall understanding of the design and construction process for this Project.
- **Reimbursable Cost:** N/A

Task #3: Planting Plan

- **Description:** Develop a plant installation plan that identifies all the specific plant species, their size and location to be planted. Illustrate the limits of hydroseed and identify the seed mix types using information generated in Task 1 and the Vegetation Management Plans (VMP).
- **Purpose:** To implement the VMP's Vegetation Management Units (VMU) with appropriate plant species in the desired densities and locations to achieve the most desirable ecological restoration of the Pilot Project site.
- **Deliverable Description:** A map graphically illustrating appropriate plant species in the desired densities per the VMU's.
- **Responsible Personnel:**
    - Stillwater Sciences
    - District
- **Deliverable Due Date:** Preliminary Planting Plan prepared 6 weeks after execution of the Water Protection Fund grant contract with subsequent revisions based on review comments from permitting agencies.
- **Reimbursable Cost:** **$7,205.00 (Cost includes a 5% Administration Cost. See Detailed Budget Breakdown)**

Task #4: Preparing Permit Applications

- **Description:** Stillwater will develop documentation necessary for permit application development and permit acquisition for the Pilot Project. The objective of the Preparing Permit Application, which will be to facilitate the District-led permitting effort, discussions with permitting agencies, and completion of permitting application requirements.
    - Based on the Planting Plan package (map/AutoCAD drawings, tamarisk removal specifications, and planting plan), Stillwater will write a description of the Pilot Project suitable for inserting into individual permit application packages and serving as the basis for potential impact assessments. In addition to describing the primary elements of the project, as presented in the Planting Plan design map/AutoCAD drawings, the project description will include the tamarisk removal and planting methods; approximate schedule for implementation, maintenance, and monitoring activities; and best management practices (BMPs) and resource protection measures that will be employed during the project to avoid or reduce impacts to environmental resources.
    - The project description will be revised in light of District, U.S. Army Corps of Engineers (USACE, the presumed lead agency for permitting), and U.S. Fish and Wildlife Service (USFWS) comments.
    - **Preliminary Jurisdictional Determination (PJD):** Stillwater will prepare a map of waters and wetlands in the Pilot Project area that are potentially subject to the jurisdiction of the USACE. The map will meet USACE minimum standards, be suitable for submittal to the Arizona Department of Environment Quality for Section 401 water quality certification, and be derived from one of the delineations of jurisdictional waters and wetlands that were developed for the El Rio planning reach using a combination of aerial photography interpretation and hydraulic modeling results. It is anticipated that

the delineation based on an approximately 10-year flow event will be used, so that the area under USACE jurisdiction is maximized, but the delineation based on an approximately 2-year flow event could be used as well. (Both extents have been used previously in USACE-approved projects in the El Rio planning reach.)

    - The methods for developing the map will be described in a Preliminary Jurisdictional Determination (PJD) form, and the map will be used to fill in the required sections of the PJD form. It is assumed that the delineation based on aerial photography interpretation and hydraulic modeling will be sufficient for USACE, and that sample points for wetlands, any other field-based data collection, or an associated wetland delineation report (which described wetland sample point results) will not be necessary, due to the fact that the Gila River channel is the only potential jurisdictional feature in Pilot Project.
    - The delineation map and PJD form will be revised based on District and USACE comments and includes responses to USACE additional information request and/or conference call meeting(s).
  - **Biological Resources Evaluation:** Stillwater will prepare a Biological Resources Evaluation report. The southwestern willow flycatcher, western yellow-billed cuckoo, Yuma clapper rail, and migratory birds will be the focus of the report. The effects analysis will be based on the project description the evaluation of habitat features conducted during the site assessment, and the results of any wildlife surveys in or nearby to Pilot Project (e.g., AGFD's summer 2016 bird surveys for the District). The report will provide the information necessary for consultation with USFWS; if the project description suggests that one or more of the anticipated focal species may be negatively affected by the project and that formal consultation with USFWS may be necessary, the report will be titled a Biological Assessment (BA).
- **Purpose:** To complete all permitting application requirements as applied to the Pilot Project's potential temporary, permanent, indirect, and cumulative effects on relevant species protected under the Endangered Species Act (ESA), Migratory Bird Treaty Act (MBTA), and/or Bald and Golden Eagle Protection Act., the Army Corps of Engineer's Clean Water Act 404 Permit, the State, of Arizona's Clean Water Act 402 permit, the County's Dust Permit and Floodplain Permit.
- **Deliverable Description:** Biological Resources Evaluation Report
  - Draft USACE submission of project description, PJD, and Biological Resources Evaluation.
  - Draft USFWS submission of project description and Biological Resources Evaluation.
  - Final PJD submission to USACE.
  - Final project description and Biological Resources Evaluation submission to USFWS.
- **Responsible Personnel:**
  - Stillwater Sciences
  - District
- **Deliverable Due Date:** To expedite the design, permitting (long lead item), and other pre-construction efforts many of the activities in this Task will be initiated prior to the execution of

the Water Protection Fund grant contract and will be paid for entirely by the District. As such, this task is not recognized as a match, but is documented in the Scope because of how integral it is to the overall understanding of the design and construction process for this Project. 18 months after execution of the Water Protection Fund grant contract.

- **Reimbursable Cost:** (District Match - $41,237.00)

Task #5: Cultural Survey

- **Description:** The District will consult with The State Historic Preservation Office (SHPO) to see if they would consider issuing a letter of "No Impact" since the construction activities will occur within the floodway where the ground has been forcibly impacted due to major flooding. The District will have an archeologist on site during any ground disturbance activities to monitor for cultural resources. If SHPO rejects issuing the Letter of No Impact then the District is prepared to hire an archeologist from their on-call list to perform a Cultural Survey of the Pilot Project.
- **Purpose:** The SHPO clearance letter is required for inclusion in the Army Corps of Engineer's Nation Wide Permit #27.
- **Deliverable Description:** If required, The District's on-call archeologist will submit a Cultural Survey that meets the requirements of SHPO. Alternatively a letter of "No Impact" would be submitted if approved by SHPO followed up with an on-site monitoring report for the Implementation Phase.
- **Responsible Personnel:**
  - District
  - District's On-Call Archeologist
- **Deliverable Due Date:** 12 months after the Water Protection Fund grant contract is executed.
- **Reimbursable Cost:** (District Match - $50,768.00)

Work Assignment: Native Plant Collection & Propagation Phase

Task #6: Plant Collection & Initial Propagation

- **Description:** The District will propagate identified species to supply pole plantings for revegetating the site. Initial plants will be propagated early on to allow time to establish the stock material that will be utilized for implementation during Task 9. Material will be propagated at the District nursery and/or an appropriate site. Work completed under this task includes:
  - Conduct site analysis to identify existing species that can be a source for seed or cuttings
  - Conduct field work to collect the required seed and/or cuttings
  - Propagate and plant species that will be used for stock material for the Pilot Project
- **Purpose:** The propagation protocols developed during this task will be used produce native plants for future riparian revegetation efforts conducted by the District. Collections of appropriate native plants using specimens propagated from locally adapted parent material will increase the projects survivability and chances for success.

- **Deliverable Description:** The District will propagate plant species, record the quantities planted, and document the plantings with photographs.
- **Responsible Personnel:**
  - District
- **Deliverable Due Date:** Documentation will be submitted once all initial propagation is complete, approximately May/June 2017.
- **Reimbursable Cost:** **$8,703.00 (Cost includes a 5% Administration Cost. See Detailed Budget Breakdown)**

Task #7: Propagation Oversight and Data Collection

- **Description:** The plant material propagated in Task 5 will be established over two growing seasons before it can be used to implement the Planting Plan. During this time staff will care for the trees and monitor growth. Work completed under this task includes:
  - Monthly monitoring of propagated plants
  - Propagation of additional plants as required
- **Purpose:** Care for and monitor the propagated plant material to ensure that it will be available for use during Task 10.
- **Deliverable Description:** Data will be recorded from the propagated material at regular intervals during the two growing seasons. The data will be summarized in a final report.
- **Responsible Personnel:**
  - District
- **Deliverable Due Date:** The final report will be prepared in December 2019. Partial updates can be provided at more frequent intervals if requested by the Arizona Water Protection Fund' project manager.
- **Reimbursable Cost:** **$18,252.00 (Cost includes a 5% Administration Cost. See Detailed Budget Breakdown)**

Work Assignment: Implementation Phase

Task #8: Saltcedar Removal

- **Description:** Identify limits, quantity and saltcedar eradication methodologies for the specific VMU's as identified on the Pilot Project Planting Plan. Spraying of approved herbicide will cover two full growing seasons. Obtain dust permit, post sign and implement the Stormwater Pollution Protection Plan.
- **Purpose:** To prepare the site for restoration
- **Deliverable Description:** The site has been eradicated of saltcedar from the Bridge Clearance, Saltcedar Treatment and Riparian Enhancement, and Saltcedar Treatment and Mesquite Bosque Enhancement VMU's areas per the Pilot Project Planting Plan. Spraying of herbicide will cover two full growing seasons.

- **Responsible Personnel:**
    - District
- **Deliverable** December 2019
- **Reimbursable Cost:** (District Match - $160,816.00)

Task #9: Clear, Grub, & Grade

- **Description:** Remove all undesirable and or non-native vegetation from the site and prepare for planting operations and hydroseeding. Obtain dust permit, post sign and implement the Stormwater Pollution Protection Plan.
- **Purpose:** To prepare the Pilot Project site for restoration Implementation activities.
- **Deliverable Description:** The site will be ready to begin installing the planting plan
- **Responsible Personnel:**
    - District
- **Deliverable:** December 2019
- **Reimbursable Cost:** (District Match - $70,012.00)

Task #10: Plant & Hydroseed

- **Description:** The District will implement revegetation with native species following the Planting Plan developed for the project site. Plant material will come from a combination of plants propagated during Task 5/6 and via hydroseed application. Planting of propagated plant material will be completed by internal O&M Staff. A qualified contractor will be selected to apply the hydroseed using FCDMC specifications.
- **Purpose:** Promote the establishment of a self-sustaining native plant community in areas where Saltcedar has been removed by planting native species.
- **Deliverable Description:** The District will schedule staff to plant native species and hire a contractor to apply hydroseed. Documentation of completed tasks will be provided via photographs and written reports.
- **Responsible Personnel:**
    - District
- **Deliverable Due Date:** Begins December 2019 or earlier contingent on the successful removal the saltcedar and other non-native species.
- **Reimbursable Cost:** **$91,053.00 (Cost includes a 5% Administration Cost. See Detailed Budget Breakdown)**

Work Assignment: Adaptive Management Program Development Phase

Task #11: Develop Maintenance Plan

- **Description:** Develop a set of restoration maintenance guidelines that follow all permit requirements and best management practices to achieve the greatest habitat values possible. The Maintenance Plan activities are to work in collaboration with the Monitoring Plan and will be for a five-year period initially, but will be extended if sustainable results have not been achieved. Tamarisk retreatment, and replacement plantings or alternative plantings are alternatives that will be evaluated during the maintenance period based on the achievement results. The saltcedar removal process, pre and post-treatment of seedings and re-sprouts along with mulching practices are intended to minimize establishment of saltcedar or other non-native invasive plants. Subsequent herbicide applications over the maintenance period may be required to achieve the desired results.
- **Purpose:** To sustain revegetation survival and non-native invasive species (e.g. saltcedar and secondary weed growth) suppression.
- **Deliverable Description:** Develop a set of restoration maintenance guidelines that includes copies of all permits, BMP's, approved chemicals, individual photographs of non-native invasive species.
- **Responsible Personnel:**
    - District
- **Deliverable Due Date:** 24 months after Water Protection Fund grant contract is executed.
- **Reimbursable Cost:** (District Match - $6,977.00)

Task #11: Develop Monitoring Plan

- **Description: The District and** Stillwater will prepare a project monitoring plan that will work in collaboration with the Maintenance Plan based on the goals and objectives of Pilot Project and requirements of the permitting agency. Additionally, the Monitoring Plan activities will include evaluating how effective the treatment and revegetation methods were pre and post beetle colonization, identify the amount of occupied or highly suitable T&E critical habitats were protected and or created by the Project and report on the extent of the overall habitat recovery over a five-year monitoring period.
- **Purpose:** The monitoring plan will provide the parameters or metrics to be monitored.
    - The primary metrics to be monitored and described in the plan will be tamarisk resprouting, survival of habitat enhancement plantings, natural recruitment by both native and nonnative plants, and native vegetation cover (as an indicator of habitat development). Monitoring metrics for depth to groundwater and wildlife surveys will be described as well as action steps in the event and T&E species are encountered.
- **Deliverable Description:** The monitoring plan will provide the parameters or metrics to be monitored as defined by permitting agencies and complemented by the Districts team of riparian ecologist, wildlife biologist, and landscape architects. The plan will monitor tamarisk re-sprouting, survival of habitat enhancement plantings, natural recruitment by both native and nonnative plants, and native vegetation cover (as an indicator of habitat development). Additional monitoring metrics, such as depth to groundwater and wildlife surveys, may be

recommended and described. The monitoring plan will describe monitoring methods and reporting, a monitoring schedule and duration, and description of adaptive management strategies applicable to the maintenance operations, monitoring activities, or changed site conditions in response to the overall health of the Project's ecosystem.

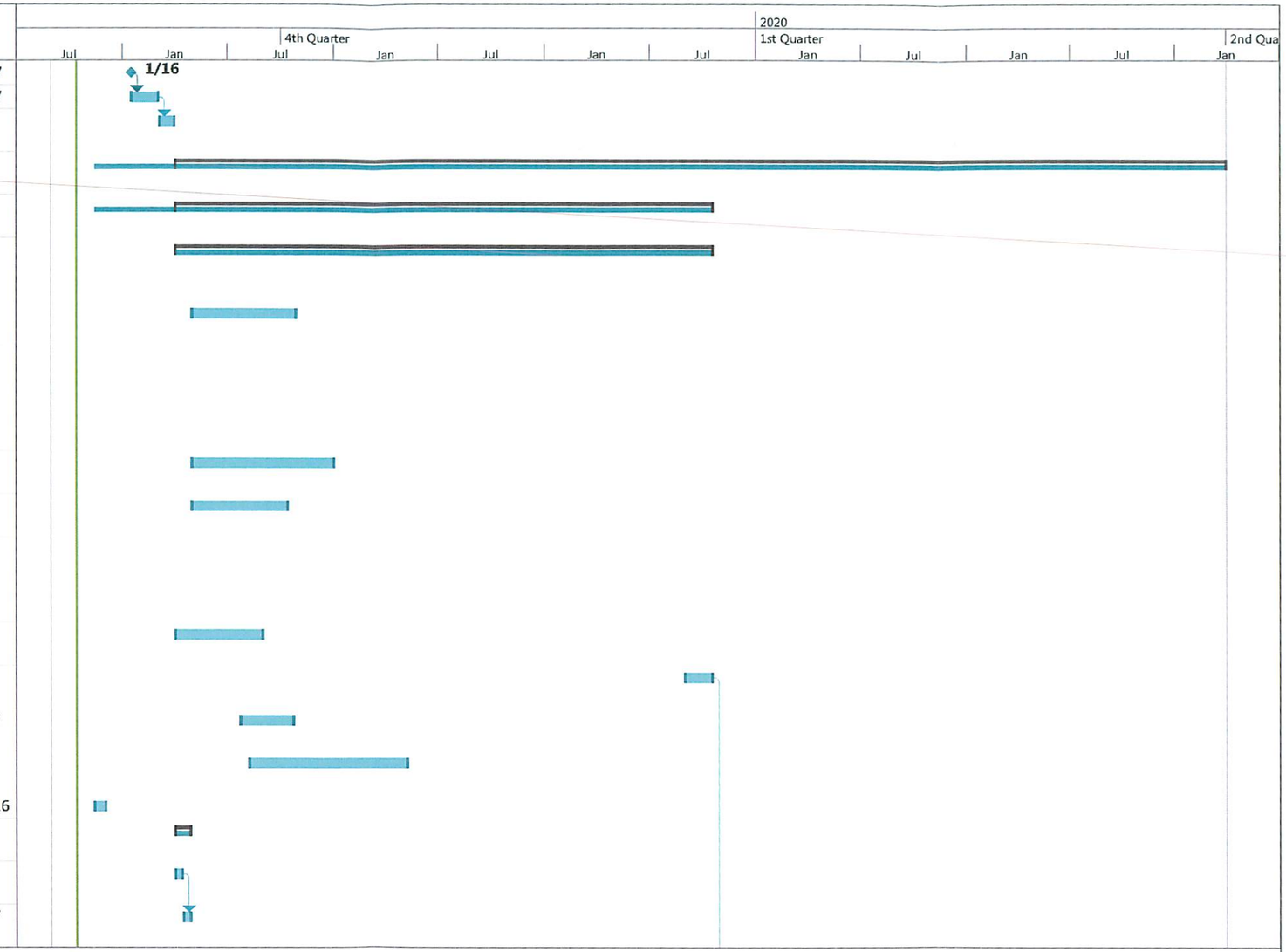
- **Responsible Personnel:**
  - Stillwater Sciences
  - District
- **Deliverable Due Date:** 24 months from the Water Protection Fund grant contract execution.
- **Reimbursable Cost:** (District Match - $8,167.00 h)

Task #13: Administer Adaptive Management Plan

- **Description:** The District will apply the prescribed Adaptive Management activities outlined in the specific Maintenance and Monitoring Plans. The District staff will document activities; schedules, methods, equipment, crews, the potential or existence of any T&E species, actions if a resident T&E species is identified, impact of the TLB to the Project area including plant life, wildlife, and river functions, as well as an overall assessment of the overall health of the restored riparian ecosystem. Administering the Adaptive Management Plan will be done over a minimum of twenty years and modified based on the restored site's natural succession.
- **Purpose:** To maintain and track the success of the Project restoration efforts with the ability to implement adaptive management strategies when necessary to improve the ecosystems health, divert a reduction in habitat value (i.e. removal of nonnative vegetation), or react to the presence of T&E species. This Task will also provide an opportunity to document and convey to landowners improved methods of how riparian restoration projects are designed, constructed and maintained.
- **Deliverable Description:** The District will provide overall maintenance and monitoring of the Project area as required in the Maintenance and Monitoring Plans. The District will provide documentation of their maintenance activities and with the help of Stillwater Sciences evaluate the overall health of the restored ecosystem in an Adaptive Management monitoring report. The report will describe monitoring methods and reporting, a monitoring schedule and duration, and description of adaptive management strategies that may be appropriate based on monitoring results and will comply with the submittal and data requirements of the permitting agencies. In addition, the report will be submitted not less than annually to the Arizona Water Protection Fund project manager for the contract duration. Administering the Adaptive Management Plan may be modified due to permitting requirements or changed site conditions to maximize habitat values and available restoration resources.
- **Responsible Personnel:**
  - Stillwater Science
  - District
- **Deliverable Due Date:** Annual Adaptive Management Reports to Arizona Water Protection Fund for the contract duration and as required by individual permitting agencies.
- **Reimbursable Cost:** (District Match - $176,693.00)

Project Timeline

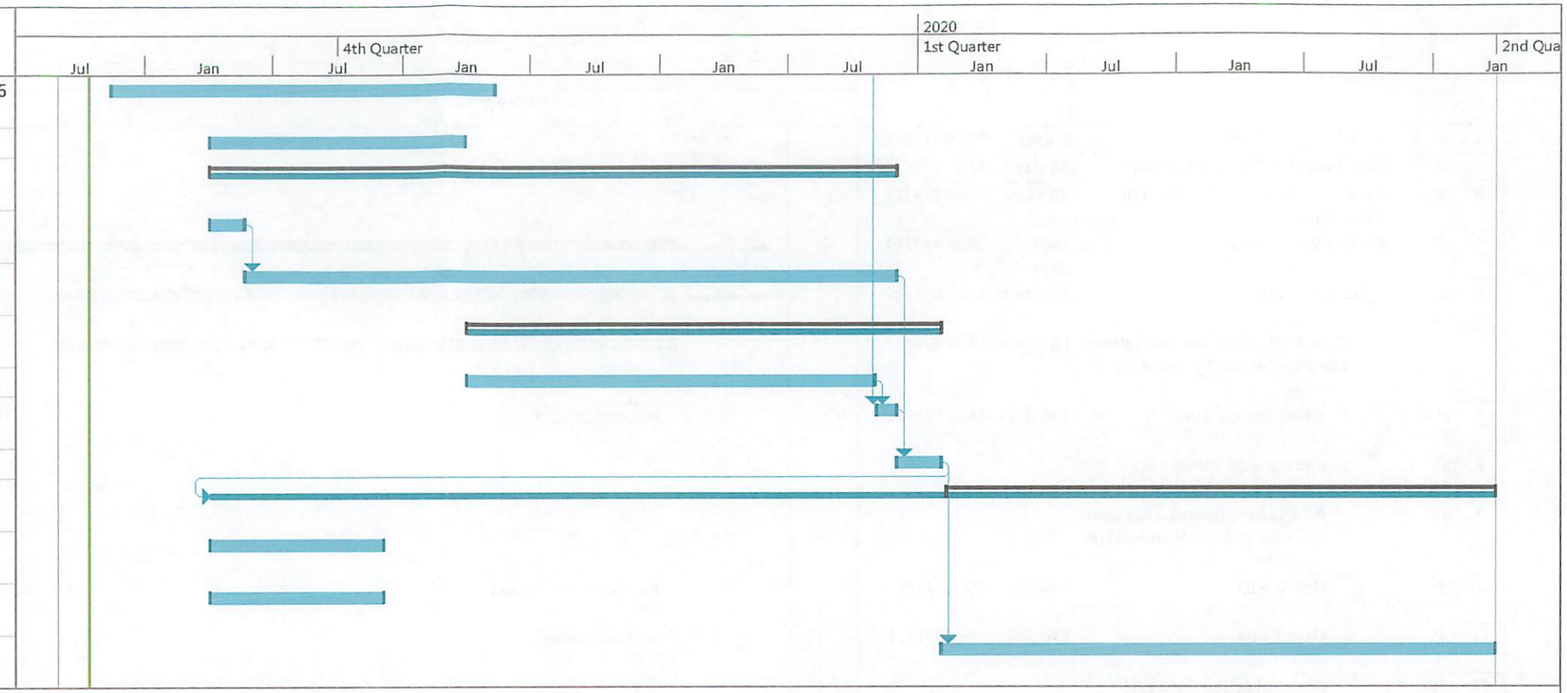
ID	Task Mode	Task Name	Duration	Start
1		**AWPF Grant Award**	**0 days**	**Mon 1/16/17**
2		**Negotiate AWPF Grant Contract**	**35 days**	**Mon 1/16/17**
3		**Board of Supervisor Approval of AWPF Grant**	**20 days**	**Mon 3/6/17**
4		**AWPF Pilot Project**	**1304 days**	**Mon 4/3/17**
5		**Design Phase**	**665 days**	**Mon 4/3/17**
6		**Task 1: Permits, Authorizations, Clearances and Agreements**	**665 days**	**Mon 4/3/17**
7		SHPO Section 106	130 days	Mon 5/1/17
8	?	Endangered Species Act Section 7 (if required)		
9	?	Access Agreement(s) between Grantee and Landowner(s) (if required)		
10		USACE PJD	176 days	Mon 5/1/17
11		USACE 404	120 days	Mon 5/1/17
12	?	Data Collection Permit(s)		
13	?	Water Right Permit(s)		
14		USFWS Bio Survey	109 days	Mon 4/3/17
15		401 CWA ADEQ - AZPDES, NOI, SWPPP	35 days	Mon 9/2/19
16		ADEQ - Pesticide General Permit	66 days	Mon 7/24/17
17		FCD - Floodplain Use Permit	196 days	Tue 8/8/17
18		**Task 2: Site Assessment**	15 days	Mon 11/14/16
19		**Task 3: Planting Plan**	**20 days**	**Mon 4/3/17**
20		Preliminary Concept Design	10 days	Mon 4/3/17
21		Final Concepts Design	10 days	Mon 4/17/17



Project: Pilot Site Project Timeli
Date: Fri 10/14/16

Task	Project Summary	Manual Task	Start-only	Deadline
Split	Inactive Task	Duration-only	Finish-only	Progress
Milestone	Inactive Milestone	Manual Summary Rollup	External Tasks	Manual Progress
Summary	Inactive Summary	Manual Summary	External Milestone	

ID	Task Mode	Task Name	Duration	Start
22		**Task 4: Prepare Permit Applications**	390 days	Mon 11/14/16
23		**Task 5: Cultural Survey**	260 days	Mon 4/3/17
24		**Native Plant Collection & Propogation Phase**	**696 days**	**Mon 4/3/17**
25		**Task 6: Plant Collection & Initial Propagation**	36 days	Mon 4/3/17
26		**Task 7: Propogation Oversight and Data Collection**	660 days	Tue 5/23/17
27		**Implementation Phase**	**481 days**	**Mon 4/2/18**
28		**Task 8: Salt Cedar Removal**	415 days	Mon 4/2/18
29		**Task 9: Clearing and grubbing of project site**	**21 days**	**Mon 11/4/19**
30		**Task 10: Plant & Hydroseed**	45 days	Tue 12/3/19
31		**Adaptive Management Program Development Phase**	**558 days**	**Tue 2/11/20**
32		**Task 11: Develop Maintenance Plan**	176 days	Mon 4/3/17
33		**Task 12: Develop Monitoring Plan**	176 days	Mon 4/3/17
34		**Task 13: Administer Adaptive Management Plan**	563 days	Tue 2/4/20



Project: Pilot Site Project Timeli
Date: Fri 10/14/16

Task		Project Summary		Manual Task		Start-only		Deadline			
Split		Inactive Task		Duration-only		Finish-only		Progress			
Milestone		Inactive Milestone		Manual Summary Rollup		External Tasks		Manual Progress			
Summary		Inactive Summary		Manual Summary		External Milestone					

6) Detailed Budget:

Work Assignment: Design Phase					
Task #1: Permits, Authorizations, Clearances and Agreements					
Description	**Unit Cost**	**Qty.**	**Total**	**FCD Match**	**AWPF**
Environmental Program Analyst	52.06/hr.	16	833.00	0.00	833.00
Planner	31.39/hr.	5	157.00	0.00	157.00
Landscape Architect	44.07/hr.	10	440.00	0.00	440.00
Surveyor	30.22/hr.	48	1,450.00	0.00	1,450.00
Total			**2,880.00**	**0.00**	**2,880.00**
5% Administrative Cost					**144.00**
Total AWPF Grant Portion					**3,024.00**
Task #2: Site Assessment (This Task will be initiated prior to the grant contract execution)					
Task #3: Planting Plan					
Description	**Unit Cost**	**Qty.**	**Total**	**FCD Match**	**AWPF**
Landscape Architect	44.07/hr.	35	1,542.00	0.00	1,542.00
Landscape Architect	34.25/hr.	100	3,425.00	0.00	3,425.00
CAD Technician	27.06/hr.	50	1,353.00	0.00	1,353.00
Environmental Program Analyst	52.06/hr.	8	416.00	0.00	416.00
Planner	31.39/hr.	4	126.00	0.00	126.00
Total			**6,862.00**	0.00	**6,862.00**
5% Administrative Cost					**343.00**
Total AWPF Grant Portion					**7,205.00**
Task #4: Preparing Permit Applications					
Description	**Unit Cost**	**Qty.**	**Total**	**FCD Match**	**AWPF**
Principal Scientist/Ecologist	218.32/hr.	10	2,183.00	2,183.00	0.00
Geomorphologist	143.55/hr.	30	4,306.00	4,306.00	0.00
Riparian Ecologist	154.52/hr.	119	18,388.00	18,388.00	0.00
Wildlife Biologist	117.63/hr.	60	7,058.00	7,058.00	0.00
GIS Analyst and Cartographer	91.71/hr.	67	6,145.00	6,145.00	0.00
Scientist/Admin 1	60.81/hr.	12	730.00	730.00	0.00
Environmental Program Analyst	52.06/hr.	8	416.00	416.00	0.00
Planner	31.39/hr.	8	251.00	251.00	0.00
Landscape Architect	44.07/hr.	20	880.00	880.00	0.00
Project Manager	44.07/hr.	20	880.00	880.00	0.00
Total			**41,237.00**	**41,237.00**	**0.00**
Task # 5: Cultural Survey					
Description	**Unit Cost**	**Qty.**	**Total**	**FCD Match**	**AWPF**
Archeologist (Contract)	L.S.	1	50,000.00	50,000.00	0.00
Environmental Program Analyst	52.06/hr.	8	416.00	416.00	0.00
Landscape Architect	44.07/hr.	4	176.00	176.00	0.00
Project Manager	44.07/hr.	4	176.00	176.00	0.00
Total			**50,768.00**	**50,768.00**	**0.00**

Work Assignment: Native Plant Collection and Propagation Phase					
Task #6: Plant Collection & Initial Propagation					
Description	**Unit Cost**	**Qty.**	**Total**	**FCD Match**	**AWPF**
Laborer	25.87/hr.	16	414.00	0.00	414.00
Laborer	25.87/hr.	16	414.00	0.00	414.00
Nursery Tech	33.58/hr.	78	2,620.00	0.00	2,620.00
Equipment Operator	35.14/hr.	8	280.00	0.00	280.00
Tree Guards	135/roll	2	270.00	0.00	270.00
Misc. Supplies	1,500/task	1	1,500.00	0.00	1,500.00
Equipment (Auger)	45.00/day	2	90.00	0.00	90.00
Landscape Architect	34.25/hr.	66	2,260.00	0.00	2,260.00
Landscape Architect	44.07/hr.	10	441.00	0.00	441.00
Total			**8,289.00**	**0.00**	**8,289.00**
5% Administrative Cost					**414.00**
Total AWPF Grant Portion					**8,703.00**
Task #7: Propagation Oversight and Data Collection					
Description	**Unit Cost**	**Qty.**	**Total**	**FCD Match**	**AWPF**
Labor	25.87/hr.	119	3,078.00	0.00	3,078.00
Nursery Tech	33.58/hr.	258	8,665.00	0.00	8,665.00
Equipment Operator	35.14/hr.	8	280.00	0.00	280.00
Tree Guards	135.00/roll	1	135.00	0.00	135.00
Misc. Supplies	500/task	1	500.00	0.00	500.00
Landscape Architect	34.25/hr.	138	4,725.00	0.00	4,725.00
Total			**17,383.00**	**0.00**	**17,383.00**
5% Administrative Cost					**869.00**
Total AWPF Grant Portion					**18,252.00**
Work Assignment: Implementation Phase					
Task #8: Saltcedar Removal					
Description	**Unit Cost**	**Qty.**	**Total**	**FCD Match**	**AWPF**
Implement SWPPP Components, Obtain Dust Permit and Post Project Sign	L.S.	1	7,500.00	7,500.00	0.00
Laborer w/Chainsaw	25.87/hr.	100	2,587.00	2,587.00	0.00
Laborer w/Chainsaw	25.87/hr.	100	2,587.00	2,587.00	0.00
Laborer w/Chainsaw	25.87/hr.	100	2,587.00	2,587.00	0.00
Laborer w/Chainsaw	25.87/hr.	100	2,587.00	2,587.00	0.00
Supervisor w/Chainsaw	37.83/hr.	100	3,783.00	3,783.00	0.00
Chainsaw Rental	65.00/day	65	4,225.00	4,225.00	0.00
Pesticide Applicator	33.58/hr.	80	2,686.00	2,686.00	0.00
Pesticide Applicator	33.58/hr.	80	2,686.00	2,686.00	0.00
Pesticide	75.00/gal.	45	3,375.00	3,375.00	0.00
Track Hoe / Excavator Rental	850/day	30	25,500.00	25,500.00	0.00
Equipment Operator	35.14/hr.	880	30,923.00	30,923.00	0.00
Frontend Loader Rental	850/day	15	12,750.00	12,750.00	0.00
Bulldozer Rental	850/day	30	25,500.00	25,500.00	0.00
Water Truck Rental	400/day	34	13,600.00	13,600.00	0.00
Potable Water Meter w/BFP & Lock,	2,500/ea.	L.S.	2,500.00	2,500.00	0.00

Large Portable Grinder Rental	3,500/wk.	3	10,500.00	10,500.00	0.00
Environmental Program Analyst	52.06/hr.	8	416.00	416.00	0.00
Landscape Architect	34.25/hr.	36	1,233.00	1,233.00	0.00
Landscape Architect	44.07/hr.	36	1,586.00	1,586.00	0.00
Project Manager	44.07/hr.	16	705.00	705.00	0.00
Total			**160,816.00**	**160,816.00**	**0.00**
Task #9: Clear, Grub, & Grade					
Description	**Unit Cost**	**Qty.**	**Total**	**FCD Match**	**AWPF**
Implement SWPPP Components, Obtain Dust Permit and Post Project Sign	L.S.	1	7,500.00	7,500.00	0.00
Equipment Operator	35.14/hr.	512	17,992.00	17,992.00	0.00
Water Truck Rental	400/day	34	13,600.00	13,600.00	0.00
Bulldozer Rental	850/day	30	25,500.00	25,500.00	0.00
Potable Water Meter w/BFP & Lock,	2,500.00	L.S.	2,500.00	2,500.00	0.00
Planner	31.29/hr.	16	501.00	501.00	0.00
Landscape Architect	44.07/hr.	20	882.00	882.00	0.00
Landscape Architect	34.25/hr.	32	1,096.00	1,096.00	0.00
Project Manager	44.07/hr.	10	441.00	441.00	0.00
Total			**70,012.00**	**70,012.00**	**0.00**
Task #10: Plant & Hydroseed					
Description	**Unit Cost**	**Qty.**	**Total**	**FCD**	**AWPF**
Laborer	25.87/hr.	144	3,725.00	0.00	3,725.00
Nursery Tech	33.58/hr.	120	4,030.00	0.00	4,030.00
Working Supervisor	37.83/hr.	80	3,025.00	0.00	3,025.00
Equipment Operator	35.14/hr.	64	2,250.00	0.00	2,250.00
Tree Guards	135.00/roll	45	6,075.00	0.00	6,075.00
Misc. Supplies	2,200/task	1	2,200.00	0.00	2,200.00
Equipment (Auger)	45.00/day	4	180.00	0.00	180.00
Equipment (Rotary Hammer)	45.00/day	6	270.00	0.00	270.00
Hydroseed	3,000/ac	14.16	42,480.00	0.00	42,480.00
Water Truck	400/day	20	8,000.00	0.00	8,000.00
DriWATER Gel Packs	36.00/case	295	10,615.00	0.00	10,615.00
Environmental Program Analyst	52.06/hr.	4	208.00	0.00	208.00
Landscape Architect	34.25/hr.	60	2,055.00	0.00	2,055.00
Landscape Architect	44.07/hr.	20	880.00	0.00	880.00
Surveyor	30.22/hr.	24	725.00	0.00	725.00
Total			**76,103.00**	**0.00**	**86,718.00**
5% Administrative Cost					**4,335.00**
Total AWPF Grant Portion					**91,053.00**
Work Assignment: Develop Adaptive Management Program					
Task #11: Develop Maintenance Plan					
Description	**Unit Cost**	**Qty.**	**Total**	**FCD**	**AWPF**
Environmental Program Analyst	52.06/hr.	8	416.00	416.00	0.00
Landscape Architect	34.25/hr.	24	822.00	822.00	0.00
Landscape Architect	44.07/hr.	24	1,058.00	1,058.00	0.00
Planner	31.39/hr.	8	251.00	251.00	0.00

Riparian Ecologist	154.52/hr.	14	2,163.00	2,163.00	0.00
Wildlife Biologist	117.63/hr.	4	470.00	470.00	0.00
Maintenance Division Manager	56.82/hr.	24	1,364.00	1,264.00	0.00
Pesticide Applicator	33.58/hr.	8	269.00	269.00	0.00
Project Manager	44.07/hr.	6	264.00	264.00	0.00
Total			**6,977.00**	**6,977.00**	**0.00**
Task #12: Develop Monitoring Plan					
Description	**Unit Cost**	**Qty.**	**Total**	**FCD**	**AWPF**
Environmental Program Analyst	52.06/hr.	8	416.00	416.00	0.00
Landscape Architect	34.25/hr.	24	822.00	822.00	0.00
Landscape Architect	44.07/hr.	24	1,058.00	1,058.00	0.00
Planner	31.39/hr.	8	251.00	251.00	0.00
Riparian Ecologist	154.52/hr.	24	3,708.00	3,708.00	0.00
Wildlife Biologist	117.63/hr.	4	470.00	470.00	0.00
Maintenance Division Manager	56.82/hr.	16	909.00	909.00	0.00
Pesticide Applicator	33.58/hr.	8	269.00	269.00	0.00
Project Manager	44.07/hr.	6	264.00	264.00	0.00
Total			**8,167.00**	**8,167.00**	**0.00**
Task #13: Administer Adaptive Management Plan					
Description	**Unit Cost**	**Qty.**	**Total**	**FCD**	**AWPF**
Environmental Program Analyst	52.06/hr.	80	4,165.00	4,165.00	0.00
Pesticide Applicator	33.58/hr.	2,400	80,592.00	80,592.00	0.00
Pesticide	75.00/gal.	75	5,625.00	5,625.00	0.00
Laborer	25.87/hr.	3,200	82,784.00	82,784.00	0.00
Project Manager	44.07/hr.	80	3,527.00	3,527.00	0.00
Total			**176,693.00**	**176,693.00**	**0.00**
SUBTOTAL PROJECT COST			**623,802.00**		
FCD TOTAL MATCH				**514,670.00**	
SUBTOTAL AWPF GRANT REQUEST					**122,132.00**
5% ADMINISTRATION COST					**6,105.00**
TOTAL AWPF GRANT REQUEST					**128,237.00**
GRAND TOTAL PROJECT COST			**642,907.00**		

TOTAL PROJECT BUDGET BREAKDOWN

AWPF Grant Request (20%)	**$128,237.00**
FCD Match (80%)	**$514,670.00**
Total Project Cost	**$642,907.00**

7) Detailed Matching Funds Breakdown

Work Assignment: Design Phase					
Task #4: Preparing Permit Applications					
Description	**Unit Cost**	**Qty.**	**Total**	**FCD Match**	**AWPF**
Principal Scientist/Ecologist	218.32/hr.	10	2,183.00	2,183.00	0.00
Geomorphologist	143.55/hr.	30	4,306.00	4,306.00	0.00
Riparian Ecologist	154.52/hr.	119	18,388.00	18,388.00	0.00
Wildlife Biologist	117.63/hr.	60	7,058.00	7,058.00	0.00
GIS Analyst and Cartographer	91.71/hr.	67	6,145.00	6,145.00	0.00
Scientist/Admin 1	60.81/hr.	12	730.00	730.00	0.00
Environmental Program Analyst	52.06/hr.	8	416.00	416.00	0.00
Planner	31.39/hr.	8	251.00	251.00	0.00
Landscape Architect	44.07/hr.	20	880.00	880.00	0.00
Project Manager	44.07/hr.	20	880.00	880.00	0.00
Total			**41,237.00**	**41,237.00**	**0.00**
Task # 5: Cultural Survey					
Description	**Unit Cost**	**Qty.**	**Total**	**FCD Match**	**AWPF**
Archeologist (Contract)	L.S.	1	50,000.00	50,000.00	0.00
Environmental Program Analyst	52.06/hr.	8	416.00	416.00	0.00
Landscape Architect	44.07/hr.	4	176.00	176.00	0.00
Project Manager	44.07/hr.	4	176.00	176.00	0.00
Total			**50,768.00**	**50,768.00**	**0.00**
Work Assignment: Implementation Phase					
Task #8: Saltcedar Removal					
Description	**Unit Cost**	**Qty.**	**Total**	**FCD Match**	**AWPF**
Implement SWPPP Components, Obtain Dust Permit and Post Project Sign	L.S.	1	7,500.00	7,500.00	0.00
Laborer w/Chainsaw	25.87/hr.	100	2,587.00	2,587.00	0.00
Laborer w/Chainsaw	25.87/hr.	100	2,587.00	2,587.00	0.00
Laborer w/Chainsaw	25.87/hr.	100	2,587.00	2,587.00	0.00
Laborer w/Chainsaw	25.87/hr.	100	2,587.00	2,587.00	0.00
Supervisor w/Chainsaw	37.83/hr.	100	3,783.00	3,783.00	0.00
Chainsaw Rental	65.00/day	65	4,225.00	4,225.00	0.00
Pesticide Applicator	33.58/hr.	80	2,686.00	2,686.00	0.00
Pesticide Applicator	33.58/hr.	80	2,686.00	2,686.00	0.00
Pesticide	75.00/gal.	45	3,375.00	3,375.00	0.00
Track Hoe / Excavator Rental	850/day	30	25,500.00	25,500.00	0.00
Equipment Operator	35.14/hr.	880	30,923.00	30,923.00	0.00
Frontend Loader Rental	850/day	15	12,750.00	12,750.00	0.00
Bulldozer Rental	850/day	30	25,500.00	25,500.00	0.00
Water Truck Rental	400/day	34	13,600.00	13,600.00	0.00
Potable Water Meter w/BFP & Lock,	2,500/ea.	L.S.	2,500.00	2,500.00	0.00
Large Portable Grinder Rental	3,500/wk.	3	10,500.00	10,500.00	0.00
Environmental Program Analyst	52.06/hr.	8	416.00	416.00	0.00
Landscape Architect	34.25/hr.	36	1,233.00	1,233.00	0.00

Landscape Architect	44.07/hr.	36	1,586.00	1,586.00	0.00
Project Manager	44.07/hr.	16	705.00	705.00	0.00
Total			**160,816.00**	**160,816.00**	**0.00**
Task #9: Clear, Grub, & Grade					
Description	**Unit Cost**	**Qty.**	**Total**	**FCD Match**	**AWPF**
Implement SWPPP Components, Obtain Dust Permit and Post Project Sign	L.S.	1	7,500.00	7,500.00	0.00
Equipment Operator	35.14/hr.	512	17,992.00	17,992.00	0.00
Water Truck Rental	400/day	34	13,600.00	13,600.00	0.00
Bulldozer Rental	850/day	30	25,500.00	25,500.00	0.00
Potable Water Meter w/BFP & Lock,	2,500.00	L.S.	2,500.00	2,500.00	0.00
Planner	31.29/hr.	16	501.00	501.00	0.00
Landscape Architect	44.07/hr.	20	882.00	882.00	0.00
Landscape Architect	34.25/hr.	32	1,096.00	1,096.00	0.00
Project Manager	44.07/hr.	10	441.00	441.00	0.00
Total			**70,012.00**	**70,012.00**	**0.00**
Work Assignment: Develop Adaptive Management Program					
Task #11: Develop Maintenance Plan					
Description	**Unit Cost**	**Qty.**	**Total**	**FCD**	**AWPF**
Environmental Program Analyst	52.06/hr.	8	416.00	416.00	0.00
Landscape Architect	34.25/hr.	24	822.00	822.00	0.00
Landscape Architect	44.07/hr.	24	1,058.00	1,058.00	0.00
Planner	31.39/hr.	8	251.00	251.00	0.00
Riparian Ecologist	154.52/hr.	14	2,163.00	2,163.00	0.00
Wildlife Biologist	117.63/hr.	4	470.00	470.00	0.00
Maintenance Division Manager	56.82/hr.	24	1,364.00	1,264.00	0.00
Pesticide Applicator	33.58/hr.	8	269.00	269.00	0.00
Project Manager	44.07/hr.	6	264.00	264.00	0.00
Total			**6,977.00**	**6,977.00**	**0.00**
Task #12: Develop Monitoring Plan					
Description	**Unit Cost**	**Qty.**	**Total**	**FCD**	**AWPF**
Environmental Program Analyst	52.06/hr.	8	416.00	416.00	0.00
Landscape Architect	34.25/hr.	24	822.00	822.00	0.00
Landscape Architect	44.07/hr.	24	1,058.00	1,058.00	0.00
Planner	31.39/hr.	8	251.00	251.00	0.00
Riparian Ecologist	154.52/hr.	24	3,708.00	3,708.00	0.00
Wildlife Biologist	117.63/hr.	4	470.00	470.00	0.00
Maintenance Division Manager	56.82/hr.	16	909.00	909.00	0.00
Pesticide Applicator	33.58/hr.	8	269.00	269.00	0.00
Project Manager	44.07/hr.	6	264.00	264.00	0.00
Total			**8,167.00**	**8,167.00**	**0.00**
Task #13: Administer Adaptive Management Plan					
Description	**Unit Cost**	**Qty.**	**Total**	**FCD**	**AWPF**

Environmental Program Analyst	52.06/hr.	80	4,165.00	4,165.00	0.00
Pesticide Applicator	33.58/hr.	2,400	80,592.00	80,592.00	0.00
Pesticide	75.00/gal.	75	5,625.00	5,625.00	0.00
Laborer	25.87/hr.	3,200	82,784.00	82,784.00	0.00
Project Manager	44.07/hr.	80	3,527.00	3,527.00	0.00
Total			**176,693.00**	**176,693.00**	**0.00**
FCD TOTAL MATCH				**514,670.00**	

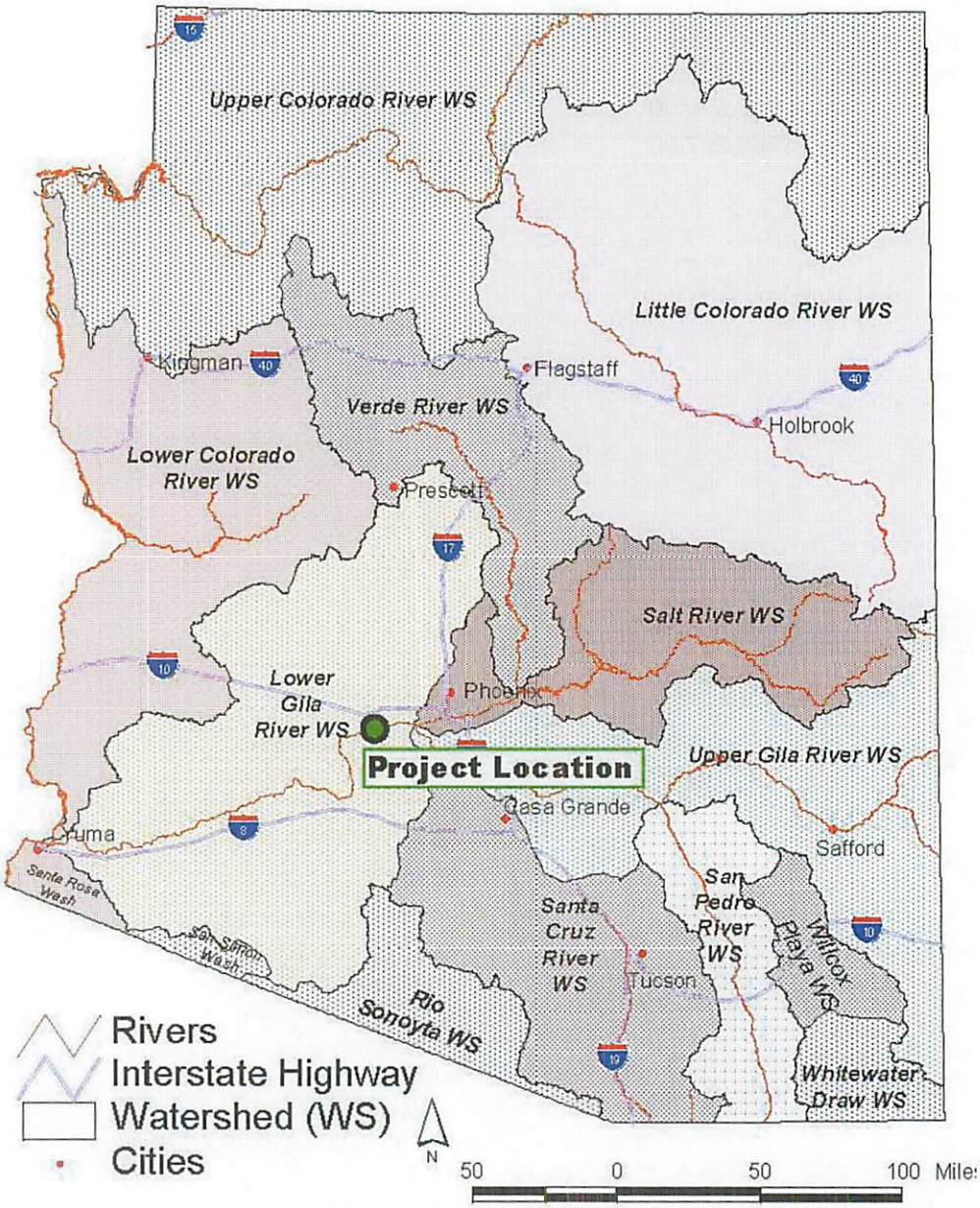
TOTAL PROJECT BUDGET BREAKDOWN

AWPF Grant Request (20%)	**$128,237.00**
FCD Match (80%)	**$516,670.00**
Total Project Cost	**$644,907.00**

8) Project Maps and Schematic

a. Arizona Watershed Map

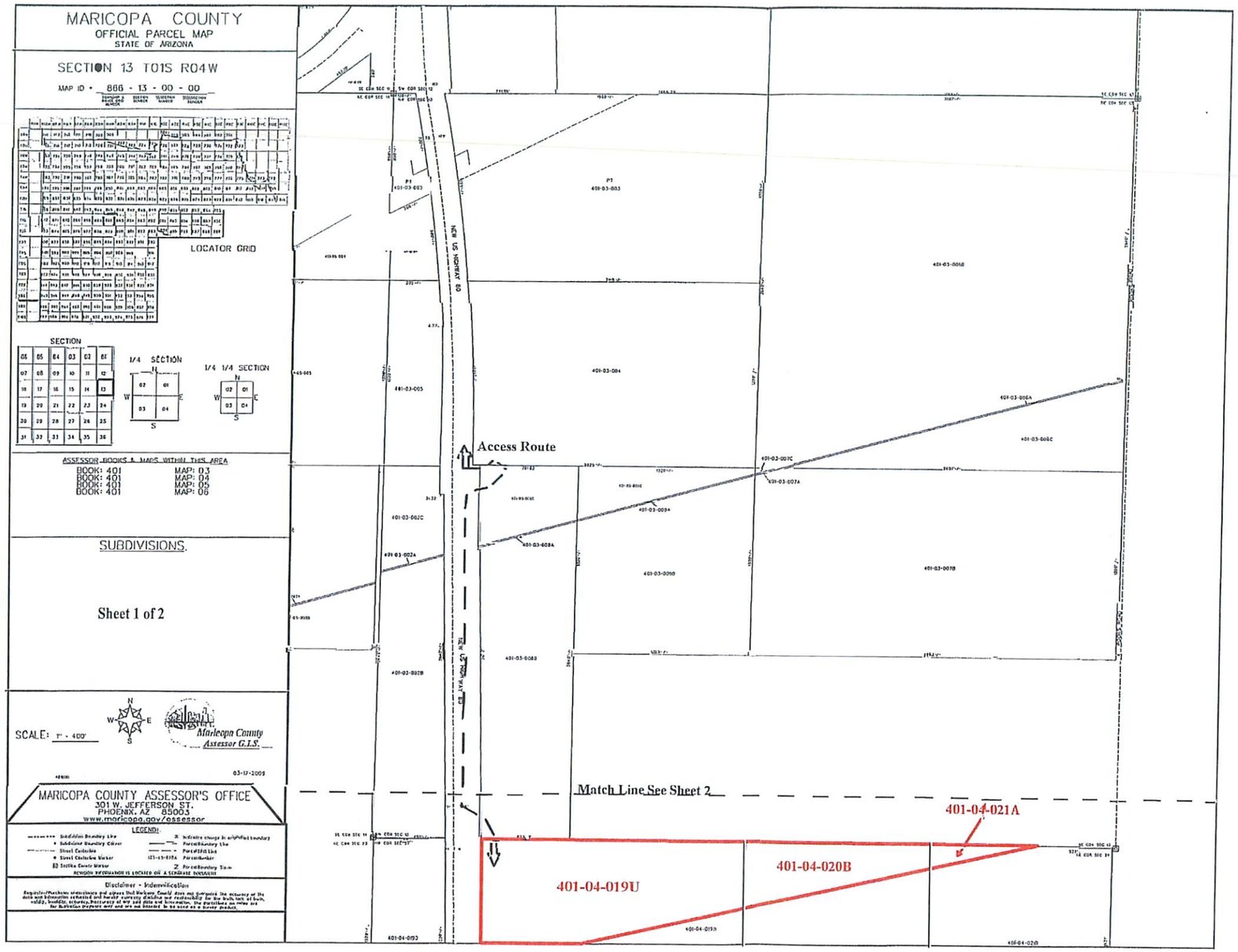
Arizona Watershed Map
FY 2017



Title of Project: Salt Cedar Management and Native Vegetation Restoration Pilot Project for the Gila River

Location: (UTM's and Tnshp./Sect./Range) Section 24 T01S R04W; 33.340919, -112.619321

b. Project Ownership Map



MARICOPA COUNTY
OFFICIAL PARCEL MAP
STATE OF ARIZONA

SECTION 24 T01S R04W

MAP ID • 866 - 24 - 00 - 00

LOCATOR GRID

SECTION

1/4 SECTION

1/4 1/4 SECTION

ASSESSOR BOOKS & MAPS WITHIN THIS AREA
BOOK: 400 MAP: 46
BOOK: 401 MAP: 04

SUBDIVISIONS

Sheet 2 of 2

SCALE: 1" = 400'

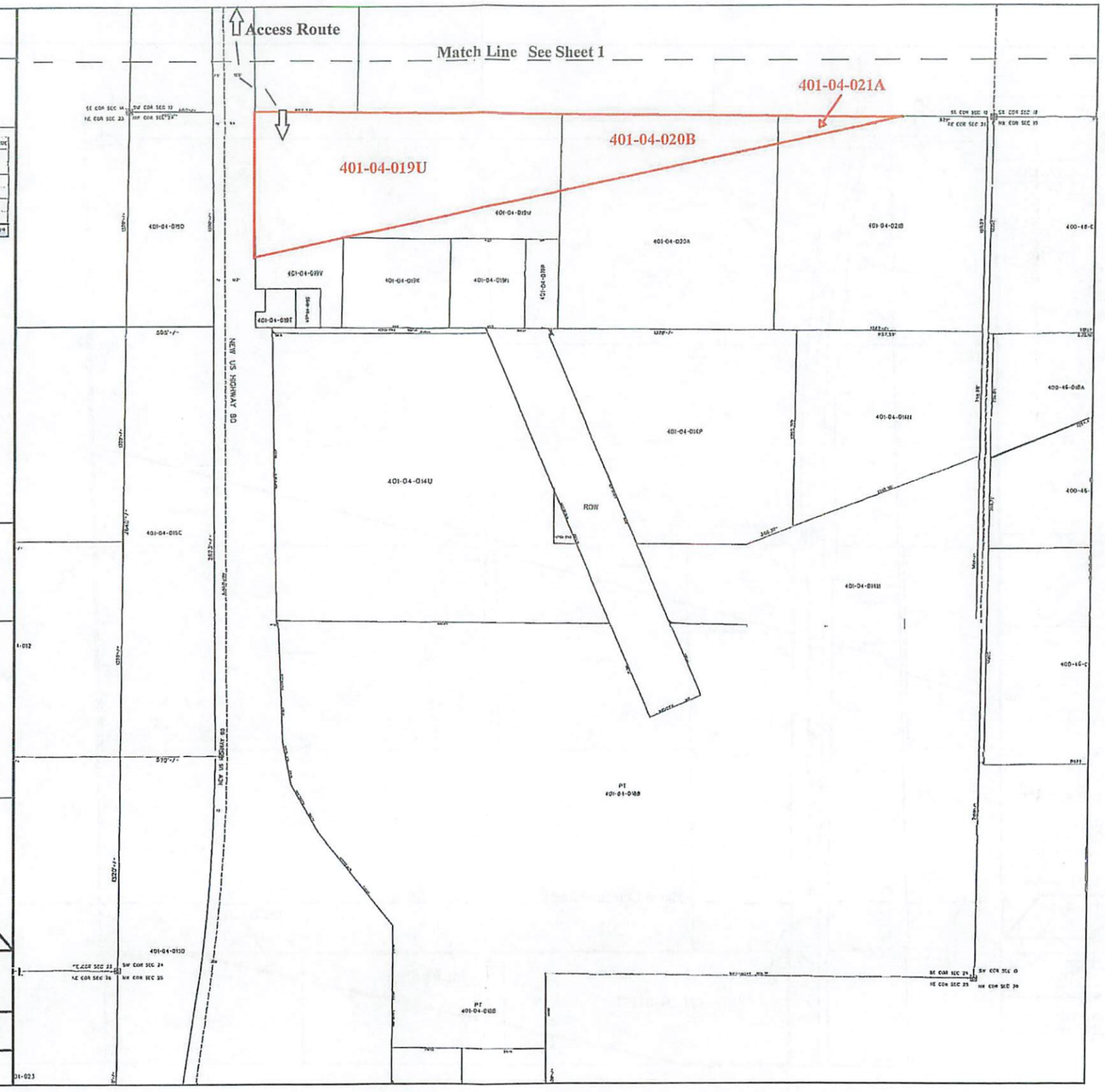
Maricopa County Assessor G.I.S.

08-23-2010

MARICOPA COUNTY ASSESSOR'S OFFICE
301 W. JEFFERSON ST.
PHOENIX, AZ 85003
www.maricopa.gov/assessor

LEGEND:

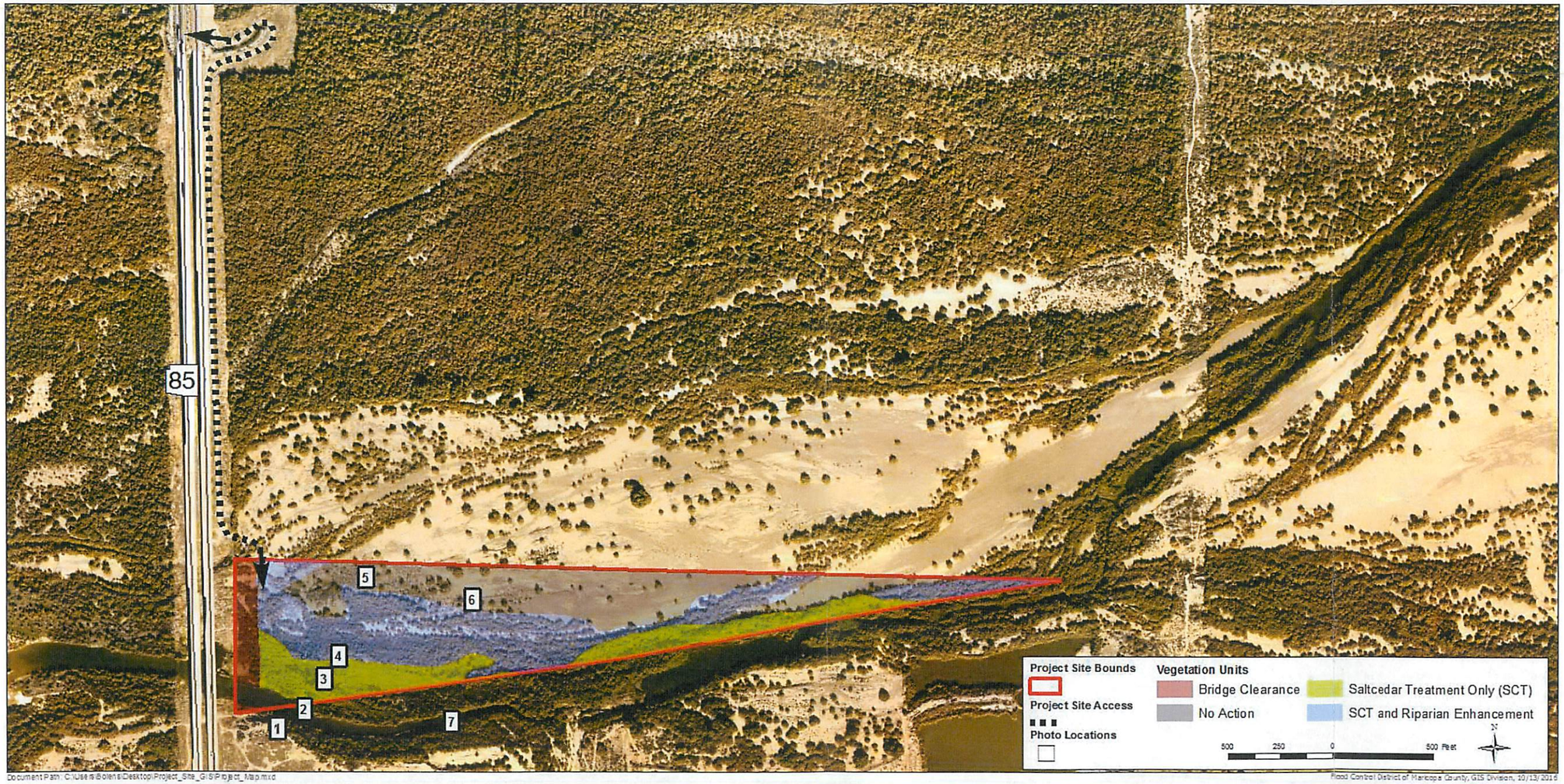
Disclaimer - Indemnification



c. Project Schematic Plans

Vegetation Management Plan

Pilot Project



Document Path: C:\Users\Bolen\Desktop\Project_Site_GIS\Project_Map.mxd

Flood Control District of Maricopa County, GIS Division, 10/13/2016

2801 West Durango Street, Phoenix, Arizona 85009, (602) 506-1501

www.fcd.maricopa.gov

Photo 1 (Looking E)

Photo 2 (Looking NE)

Photo 3 (Looking NE)

Photo 4 (Looking NE)

Photo 5 (Looking S)

Photo 6 (Looking W)

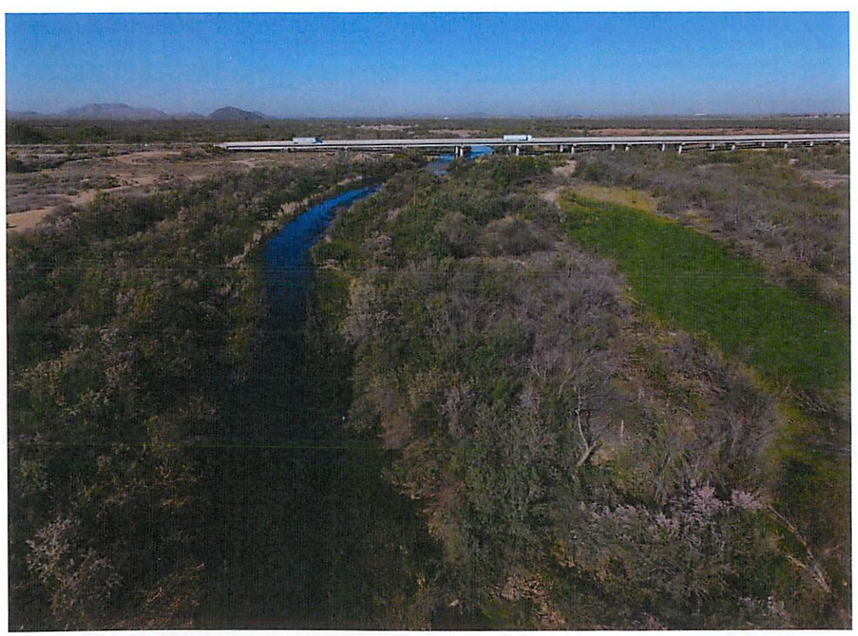


Photo 7 (Looking W)

This project will utilize the Vegetation Management Units (VMU) identified in the El Rio Vegetation Management Plan as the general guideline for the pilot project. There are four VMUs identified in the project area: Bridge Clearance, No Action, Saltcedar Treatment Only, and Saltcedar Treatment and Riparian Enhancement. The only VMU that will require new planting is Saltcedar Treatment and Riparian Enhancement. Planting will occur within the areas identified and with the species recommended in the El Rio Vegetation Management Plan. The species, propagule types, and proposed densities are identified in the table below.

Recommended Species and Densities for Riparian Enhancement Vegetation Management Unit*			
Common name	Scientific name	Propagule Type	Proposed Density
Trees			
Fremont cottonwood	*Populus fremontii*	Pole cutting	20 poles/ac
Godding's willow	*Salix goddingii*	Pole cutting	20 poles/ac
Shrubs			
Seep willow	*Baccharis salicifolia*	Pole cutting	60 poles/ac
Emory baccharis	*Baccharis emoryi*	Seed	2.0 lbs/ac
Spiny hackberry	*Celtis ehernbergiana* (Formerly *Celtis pallida)*	Tall pot	30 pots/ac
Burrobush	*Hymenoclea monogyra*	Seed	2.0 lbs/ac
Coyote willow	*Salix exigua*	Pole cutting	60 poles/ac
Herb/Forbs/Vines			
Missouri gourd	*Cucurbita foetidissima*	Seed	.5 lbs/ac
Sacred thorn-apple	*Datura wrightii*	Seed	1.0 lbs/ac
Desert saltgrass	*Distichlis spicata*	Seed	.5 lbs/ac
Fringed twinevine	*Funastrum cynanchoides*	Seed	.5 lbs/ac
Alkali muhly	*Muhlenbergia asperfolia*	Seed	1.0 lbs/ac
Alkali sacaton	*Sporobolus airoides*	Seed	1.0 lbs/ac
Additional Herb/Forbs/Vine as recommended per seed availability and presence on site			
*Referenced from Table 3, Volume 3, El Rio Vegetation Management Plan. Species type and density proposed and are subject to change based upon site analysis and final design			

9) Supplemental Information

a. State Historic Preservation Office (SHPO) Review Form

As pursuant to the National Historic Preservation Act (NHPA), the District will consult with The State Historic Preservation Office (SHPO) to determine if they would consider issuing a letter of "No Impact", as the construction activities will occur within the floodway where ground has been forcibly impacted due to major flooding. If SHPO rejects issuing a Letter of No Impact the District is prepared to hire an archeologist from their on-call list to perform a Cultural Survey of the Pilot Project site. This would occur during implementation of the design phase in task five of the scope of work. Additionally, the District will have an archeologist on site during any ground disturbance activities to monitor for cultural resources. A cultural inventory has previously been conducted for the El Rio reach of the Gila River and the full text is included in this submittal package.

STATE HISTORIC PRESERVATION OFFICE
Review Form

In accordance with the State Historic Preservation Act (SHPO), A.R.S. 41-861 *et seq*, effective July 24, 1982, each State agency must consider the potential of activities or projects to impact significant cultural resources. Also, each State agency is required to consult with the State Historic Preservation Officer with regard to those activities or projects that may impact cultural resources. Therefore, it is understood that **recipients of state funds are required to comply with this law** throughout the project period. All projects that affect the ground-surface that are funded by AWPF require SHPO clearance, **including those on private and federal lands.**

The State Historic Preservation Office (SHPO) must review each grant application recommended for funding in order to determine the effect, if any, a proposed project may have on archaeological or cultural resources. To assist the SHPO in this review, the following information MUST be submitted with each application for funding assistance:

- A completed copy of this form, and
- A United States Geological Survey (USGS) 7.5 minute map
- A copy of the cultural resources survey report if a survey of the property has been conducted, and
- A copy of any comments of the land managing agency/landowner (i.e., state, federal, county, municipal) on potential impacts of the project on historic properties.
  NOTE: If a federal agency is involved, the agency must consult with SHPO pursuant to the National Historic Preservation Act (NHPA); a state agency must consult with SHPO pursuant to the State Historic Preservation Act (SHPA),
  OR
- A copy of SHPO comments if the survey report has already been reviewed by SHPO.

Please answer the following questions:

1. Grant Program: Arizona Water Protection Fund
2. Project Title: Gila River Vegetation Management and Restoration Plan
3. Applicant Name and Address: Flood Control District of Maricopa County; 2801 W Durango St, Phoenix, AZ 85009
4. Current Land Owner/Manager(s): Flood Control District of Maricopa County
5. Project Location, including Township, Range, Section: Maricopa County; T1S, R4W, S24
6. Total Project Area in Acres (or total miles if trail): 36.7
7. Does the proposed project have the potential to disturb the surface and/or subsurface of the ground? ☒ YES ☐ NO
8. Please provide a brief description of the proposed project and specifically identify any surface or subsurface impacts that are expected: _____

The project involves the removal of previously established salt cedar using heavy machinery and planting of native riparian vegetation.

9. Describe the condition of the current ground surface within the entire project boundary area (for example, is the ground in a natural undisturbed condition, or has it been bladed, paved, graded, etc.). Estimate horizontal and vertical extent of existing disturbance. Also, attach photographs of project area to document condition: _____

   The area is in a naturally undisturbed condition.

10. Are there any known prehistoric and/or historic archaeological sites in or near the project area? ☐ YES ☒ NO

11. Has the project area been previously surveyed for cultural resources by a qualified archaeologist? ☐ YES ☒ NO ☐ UNKOWN

    If YES, submit a copy of the survey report. Please attach any comments on the survey report made by the managing agency and/or SHPO

12. Are there any buildings or structures (including mines, bridges, dams, canals, etc.), which are 50-years or older in or adjacent to the project area? ☐ YES ☒ NO

    If YES, complete an Arizona Historic Property Inventory Form for each building or structure, attach it to this form and submit it with your application.

13. Is your project area within or near a historic district? ☐ YES ☒ NO

    If YES, name of the district:

Please sign on the line below certifying all information provided for this application is accurate to the best of your knowledge.

Walt Kinsler / 10/14/16 WALT KINSLER

Applicant Signature /Date Applicant Printed Name

FOR SHPO USE ONLY
SHPO Finding: ☐ Funding this project will not affect historic properties. ☐ Survey necessary – further GRANTS/SHPO consultation required (*grant funds will not be released until consultation has been completed*) ☐ Cultural resources present – further GRANTS/SHPO consultation required (*grant funds will not be released until consultation has been completed*)
SHPO Comments
For State Historic Preservation Office: Date:

b. Key Personnel

Flood Control District of Maricopa County:

Ben Ganados, Weed and Pest Control Specialist: is the Ecology Technician for the District. Ben's primary duties for the El Rio Pilot Project will be to manage the Tall Pot Tree Nursery along with providing maintenance and monitoring for the project site and assist in developing and administering the Adaptive Management Plan.

Bob Stevens, Environmental Program Analyst: with over 20 years of District experience, Bob's primary duties have been to ensure that the design, construction and maintenance of flood control facilities, remain in compliance with all local, state and federal environmental regulations. He currently manages the 404/401 permitting program for the District which supports Regional Area Drainage and Water Course Master Plans, in addition to Dam Rehabilitation Studies and has coordinated with various municipal, state and federal agencies including the Army Corps of Engineers, Bureau of Land Management and the Natural Resource Conservation Service. Bob was worked on several restoration projects including the Rio Salado Environmental Restoration Project, the rehabilitation of the New River and Skunk Creek Channel. Bob's primary duties for the AWPF Pilot Project includes oversight of all environmental and cultural permitting including federal 404 and state 402 Clean Water Act permit compliance; with a special emphasis on habitat restoration and vegetation clearing, and archeological mitigation in compliance with the National Historic Preservation Act of 1966, b) the Arizona Antiquities Act of 1927 and the State Historic Preservation Act of 1982, and assist in developing the Adaptive Management Plan.

Charlie Klenner, Maintenance Division Manager: has over 30 years of working for the District with the last 15 years as the Operations and Maintenance (O&M) Division Manager., Charlie is responsible for the maintenance of District flood control structures to insure that they function as designed, protect the natural environment and the beneficial values served by open space. Many of the structures are within multi-use facilities that include trail systems. Charlie managed the field operations of the District's Buck Fire project that included removing invasive non-native vegetation, replanting with tall-pot stock, seeded the area with native plants, and provided maintenance of the area. The O&M Division has also been involved in the El Rio test site providing saltcedar removal, land contouring, and assisted in the pole planting of native trees. Charlie has worked closely with the US Army Corps of Engineers on the Indian Bend Wash and Tress Rios Habitat Restoration Projects providing technical review of plans and developing the O&M plans. Charlie's primary duties for the AWPF Pilot Project will be to coordinate and monitor all the construction activities and assist in developing and administering the Adaptive Management Plan.

Kaylee Colter, RLA Landscape Designer/Planner: is a registered landscape architect working for the District since the fall of 2016. She earned her undergraduate degree in Landscape Architecture (BSLA) from ASU in 2010. Following graduation she worked in the private sector for over five years acquiring landscape design and project management experience. In 2016 she earned a Master's Degree in Applied Biological Sciences (MS), where her research focused on sustainable landscape design and horticulture. Kaylee's primary duties for the AWPF Pilot Project will be planting design, collection of native seeds, oversight of plant propagation at the District's nursery, and field directives, quality control and quality assurance for all construction activities, and assist in the Adaptive Management Plan.

Spencer Bolen, Planner: received his Master's degree in Urban and Environmental Planning from ASU May 2016 and has been primarily involved as a planner on the El Rio Vegetation Management Plan and Pilot Project projects and has been with the District since February 2016. Spencer's primary duties for the AWPF Pilot Project will be to provide GIS mapping and data collection.

Walt Kinsler, RLA Project Manager: is a registered landscape architect with over 32 years of local experience working on multifaceted public works projects going from concept development through final construction closeout. He spent 10-years as the Rio Salado project manager for the City of Phoenix's and US Army Corps of Engineer's Environmental Restoration Project and the Rio Salado Oeste Project. Walt's primary duties for the AWPF Pilot Project will be as both a landscape architect and project manager responsible for overseeing and preparing the planting design, collection of native seeds, construction administration including quality control and quality assurance for all construction activities, administration of contract services and the Water Protection Fund grant, and assist in developing and administering the Adaptive Management Plan.

Stillwater Science:

Glen Leverich, P.G., Senior Geomorphologist/Geologist: has 14 years of experience in hydro-geomorphic investigations, watershed assessment, and restoration planning within upland, riverine, and coastal systems throughout the western U.S. He has worked on a diversity of projects encompassing the interaction of biophysical dynamics and anthropogenic activities, all striving to provide watershed managers with the informed, cost-effective strategies needed to implement sustainable land-use planning and resource conservation. His technical experience includes interpreting geologic and hydrologic conditions, assessing hillslope erosion rates and processes, constructing watershed-wide sediment budgets, quantifying sediment transport through upland and lowland channel networks, evaluating hydromodification drivers and impacts, and developing restoration solutions for critical fisheries and wildlife habitat. Glen's primary duties for the AWPF Pilot Project will serve as Stillwater Science's project manager, co-lead the pilot site assessment, and review all District products.

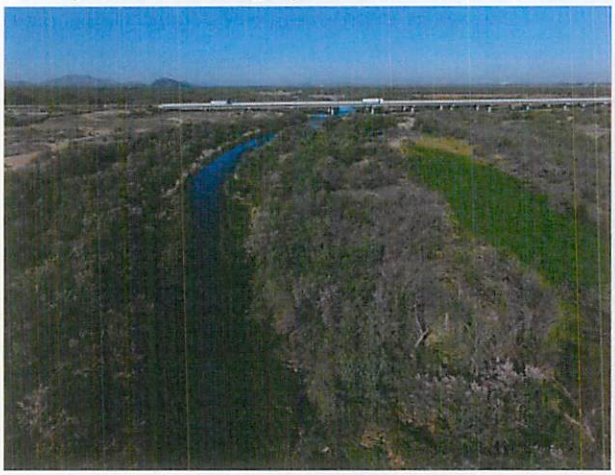
Zooey Diggory, Riparian Ecologist: graduated in 2007 with a Master's of Science Biology *(Ecology and Systematic Biology emphasis).* She is an ecologist with 18 years of experience managing watershed assessment and restoration planning programs, integrating physical and biological processes and conditions, and analyzing environmental impacts for regulatory purposes. Her technical expertise includes riparian and wetland plant ecology, vegetation mapping and rare plant surveys, vegetation monitoring design and implementation, and U.S. Army Corps of Engineers jurisdictional wetland delineation. Zooey's primary duties for the AWPF Pilot Project will be with the Site Assessment Preliminary Jurisdictional Delineation, and review of the vegetation management unit planting plan. She will also develop and implementing an adaptive management plan where she will provide technical expertise on riparian and wetland plant ecology, vegetation mapping, surveys for special-status plants and noxious weeds. Zooey's primary duties for the AWPF Pilot Project will be to co-lead the pilot site assessment, review all District products, and lead or oversee the development of documents to support permitting, such as the project description, wetland delineation, and Adaptive Management Plan. In addition she will help administer the Adaptive Management Plan

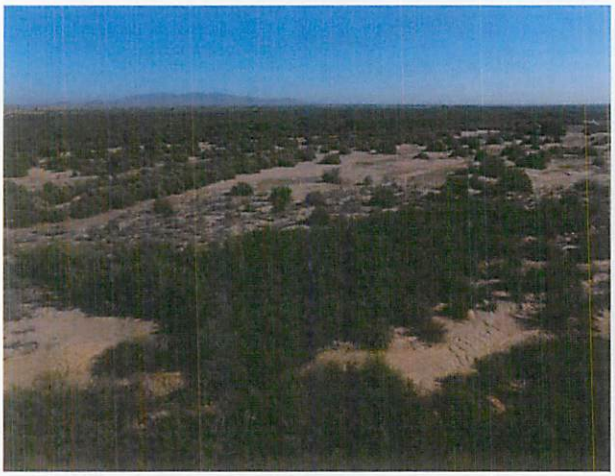
Karley Rodriguez, GIS Analyst and Project Assistance: specializes in Geographic Information Systems (GIS) analysis, geographic visualization and cartography, and data management. She works inter-disciplinarily with resource scientists to perform GIS and data analyses; produce maps and figures; and assist with project reporting. Karley's primary duties for the AWPF Pilot Project will be to develop maps

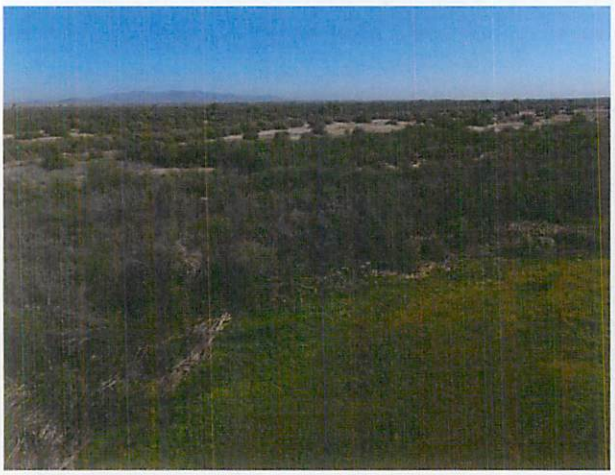
and graphics for the site assessment and other Stillwater Sciences products, and assist Glen, Zooey, and Holly with Adaptive Management Plan development.

Holly Burger, Wildlife Biologist: is a wildlife biologist with 16 years of experience conducting special-status species surveys and habitat assessments for a variety of amphibians, reptiles, birds, and mammals in the western U.S., as well as experience developing environmental impact analyses and mitigation plans for special-status terrestrial and aquatic wildlife. Holly has managed projects from the development of study plans, performing and leading field surveys, and analyzing data to writing and editing regulatory report sections. Holly's primary duties for the AWPF Pilot Project will be to provide wildlife-related input to the site assessment, review the District's site design and Adaptive Management Plan, and lead the development of the Biological Resources Evaluation report.

c. Project Site Photographs







d. Relevant Reports

- **El Rio Vegetation Management Plan (Hard Copy Enclosed & Digital Copy Provided)**

- **El Rio Watercourse Master Plan (Digital Copy Provided)**

Between 2002 and 2006, a comprehensive biological and hydrological study of the El Rio reach of the Gila River (including the Pilot Project site), called the El Rio Watercourse Master Plan (WCMP) (see Supplemental), was conducted through a cooperative effort between the District, Avondale, Buckeye, Goodyear, and the County's Parks and Recreation and Planning and Development departments. The WCMP provided the basis for evaluating and recommending flood risk management alternatives that maintain and enhance the Gila River's natural functions and recommended replacing non-native, invasive saltcedar with native TLB-resilient species. The purpose of the El Rio WCMP is to examine the benefits, opportunities, and impacts of a range of flood control management plans that address the flood and erosion hazards and impending development pressures in consideration of public safety, social, economic, and environmental factors and to recommend a preferred water course masterplan. Development of the plan is based on public coordination; hydrologic, hydraulic and sediment analyses; geomorphic evaluations and environmental and visual resource investigations.

- **El Rio Cultural Inventory (Digital Copy Provided):** "A Cultural Resource Assessment of the El Rio Archeological Research Locale in West-Central Maricopa County, Arizona"

In 2002, Scientific Archeological Services completed an assessment of prehistoric and historic archeological sites occurring in the El Rio archeological locale. This archeological assessment project was sponsored solely by the Flood Control District of Maricopa County. The El Rio Locale encompasses 69 square miles surrounding the El Rio reach of the Gila River, including the Pilot Project site.

BUCKEYE, AZ

CITY OF BUCKEYE
OFFICE OF THE MAYOR

October 5, 2016

Grant Review Committee
Arizona Water Protection Fund Commission
1110 West Washington Street, Suite 310

Re: Letter of Support for the Maricopa County Flood Control District Application FY 2017 Water Protection Fund Grant

Dear Grant Review Committee:

The City of Buckeye is writing to express our support for the Maricopa County Flood Control District's Application of the FY 2017 Water Protection Fund Grant.

The Cities of Buckeye, Goodyear, Avondale and Maricopa County along with other agencies and stakeholders have worked together over the last several years and have invested collectively over $2,000,000 in an effort to restore the Gila River through planning and mitigation measures tied to the issues that plague the rivers corridor. As you know, the salt cedar is a non-native tree species that has proliferated across the Gila River corridor over the last century adding growing concerns of fire, flooding, and stress to the water supply. Lastly, salt cedars can retain enough sediment that can severely reshape a watershed and create flooding issues that threaten critical public infrastructure like water treatment facilities, bridges, roads, and irrigation systems.

The El Rio Corridor, which is an 18 mile stretch of the Gila River from the SR85 bridge east to Bullard Avenue cannot be completed by a single entity, it will take the collective efforts of many communities, stakeholders, and agencies to restore the river and mitigate the issues. The Water Projection Grant Fund opportunity is a small step, but will get us closer to the goal of restoring the Gila River.

Thank you for your time and consideration. We look forward to supporting the Flood Control District of Maricopa County and any other agency involved in the Gila River initiatives.

Sincerely,

Jackie A. Meck, Mayor
City of Buckeye

530 E. Monroe Ave. • Buckeye, Arizona 85326
Phone 623-349-6955 • Fax 623-349-6951 • www.buckeyeaz.gov

Maricopa County

Clint Hickman, Chairman
Board of Supervisors, District 4

301 West Jefferson Street
10th Floor
Phoenix, AZ 85003-2143
Phone: 602-506-7642
Fax: 602-506-4989
www.maricopa.gov

October 6, 2016

Grant Review Committee
Arizona Water Protection Fund Commission
1110 West Washington Street, Suite 310
Phoenix, AZ 85007

RE: Letter of Support for the Maricopa County Flood Control District Application-
FY 2017 Water Protection Fund Grant

Dear Grant Review Committee:

This letter is intended to express my support for the Flood Control District of Maricopa County's (District) efforts in seeking funding through the Arizona Water Protection Fund Commission's FY2017 Grant Cycle. These funds will assist the District in restoring a 40 acre Pilot Project site in the Gila River by replacing non-native salt cedar with native riparian vegetation. These efforts will help improve flood flows, protect fish and wildlife habitats while also improving floodplain stabilization, groundwater recharge, and surface flow filtration. In addition, methods to reduce fire hazards resulting from salt cedar concentrations would be developed and demonstrated with the successful completion of the Pilot Project.

Salt cedar is a non-native invasive plant that has proliferated throughout the Gila River corridor, posing numerous environmental and public safety concerns. The concentration of salt cedar plants in the Gila River between the confluence of the Agua Fria and Painted Rock Dam has expanded the floodplain by nearly 7,000 acres. Hundreds of homes will now have to carry flood insurance as a result of the uncontrolled salt cedar growth.

Originally conceived in the El Rio Watercourse Master Plan, adopted in 2006, this revegetation effort is endorsed by the Cities of Buckeye, Avondale, and Goodyear as well as Maricopa County Planning and Development and Parks and Recreation Departments. In addition, Senator McCain, with support from Congressmen Gosar and Grijalva, sent a letter in May of this year to the United States Army Corps of Engineers expressing their interest in using the Corps ecosystem restoration and flood control missions to remove salt cedar from the Gila River.

We find ourselves at a crossroads with this critically important issue; the magnitude of the problem; removing salt cedar forest, far exceeds the District's and most municipality's available resources. Partnerships with non-profit groups, businesses, and landowners, as well as federal, state and local governments are vitally important if we are to successfully control salt cedar infestation. Grant funding through the Arizona Water Protection Fund will provide the desperately needed resources required to mitigate flood and fire hazards while also creating healthy sustainable river environments.

I appreciate your consideration of the District's grant application.

Sincerely,

Clint Hickman, Chairman
Board of Supervisors, District 4

Congress of the United States

Washington, DC 20510

May 31, 2016

The Honorable Jo-Ellen Darcy
Assistant Secretary of the Army (Civil Works)
108 Army Pentagon
Washington, D.C. 20310

Dear Assistant Secretary Darcy:

We write to express support for an Army Corps of Engineers ecosystem restoration and flood control project to remove and replace the invasive salt cedar tree along the Gila River. Restoring the river's natural ecosystem could prevent future flood events from threatening communities along the river.

As you may know, a recent floodplain designation of the Gila River area by the Federal Emergency Management Agency (FEMA) found that salt cedar growth has increased the 100-year floodplain size by seven square miles—requiring thousands of farms, homeowners, and businesses in Goodyear and Buckeye to purchase expensive flood insurance policies. There are also concerns that fires, due to a highly combustible oil found in the salt cedar, threaten existing and future infrastructure in these communities.

To address these concerns, local elected officials and representatives from relevant state and federal agencies met in March and agreed that Army Corps assistance is required for this project. Subsequently, Maricopa County's Flood Control District has submitted a proposal to the Army Corps' Los Angeles District seeking assistance under Section 205 or 206 of the Water Resources Development Act of 1996, which we have attached for your review.

Given these concerns, we respectfully ask that you respond to the Maricopa County Flood Control District's request for assistance and provide copies to our offices. As always, we ask that this matter be handled in strict accordance within existing law, rules, regulations, and ethical guidelines. Thank you for your attention to their request.

Sincerely,

John McCain
United States Senator

Paul A. Gosar
Member of Congress

Raúl M. Grijalva
Member of Congress

Enclosure

THE STATE OF ARIZONA
GAME AND FISH DEPARTMENT
5000 W. CAREFREE HIGHWAY
PHOENIX, AZ 85086-5000
(602) 942-3000 • WWW.AZGFD.GOV

GOVERNOR
DOUGLAS A. DUCEY
COMMISSIONERS
CHAIRMAN, EDWARD "PAT" MADDEN, FLAGSTAFF
JAMES R. AMMONS, YUMA
JAMES S. ZIELER, ST. JOHNS
ERIC S. SPARKS, TUCSON
KURT R. DAVIS, PHOENIX
DIRECTOR
LARRY D. VOYLES
DEPUTY DIRECTOR
TY E. GRAY

September 22, 2016

Grant Review Committee
Arizona Water Protection Fund Commission
1110 West Washington Street, Suite 310
Phoenix, AZ 85007

RE: Letter of Support for the Maricopa County Flood Control District Application-
FY 2017 Water Protection Fund Grant

Dear Grant Review Committee:

The Arizona Game and Fish Department (AZGFD) has prepared this correspondence to express support for the Maricopa County Flood Control District (District) to seek funding for its Capital Improvement Project through the Water Protection Fund Commission FY2017 Grant Cycle.

The AZGFD has been involved in restoration efforts within the Lower Gila River Basin for many years and fully understand the challenges in managing vegetation and ephemeral flows in this area. There are currently many collaborative efforts underway to address the salt cedar infestation problem but to date the implementation of many of these efforts have been put on hold due to lack of funding. Habitat restoration is an expensive undertaking and given the amount of acreage that would need to be re-claimed in the Lower Gila River Basin, the cost is extensive. However, in order to possibly attract the level of funding that is needed, pilot projects must be implemented to illustrate that salt cedar removal and subsequent restoration can occur given the right collaborators and adequate funding.

The AZGFD understands that there is a critical need to start as soon as possible eradicating the salt cedar to reduce the risk of devastating wildfires and flooding in the area. It is also vital to start establishing native vegetation in the area prior to the arrival of the tamarisk beetle so that habitat for a wide variety of wildlife species in the area, some of which are endangered, can be re-established prior to the defoliation that will occur once the beetle becomes present in the area. Funding received from the Water Protection Fund will help to jumpstart all of these efforts that have been in the planning stages for many years. The AZGFD is committed in providing technical support to the MCFCD and is in full support of this grant funding request.

Should you have questions regarding this letter, please do not hesitate to contact me at (602) 828-4239.
Sincerely,

Timothy P. Wade
In Lieu Fee and Habitat Restoration Program Manager

f. Evidence of Control and Tenure of Land

a. Parcel 401-04-019U (West Parcel)

401-04-019U Land Parcel

This is a land parcel and the current owner is FLOOD CONTROL DISTRICT OF MARICOPA COUNTY. Its current year full cash value is $69,900.

Property Information

MCR #	
Description:	TH PT N2 NW4 SEC WH LIES E OF STATE ROUTE 85 (OLD U S HWY 80) P/D 1226-393 & 6723-690 & N OF FOL DESC LN COM SW COR E2 NW4 NW4 TH N ALG W LN TH/OF 550F TO TPOB TH NELY TO PT OF TERMINUS ON E LN NW4 SEC WH IS 865F N OF SE COR N2 NW4 SEC
Lat/Long	
Lot Size	1,147,370 sq ft.
Zoning	RR
Lot #	
High School District	BUCKEYE UNION #201
Elementary School District	BUCKEYE ELEMENTARY SCHOOL DISTRICT
Local Jurisdiction	BUCKEYE
S/T/R	24 1S 4W
Market Area/Neighborhood	25/004
Subdivision (0 Parcels)	

Owner Information

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Mailing Address	2801W DURANGO ST , PHOENIX, AZ 85009
Deed Number	900111573
Last Deed Date	03/14/1990
Sale Date	n/a
Sale Price	n/a

Valuation Information

We provide valuation information for the past 5 years. For mobile display, we only show 1 year of valuation information. Should you need more data, please look at our data sales.

Tax Year	2017	2016	2015	2014	2013
Full Cash Value	$69,900	$69,900	$69,900	$69,500	$69,500
Limited Property Value	$69,900	$69,900	$69,900	$69,500	$69,500
Legal Class	2	2	2	2	2
Description	AG / VACANT LAND / NON-PROFIT R/P	AG / VACANT LAND / NON-PROFIT R/P	AG / VACANT LAND / NON-PROFIT R/P	AG / VACANT LAND / NON-PROFIT R/P	AG / VACANT LAND / NON-PROFIT R/P
Assessment Ratio	15%	15%	16%	16%	16%
Assessed FCV	n/a	n/a	n/a	$11,120	$11,120
Assessed LPV	$10,485	$10,485	$11,184	$11,120	$11,120
Property Use Code	9600	9600	9600	9600	9600
PU Description	County Property	County Property	County Property	County Property	County Property
Tax Area Code	330200	330200	330200	330200	330200
Valuation Source	Notice	Notice	Notice	Notice	Notice

Similar Parcels

Parcels that are similar to this one (known as the reference parcel) are displayed below.

APN Address Sale Info FCV Size Livable Sq Ft Year Built Pool Foreclosed

No similar parcels found.

FIRST SERVICE TITLE AGENCY, INC.

Approved: 2-8-89

When recorded, return to:

Flood Control District
of Maricopa County
3335 West Durango Street
Phoenix, Arizona 85009
02773 Lot

RECORDED IN OFFICIAL RECORDS
OF MARICOPA COUNTY, ARIZONA
MAR 14 '90 -10 00
HELEN PURCELL, County Recorder
FEE NC PGS 5 /B

WARRANTY DEED

90-111573

Project: Salt/Gila 1000 Foot Corridor

Item: G-33

Assessor Parcel No.: 401-4-19J,K,L,Q,N,T

GEORGE WILHITE and LILA WILHITE, his wife, GRANTORS, of Maricopa County, Arizona, for and in consideration of the sum of Ninety-two Thousand Two Hundred Dollars ($92,200.00), receipt of which is acknowledged, paid by the FLOOD CONTROL DISTRICT OF MARICOPA COUNTY, a municipal corporation and a political subdivision of the STATE OF ARIZONA, GRANTEE herein, has granted, sold, and conveyed and by this Deed does grant, sell, and convey unto the said GRANTEE all that certain real property situated in the County of Maricopa, State of Arizona, described as follows:

See Exhibit "A"
Attached hereto and incorporated herein

The GRANTORS bind themselves and their heirs, executors, and administrators to warrant the title against all persons whomsoever.

SUBJECT TO: Current (or prorated as necessary) real estate taxes, assessments, reservations, easements, rights-of-way, and deed restrictions as may appear of record.

EXCERPT
UNDER ARS 42-1614 A 3

90 111573

GRANTORS warrant that no portion of the property is the subject of a threatened or pending investigation or lawsuit or administrative action by any person, firm, governmental body or other entity relating to or arising from any matter or circumstance subject to regulation pursuant to any statute, ordinance, rule or regulation, and seller has received no unofficial or official notice of any alleged violations of any statutes, ordinances, or regulations.

George Vilhite

George Vilhite

Lila Vilhite

Lila Vilhite

STATE OF ARIZONA)
) ss.
COUNTY OF MARICOPA)

The foregoing instrument was acknowledged before me this 31st day of JANUARY, 1990, by George Vilhite and Lila Vilhite, his wife.

My Commission Expires:

Troy E. Shoke

Notary Public

OFFICIAL SEAL
TROY E. SHOKE
NOTARY PUBLIC - STATE OF ARIZONA
MARICOPA COUNTY
My Comm. Expires July 31, 1993

Unofficial Document

90 111573

RECOMMENDED FOR APPROVAL:

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

RANDLEY L. SMITH JR., P.E.
DEPUTY CHIEF ENGINEER 2/15/90

D. E. Sagramoso, P.E. Date
Chief Engineer and General Manager

2/15/90

Edward D. Opstein, Date
Chief, Land Management Division

1-31-90

Right of Way Agent Date

2-1-90

Deputy County Engineer Date

ACCEPTED AND APPROVED:

BOARD OF DIRECTORS OF
FLOOD CONTROL DISTRICT OF
MARICOPA COUNTY

Chairman of the Board

ATTEST:

Clerk of the Board

Date FEB 20 1990

Unofficial Document

90 111573

SALT-GILA 1000 FOOT CORRIDOR
G-33; 401-04-19J,19K,19L,19N,19P,19Q,19T
GEORGE & LILA WILHITE

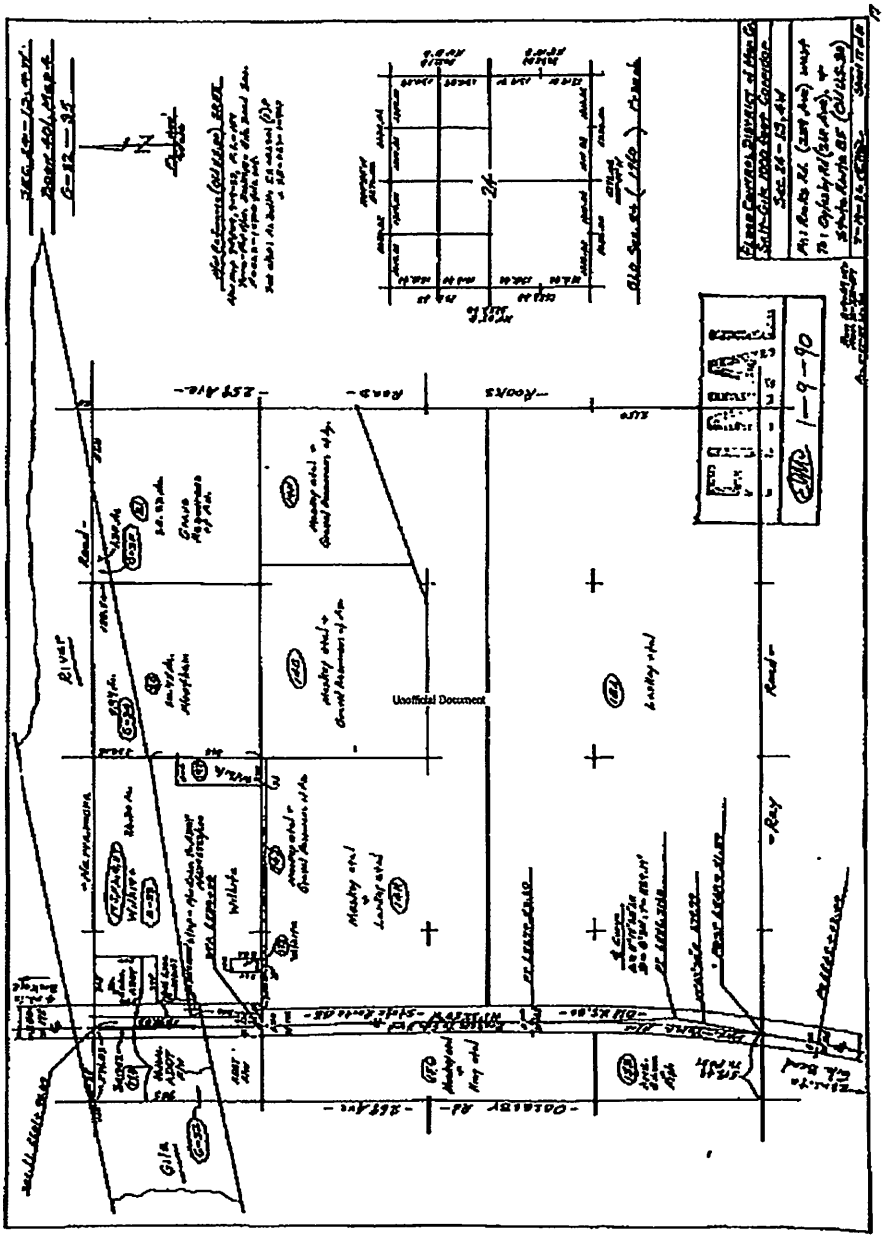
That portion of the North half of the Northwest quarter (N2NW4) of Section Twenty-four (24), Township One (1) South, Range Four (4) West, Gila and Salt River Base and Meridian, Maricopa County, Arizona, which lies East of State Route 85 (Old U.S. Highway 80) and lying North of the following described line: Beginning at the Southwest corner of the East half of the Northwest quarter of the Northwest quarter (E2NW4NW4) of said section; thence along the West line thereof, North 550' to the South Line of the "SALT-GILA 1000 FOOT CORRIDOR" and the True Point of Beginning of said line; thence Northeasterly in a straight line to termination on the East line of the Northwest quarter (NW4) of said section at a point 865' North of the Southeast corner of said N2NW4; except any part within the right of way of said State Route 85; containing 26.34 acres more or less.

Unofficial Document

Flood Control District of Maricopa County; AZ	EMP 5-14-89	JS 1/9/90	Ref. Sheet 17
PRELIMINARY: 11/18/81 Revised: 3/22/89		FINAL: EMP 1-9-90	

Exhibit "A"
Page 1 of 2

G-33



90-111573

Exhibit "A"
Page 2 of 2

THIS PAGE WILL NOT REPRODUCE SATISFACTORILY

Unofficial Document

b. Parcel 401-04-020B (Middle Parcel)

401-04-020B Land Parcel

This is a land parcel and the current owner is FLOOD CONTROL DISTRICT OF MARICOPA COUNTY. Its current year full cash value is $20,700.

Property Information

MCR #	
Description:	TH PT NW4 NE4 SEC 24 LY WI-IN DAF BEG N LI SD SEC AT A PT 560F W OF NE COR SD SEC TH SWLY TO W LI SD SEC AT A PT 985F S OF NW COR SD SEC TH N TO NW COR SD SEC TH E TO POB
Lat/Long	
Lot Size	390,733 sq ft.
Zoning	RR
Lot #	
High School District	BUCKEYE UNION #201
Elementary School District	BUCKEYE ELEMENTARY SCHOOL DISTRICT
Local Jurisdiction	BUCKEYE
S/T/R	24 1S 4W
Market Area/Neighborhood	25/004
Subdivision (0 Parcels)	

Owner Information

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Mailing Address	2801W DURANGO ST , PHOENIX, AZ 85009
Deed Number	900146503
Last Deed Date	04/03/1990
Sale Date	n/a
Sale Price	n/a

Valuation Information

We provide valuation information for the past 5 years. For mobile display, we only show 1 year of valuation information. Should you need more data, please look at our data sales.

Tax Year	2017	2016	2015	2014	2013
Full Cash Value	$20,700	$20,700	$20,700	$20,500	$20,500
Limited Property Value	$20,700	$20,700	$20,700	$20,500	$20,500
Legal Class	2	2	2	2	2
Description	AG / VACANT LAND / NON-PROFIT R/P	AG / VACANT LAND / NON-PROFIT R/P	AG / VACANT LAND / NON-PROFIT R/P	AG / VACANT LAND / NON-PROFIT R/P	AG / VACANT LAND / NON-PROFIT R/P
Assessment Ratio	15%	15%	16%	16%	16%
Assessed FCV	n/a	n/a	n/a	$3,280	$3,280
Assessed LPV	$3,105	$3,105	$3,312	$3,280	$3,280
Property Use Code	9600	9600	9600	9600	9600
PU Description	County Property	County Property	County Property	County Property	County Property
Tax Area Code	330200	330200	330200	330200	330200
Valuation Source	Notice	Notice	Notice	Notice	Notice

Similar Parcels

Parcels that are similar to this one (known as the reference parcel) are displayed below.

APN Address Sale Info FCV Size Livable Sq Ft Year Built Pool Foreclosed

No similar parcels found.

FIRST SERVICE TITLE AGENCY, INC.
Drafted: 1/31/90
When recorded, return to:
Flood Control District
of Maricopa County
3335 West Durango Street
Phoenix, Arizona 85009

10 2823 1of1

RECORDED IN OFFICIAL RECORDS
OF MARICOPA COUNTY, ARIZONA
APR 03 '90 -8 00
HELEN PURCELL, County Recorder
FEE N/C PGS 3 IG

90 146503

WARRANTY DEED

EXEMPT
UNDER ARS 42-1614 A3

Project: Salt/Gila 1000 Foot Corridor
Item: G-34
Assessor Parcel No.: 401-04-020

DURWOOD F. FLEETHAM AND AZULA J. FLEETHAM, his wife, GRANTORS, of Maricopa County, Arizona, for the sum of Twenty Six Thousand Nine Hundred Dollars ($26,900.00), and other valuable consideration, receipt of which is acknowledged, paid by the FLOOD CONTROL DISTRICT OF MARICOPA COUNTY, a municipal corporation and a political subdivision of the STATE OF ARIZONA, GRANTEE herein, have granted, sold, and conveyed and by this Deed does grant, sell, and convey unto the said GRANTEE all that certain real property situated in the County of Maricopa, State of Arizona, described as follows:

See Exhibit "A"
Attached hereto and incorporated herein

The GRANTORS bind themselves and their heirs, executors, and administrators to warrant the title against all persons whomsoever.

SUBJECT TO: Current (or prorated as necessary) real estate taxes, assessments, reservations, easements, rights-of-way, and deed restrictions as may appear of record.

GRANTORS warrant that no portion of the property is the subject of a threatened or pending investigation or lawsuit or administrative action by any person, firm, governmental body or other entity relating to or arising from any matter or circumstance subject to regulation pursuant to any statute, ordinance, rule or regulation, and seller has received no unofficial or official notice of any alleged violations of any statutes, ordinances, or regulations.

Durwood F. Fleetham

Durwood F. Fleetham

Azula J. Fleetham

Azula J. Fleetham

STATE OF ARIZONA)
) ss.
COUNTY OF MARICOPA)

90 146503

The foregoing instrument was acknowledged before me this 28th day of FEBRUARY, 1990 by Durwood F. Fleetham and Azula J. Fleetham, his wife.

My Commission Expires:

Notary Public

OFFICIAL SEAL
TROY E. MOORE
NOTARY PUBLIC - STATE OF ARIZONA
MARICOPA COUNTY
My Comm. Expires July 21, 1993

Unofficial Document

90 146503

RECOMMENDED FOR APPROVAL:

FLOOD CONTROL DISTRICT
OF MARICOPA COUNTY

3-9-90

D. E. Sagramoso, P.E. Date
Chief Engineer and General Manager

3/9/90

Edward D. Opstein, Date
Chief, Land Management Division

2-28-90

Right of Way Agent Date

3.2.90

Deputy County Engineer Date

ACCEPTED AND APPROVED:

BOARD OF DIRECTORS OF
FLOOD CONTROL DISTRICT OF
MARICOPA COUNTY

Chairman of the Board

ATTEST:

Clerk of the Board

Date MAR 12 1990

Unofficial Document

90 146503

SALT-GILA 1000 FOOT CORRIDOR
G-34; 401-04-20
FLEETHAM

That portion of the Northwest quarter of the Northeast quarter (NW4NE4) of Section 24 - T1S,R4W, G&SRB&M, Maricopa County, Arizona, lying within the following described property in the "SALT-GILA 1000 FOOT CORRIDOR": Beginning on the North line of said section at a point 560' West of the Northeast corner of said section; thence Southwesterly to the West line of said section at a point 985' South of the Northwest corner of said section; thence North to the Northwest corner of said section; thence East to the Point of Beginning; Containing 8.97 acres more or less.

Unofficial Document

Flood Control District of Maricopa County: AZ	EMP 3-8-90		Ref: Sheet 17
PRELIMINARY: 07/28/82 Revised: 05/16/89		FINAL: EMP 3-8-90	

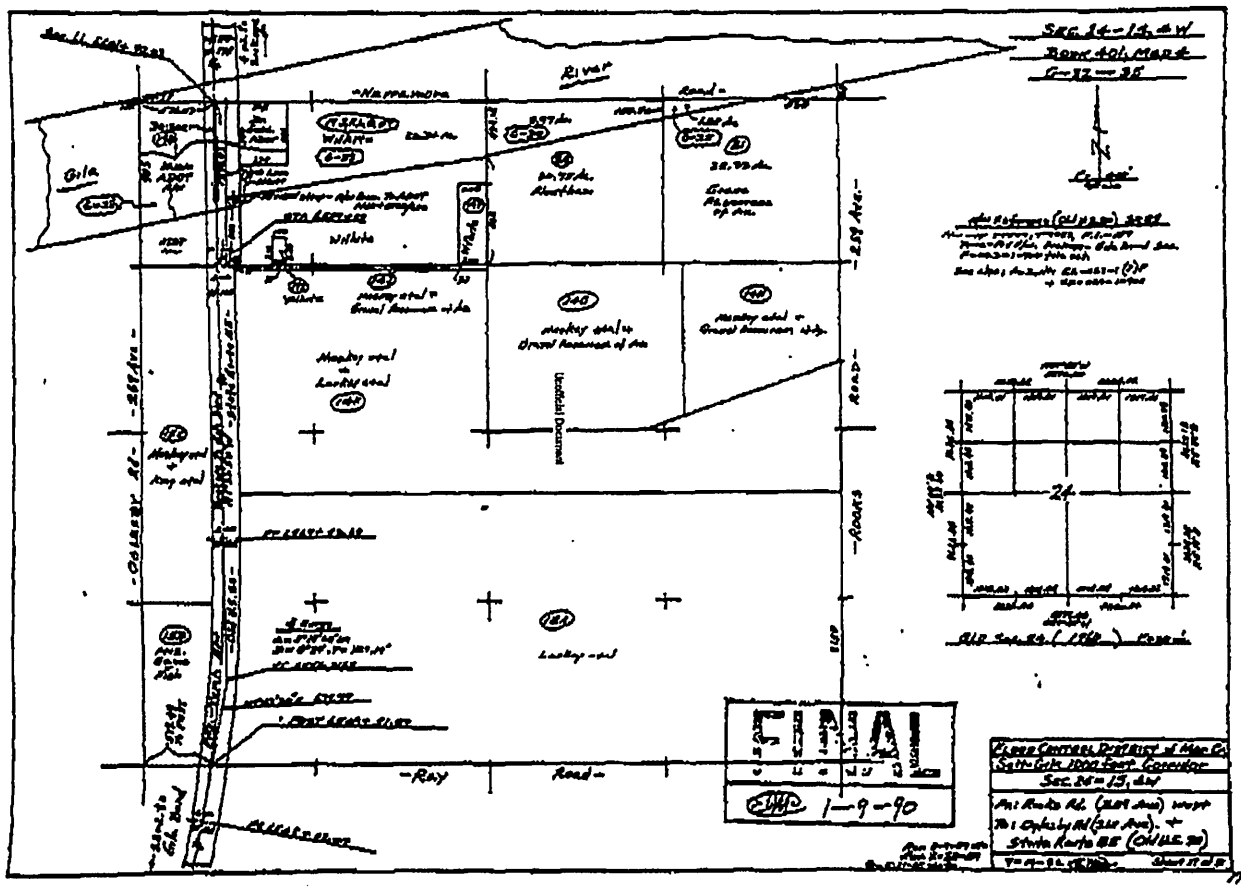


Exhibit "A"
Page 2 of 2

THIS PAGE WAS NOT REPRODUCE SATISFACTORILY

90 146503

c. Parcel 401-04-021A (East Parcel)

401-04-021A Land Parcel

This is a land parcel and the current owner is FLOOD CONTROL DISTRICT OF MARICOPA COUNTY. Its current year full cash value is $2,500.

Property Information

MCR #	
Description:	TH PT NE4 NE4 SEC 24 LY WI/IN FOL DESC PROP IN SALT-GILA 1000F CORRIDOR BEG ON N LN SD SEC 24 AT PT 560F W OF NE COR SD SEC TH SWLY TO THE W LN SD SEC AT PT 985F S OF NW COR SD SEC TH N TO NW COR SEC TH E TPOB
Lat/Long	
Lot Size	60,113 sq ft.
Zoning	RU-43
Lot #	
High School District	BUCKEYE UNION #201
Elementary School District	BUCKEYE ELEMENTARY SCHOOL DISTRICT
Local Jurisdiction	NO CITY/TOWN
S/T/R	24 1S 4W
Market Area/Neighborhood	25/004
Subdivision (0 Parcels)	

Owner Information

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY

Mailing Address	2801W DURANGO ST , PHOENIX, AZ 85009
Deed Number	900391403
Last Deed Date	08/29/1990
Sale Date	n/a
Sale Price	n/a

Valuation Information

We provide valuation information for the past 5 years. For mobile display, we only show 1 year of valuation information. Should you need more data, please look at our data sales.

Tax Year	2017	2016	2015	2014	2013
Full Cash Value	$2,500	$2,500	$2,500	$2,500	$2,500
Limited Property Value	$2,500	$2,500	$2,500	$2,500	$2,500
Legal Class	2	2	2	2	2
Description	AG / VACANT LAND / NON-PROFIT R/P	AG / VACANT LAND / NON-PROFIT R/P	AG / VACANT LAND / NON-PROFIT R/P	AG / VACANT LAND / NON-PROFIT R/P	AG / VACANT LAND / NON-PROFIT R/P
Assessment Ratio	15%	15%	16%	16%	16%
Assessed FCV	n/a	n/a	n/a	$400	$400
Assessed LPV	$375	$375	$400	$400	$400
Property Use Code	9600	9600	9600	9600	9600
PU Description	County Property	County Property	County Property	County Property	County Property
Tax Area Code	330000	330000	330000	330000	330000
Valuation Source	Notice	Notice	Notice	Notice	Notice

Similar Parcels

Parcels that are similar to this one (known as the reference parcel) are displayed below.

APN Address Sale Info FCV Size Livable Sq Ft Year Built Pool Foreclosed

No similar parcels found.

pav00148n JRP:cj 082090.1

CIV DEED (CV)

90 AUG 28 PM 4:30

GUST, ROSENFELD & HENDERSON
3300 Valley Bank Center
201 North Central Avenue
Phoenix, Arizona 85073-3300
(602) 257-7422
Joe R. Purcell - 001145

RECORDED IN OFFICIAL RECORDS OF MARICOPA COUNTY, ARIZONA
AUG 29 '90 4 00
HELEN PURCELL, County Recorder
FEE NC PGS 3 BJ

90 391403

Attorneys for Plaintiff

IN THE SUPERIOR COURT OF THE STATE OF ARIZONA

IN AND FOR THE COUNTY OF MARICOPA

CERTIFIED COPY

FLOOD CONTROL DISTRICT OF MARICOPA COUNTY, a municipal corporation and a political subdivision of the State of Arizona, Plaintiff, v. GRAVEL RESOURCES OF ARIZONA, an Arizona general partnership; ARTHUR JOHN WINKLER, an unmarried man; MARICOPA COUNTY TREASURER; and the UNKNOWN HEIRS OF THE ABOVE INDIVIDUAL PARTY, IF DECEASED, Defendants.	NO. CV 90-09948 FINAL ORDER OF CONDEMNATION (P.A. to The Honorable Alan S. Kamin, Div. 27)

It appearing to the Court that the Judgment heretofore entered in favor of Defendants Arthur John Winkler, an unmarried man; and Maricopa County Treasurer, against the Plaintiff, Flood Control District of Maricopa County, a municipal corporation and a political subdivision of the State of Arizona, in the above-entitled action has been paid; and

90 391403

It further appearing to the Court that pursuant to the provisions of the Judgment in Condemnation dated July 20, 1990, this Court may enter its Final Order of Condemnation.

IT IS THEREFORE ORDERED, ADJUDGED AND DECREED that the Fee Simple Title in and to the real property described in Exhibit "A" attached hereto and incorporated herein by reference be and the same is hereby condemned and vested in Plaintiff, Flood Control District of Maricopa County.

DONE IN OPEN COURT this 27 day of AUGUST, 1990.

The Honorable Alan S. Kamin
Judge of the Superior Court

Unofficial Document

The ORIGINAL of the foregoing LODGED WITH THE COURT this 28 day of August 1990, and a COPY of the foregoing was mailed this 28 day of Aug, 1990, to:

Mr. Arthur John Winkler
2930 North 52nd Street, #106
Phoenix, Arizona 85018

Mr. James R. Minter
Deputy County Attorney
Maricopa County Attorney's Office
First American Title Building
16th Floor
111 West Monroe
Phoenix, Arizona 85003
Attorney for Defendant
Maricopa County Treasurer

Joe R. Purcell

g. Permission for Site Access

The District has been working in collaboration with the cities of Avondale, Goodyear and Buckeye as well as private property landowners adjacent to the Gila River for over 17 years. The 36.7 acre District owned Pilot Project located in the City of Buckeye is a smaller restoration project within the larger El Rio efforts. Access to this Pilot Project, requires crossing land owned by the Arizona Department of Transportation (ADOT) (parcel number 401-03-008B) and Arizona Game and Fish Department (AG&FD) (parcel numbers 401-03-004 and 401-03008C). A permit application was submitted to ADOT to allow egress and ingress across their property in late September 2016. The District was told that a permit could be provided within 1-6 weeks. AG&FD granted the District access across their property via an email included in the Supplemental Information. A formal right of entry agreement with AG&FD will be executed immediately after the Water Protection Fund grant is awarded.

Property owners adjacent to the Pilot Project where access is not being sought include the Bureau of Land Management (BLM) due north, additional ADOT property (parcel numbers 401-04-19V, 401-04-019W), on the southwest of the Pilot Project, Camelback Six Hundred (parcel number 401-04-021B), directly south of the District's middle property (parcel number 401-04-020B) and Arizona Materials (parcel number 401-04021B) south of the District's eastern property (parcel number 401-04-021A) .

These property owners will be contacted by the District during the Design Phase of the Pilot Project to provide a description of the activities that will occur, a schedule outlining the timeframe of when these activities will take place, and an opportunity to discuss the project and any concerns that they may have.

A copy of the District's Warranty Deeds for the properties within the Pilot Project are referenced in the "Evidence of Control and Tenure of Land" section of this application. A map of Section 24 T01S R04W that identifies the above referenced parcels is included in the "Project Map and Schematics" section of this application.

h. Letters Pledging Matching Funds

The Flood Control District of Maricopa County will be the only entity providing matching funds. Funding detailed in the budget provided will be programed into the District's operating budget.

I. Evidence of Physical and Legal Availability of Water

It is estimated that the project will use approximately 150,000 gallons of City of Buckeye Water through a construction water Hydrant Meter Rental agreement (see Supplement for application) executed by the District and City of Buckeye.

The District will purchase construction water from the City of Buckeye for dustproofing activities and to water in initial plantings of pole and container stock using a City of Buckeye authorized rented hydrant meter for construction water accompanied with a District installed backflow prevention protection devise attached.

The replacement pole cuttings and tall-pot plantings for the Pilot Project will be watered in after initial planting and re-watered three additional times approximately 3-5 days apart depending on the soil structure's water holding capacity and precipitation occurrences at the time of the planting operations.

Supplemental watering will be achieved using DriWATER gel packs; 3 per plant that will be replaced every 45 days for three consecutive applications or as needed based on weather conditions (e.g. temperatures, winds, and precipitation).

The hydroseeded areas will depend solely on available precipitation for germination and future succession.

Application for Hydrant Meter Rental(s)

CITY OF BUCKEYE
530 Monroe Avenue
Buckeye, AZ 85326
utilitybilling@buckeyeaz.gov
Phone: (623) 349-6100
Office hours: Monday - Thursday 7:00 a.m. – 5:00 p.m.

Company Name: _____

Billing Address: _____

City: _____ State: _____ Zip: _____

Tax ID or EIN #: _____ Company Phone Number: _____

Contact Name: _____ Contact Phone Number: _____

E-Mail Address: _____

Requested Location/Address (Cross Streets): _____

_____

Type of Work Being Conducted: _____

_____

Estimated Start Date: _____ Estimated Completion Date: _____

Note: Water delivery may be discontinued at any time without advance notice.

Customers are responsible for any damage related to either the meter or hydrant.

Customers are responsible for all housekeeping in or around meter or hydrant.

Backflow certification test(s) and report(s) are required to be completed and results sent to the Water Resources Department no later than 72 hours after hydrant meter has been set.

A $1,500.00 Deposit is required for Hydrant Meter.

There will be a mandatory charge of $150.00 charged for removal and relocation of hydrant meter(s).

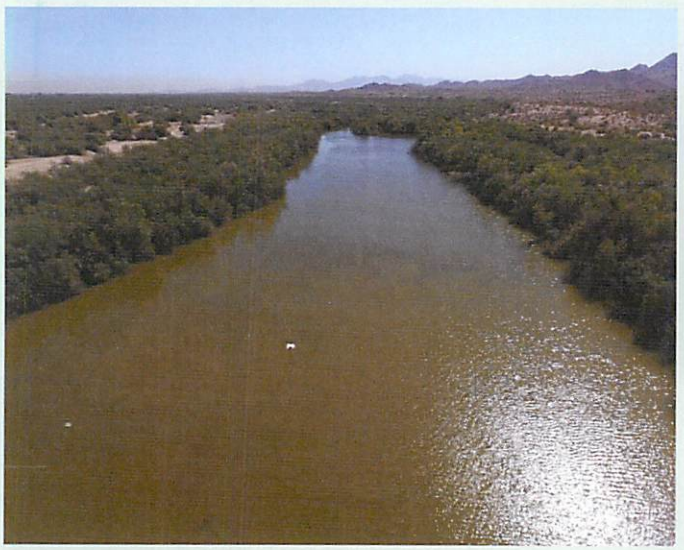
Signature of Applicant: _____ Date: _____

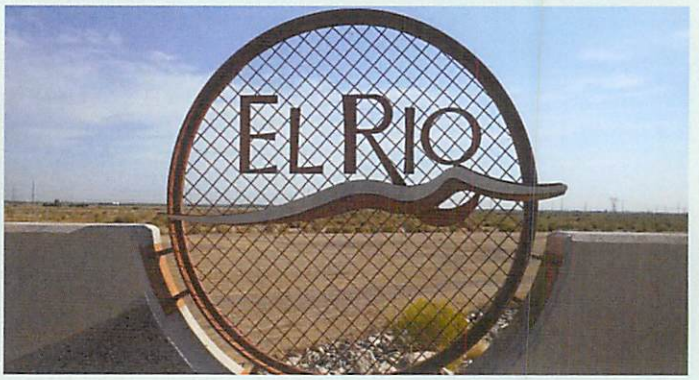
Keep a copy of this permit request within the vehicle at all times.

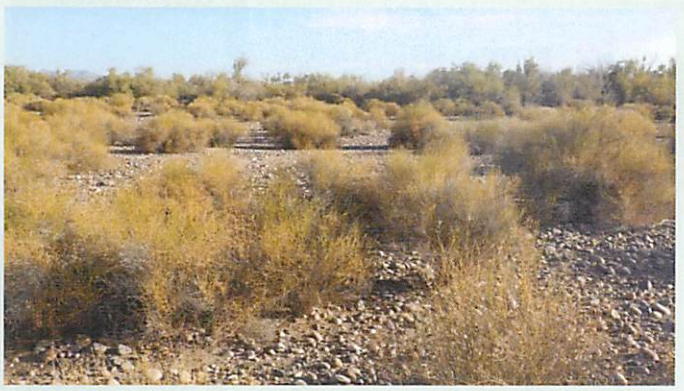
Hydrant Meter Rental Form Revised 11 16 2015

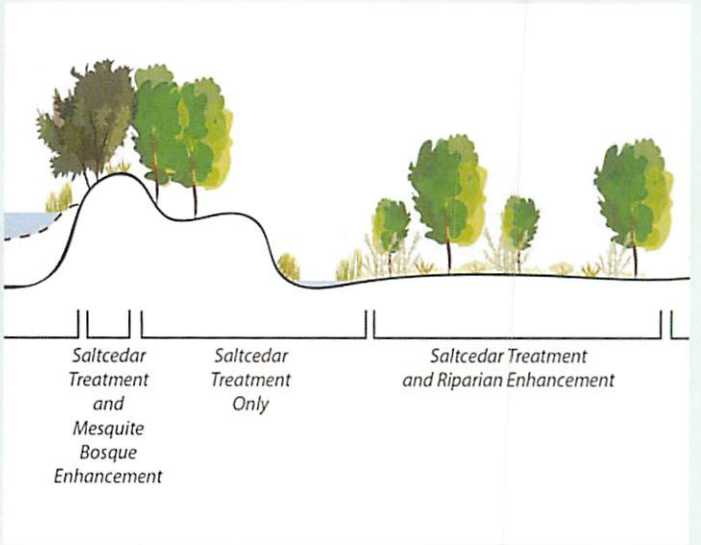
FINAL ◦ SEPTEMBER 2016

El Rio Vegetation Management Plan
Lower Gila River, Maricopa County, AZ
Volume 1: Executive Summary









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Cover graphics:

Upper left: Oblique view of riparian corridor dominated by mature saltcedar vegetation, located downstream of Waterman Wash (photo by Stillwater Sciences).

Upper right: El Rio sign, located on Cotton Lane bridge near Avondale (photo by Stillwater Sciences).

Lower left: Example of intact desert shrub vegetation from the El Rio reach that is proposed for enhancement under the El Rio Vegetation Management Plan (photo by Stillwater Sciences).

Bottom right: Partial illustration of anticipated vegetation conditions after implementation of the El Rio Vegetation Management Plan (created by Stillwater Sciences).

Suggested citation:

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INTRODUCTION

This Vegetation Management Plan (Plan) has been prepared for the Flood Control District of Maricopa County (District) for the El Rio reach of the lower Gila River in Maricopa County, Arizona. This Plan is a three-volume document. Volume 1 is this Executive Summary (this document), which presents an overview of the key components of the other two volumes. Volume 2 is the technical report describing baseline biological and physical (biophysical), or ecohydrological, conditions of the El Rio reach and the implications of those conditions on vegetation management. Volume 3 is the technical report describing the vegetation management activities that will be implemented at specific locations, which are referred to as vegetation management units, and recommendations and considerations for vegetation management implementation, funding, permitting, monitoring, and maintenance.

The Plan was prepared by Stillwater Sciences for the District, with input from District staff and a technical advisory committee (TAC). The TAC includes representatives from federal, state, and non-government organization composed of individuals with expertise in southwest riparian systems and the El Rio planning reach (see Volume 2 for the list of TAC members).

Planning Area

The El Rio reach of the lower Gila River, and the area addressed by the Plan, extends from the confluence of the Agua Fria River with the Gila River, downstream to Maricopa County Highway 85 bridge. This reach is approximately 17 miles long and 1 mile wide, and is referred to as the "planning area" throughout the Plan. The width of the planning area is defined by the extent of the 100-year floodway, which currently includes the non-developed corridor of the Gila River. The 100-year floodway typically defines the maximum amount of development encroachment allowed by the Federal Emergency Management Agency into the 100-year floodplain: development can occur within the 100-year floodplain so long as it and any associated mitigation does not result in changes to the floodway.

Oblique view of the El Rio reach, looking west towards the Highway 85 bridge (Photo by Stillwater Sciences)

Need for Vegetation Management

The overarching challenge facing flood management in the El Rio reach is the dense establishment of saltcedar, which has become the dominant woody plant species in the floodway. Saltcedar is highly tolerant of saline soils and xeric conditions, often growing at greater densities than native species in the planning area. The spread of saltcedar in the planning area is exacerbated by the disturbed hydrologic regime of the El Rio reach resulting from upstream

dams, groundwater pumping, stormwater and wastewater discharges, increased impervious surfaces and altered runoff patterns, and floodplain development. Dense saltcedar stands increase hydraulic roughness on higher surfaces in the floodway above what would normally occur resulting in floodplain expansion. A floodplain delineation of the Gila River between Bullard Avenue and Painted Rock Reservoir was completed by the District in 2014 and showed that the floodplain had expanded by 7.3 square miles since 1999. Thus, a science-based, holistic approach to active replacement of existing stands of saltcedar with appropriate native riparian and upland vegetation is needed to provide floodplain-management and associated benefits throughout the planning area. The Plan will serve as the guiding document for how vegetation will be managed within the floodway.

Dense, tall stand of saltcedar in the El Rio reach
(Photo by Stillwater Sciences)

Vegetation Management Goals and Objectives

The District and others will use this Plan as guidance for comprehensively removing saltcedar from the planning area, and for conducting a scientifically-based revegetation effort with appropriate native riparian and upland plant species that will ultimately provide floodplain-management throughout the El Rio reach. Additionally, the District will be better prepared for anticipated changes to the system, such as climate change, land-use changes, and colonization by the tamarisk beetle, and will implement active ecological restoration and other management strategies for threatened, endangered, and other native wildlife species potentially displaced by saltcedar treatment activities.

IMPLICATIONS OF EXISTING AND ANTICIPATED FUTURE CONDITIONS FOR VEGETATION MANAGEMENT

An assessment was initially undertaken to characterize the dynamic nature of the ecologically sensitive floodway corridor to provide the holistic baseline information necessary to identify appropriate vegetation-management actions (see Volume 2). The salient recommendations developed from the assessment are as follows.

Land Uses—Many areas just outside the planning area are anticipated to be developed for residential and commercial uses in the future. Most opportunities for Plan implementation will be found on the public-owned lands. As such, the Plan should incorporate flexibility in any recommended management action on and adjacent to the private lands. Communication and coordination with other entities that have previously conducted vegetation-management-related activities in the planning area should be continued to ensure that future vegetation management

activities do not conflict with one another and, ideally, can be conducted in ways that save or share costs and increase mutual benefits.

Climate—Predicted future increases in regional and local air temperatures, and the likely reduction in future water supply, will challenge local riparian habitat. Air temperature and drought tolerances for native plant species must be incorporated into the Plan when specifying appropriate species and locations for revegetation, but such specifications must incorporate sufficient flexibility to address the implications of hotter and drier conditions in the future.

Flood Hydrology and Geomorphology—The river corridor naturally experiences a wide variation of flows, punctuated episodically by short-duration but intensive high-flow events capable of dramatically repositioning the main channel and scouring large swaths of vegetation. The Plan needs to incorporate appropriate strategies for saltcedar treatment and native species revegetation within the flood reset zone (*i.e.,* that portion of the river corridor most frequently scoured during larger flood events).

Ecological Flows—Baseflows in the planning reach are supplemented by a number of stormwater, wastewater, and agricultural return-flow canals. While these inputs could be used to prioritize where saltcedar removal and habitat enhancement occurs, since plantings would have a higher likelihood of being successful, the volume, timing, and constancy of these water sources are highly subject to change in light of land-use changes outside the planning area. As residential development replaces agriculture, agricultural return flows will decrease while stormwater and wastewater discharges, which can be high in salinity, will increase. Vegetation management actions that are potentially dependent on these water supplies will need to evaluate and likely monitor water supply changes in the future.

Soils—Soil texture, salinity, and alkalinity levels in the vast majority of the planning area are within the tolerance ranges of most native woody riparian, desert wash, and upland plant species that would be appropriate for revegetation, and should not preclude the natural recruitment of these species. Given general plant soil requirements and tolerance levels, suitable areas for active restoration of many native riparian trees and shrubs include those with soils having non-saline to very slightly saline conditions, while areas with soils having slightly saline to strongly saline conditions are better suited for desert shrub species. Additional soil sampling may be necessary at sites where there are visual signs of potentially high soil salinity or other unforeseen soil characteristics. Where this is the case, planting plans will need to incorporate native species with appropriate soil condition tolerances.

Groundwater—Relative elevation above the low-flow, or baseflow, water surface in the river channel is a useful indicator of revegetation potential as native riparian plant species tend to occur in particular topographic positions relative to the river channel based largely on depth to groundwater and plant ecophysiological requirements and tolerances. Vegetation-transect surveys performed in support of Plan development found that native cottonwood and willow trees are most numerous upon surfaces within 2 to 10 feet above the low-flow channel water surface, and desert shrub vegetation is most numerous at relative elevations ranging from 5 to 18 feet. The location of the vegetation management units described in Chapter 2 were identified in part by these relative elevation/depth to groundwater preferences: areas under 7.5 feet were considered to be suitable for establishing native woody riparian trees, and areas above 7.5 feet were considered to be suitable for native desert shrub.

Vegetation—While removal of saltcedar will provide multiple benefits to the El Rio reach and surrounding lands, replacement of removed saltcedar with native vegetation will be necessary to mitigate lost habitat structure, reduce re-sprouting of saltcedar and establishment of secondary weeds, and offset impacts for regulatory compliance. The most appropriate vegetation types for revegetation in the planning area, based on existing species presence and regional vegetation

types, are riparian cottonwood (*Populus fremontii*)/willow (*Salix* spp.), mesquite (*Prosopis* spp.) bosque, and native desert shrub. A mixture of these vegetation types, particularly where a multilayered canopy develops and a wide range of appropriate locally native tree, shrub, and herb species are incorporated, would enhance native vegetation and habitat diversity and quality for wildlife. Excavated swales that reduce the distance to groundwater can be used to facilitate expansion and long-term sustainment of diverse open water/marsh and riparian woodland habitats.

Wildlife—Southwestern willow flycatcher (*Empidonax traillii extimus*), western yellow-billed cuckoo (*Coccyzus americanus*), and Yuma clapper rail (*Rallus longirostris yumanensis)* are listed as threatened or endangered under the federal Endangered Species Act (ESA) and have been documented to occur or have potential to occur in the planning area. In addition, other migratory birds and native wildlife occur in the planning area. The expected arrival of tamarisk beetle within the next 5 years is anticipated to dramatically reduce the dense saltcedar cover that these birds and other wildlife species may currently use in the planning area. As such, it is necessary to quickly establish beetle-resilient native habitat for these species to use. Saltcedar removal for vegetation management will similarly reduce the habitat available to these species. Therefore, replanting saltcedar-treatment areas with native vegetation types will be necessary to mitigate for the impacts of vegetation management. To minimize the impacts of vegetation management, saltcedar removal and subsequent native revegetation should be conducted in phases, so that the amount of habitat removed is relatively small in any given year and there is time for native habitat to grow to sufficient height, complexity, and density to suitable provide habitat before additional saltcedar is removed.

VEGETATION MANAGEMENT UNITS

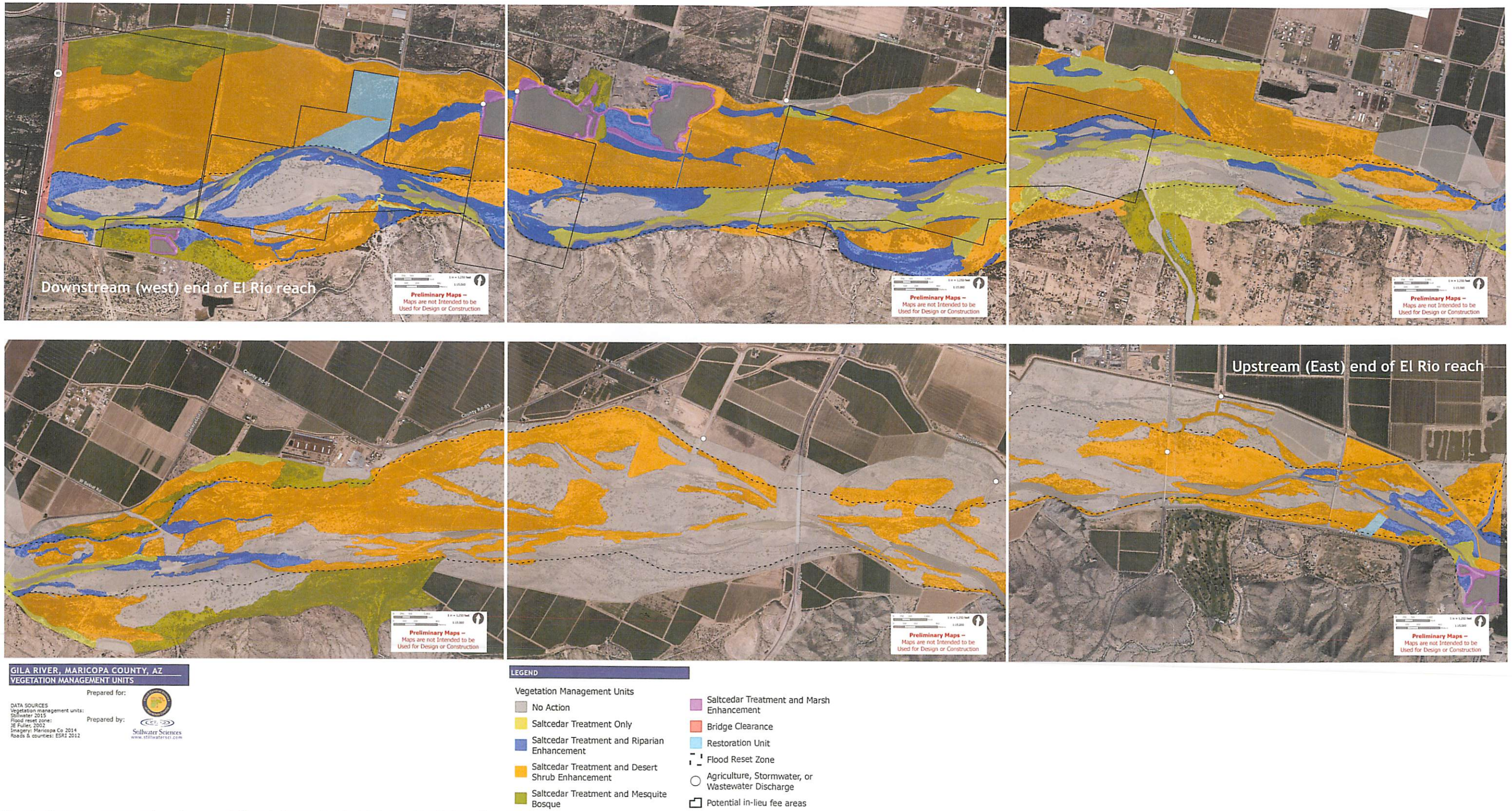
Vegetation management units are specific locations within the planning area where particular vegetation management actions, or combinations of actions, should be appropriate and sustainable, given the biophysical and land-use conditions in and around the planning area, and will promote the goals of the Plan—the removal of saltcedar, revegetation with appropriate locally native riparian and upland plant species, and, ultimately, flood-risk reduction throughout the El Rio reach (see Volume 3). The recommended vegetation management unit maps for the planning area are presented below.

In total, the vegetation management units entail approximately 5,000 acres of saltcedar removal in the planning area, which would be implemented in numerous phases and individual projects. Most removed saltcedar would be replaced with native riparian, mesquite, desert shrub, or marsh vegetation communities.

Illustrations of current and proposed vegetation conditions across a typical cross section in the planning area are presented below. The proposed illustration depicts how conditions are anticipated to change with implementation of the vegetation management units and maturity of native vegetation.

Vegetation Management Units

- *1 - No Action (35% of Planning Area)*
- *2 - Saltcedar Treatment Only (7%)*
- *3 - Saltcedar Treatment and Riparian Enhancement (9%)*
- *4 - Saltcedar Treatment and Desert Shrub Enhancement (41%)*
- *5 - Saltcedar Treatment and Mesquite Bosque Enhancement (6%)*
- *6 - Saltcedar Treatment and Marsh Enhancement (1%)*
- *7 - Bridge Clearance (<1%)*
- *8 - Planned/Completed Restoration (1%)*



Vegetation management units map (tiles 1 through 6 in Volume 3) of the planning area.

Illustration of current vegetation conditions across a typical cross section in the planning area (see Volume 3).

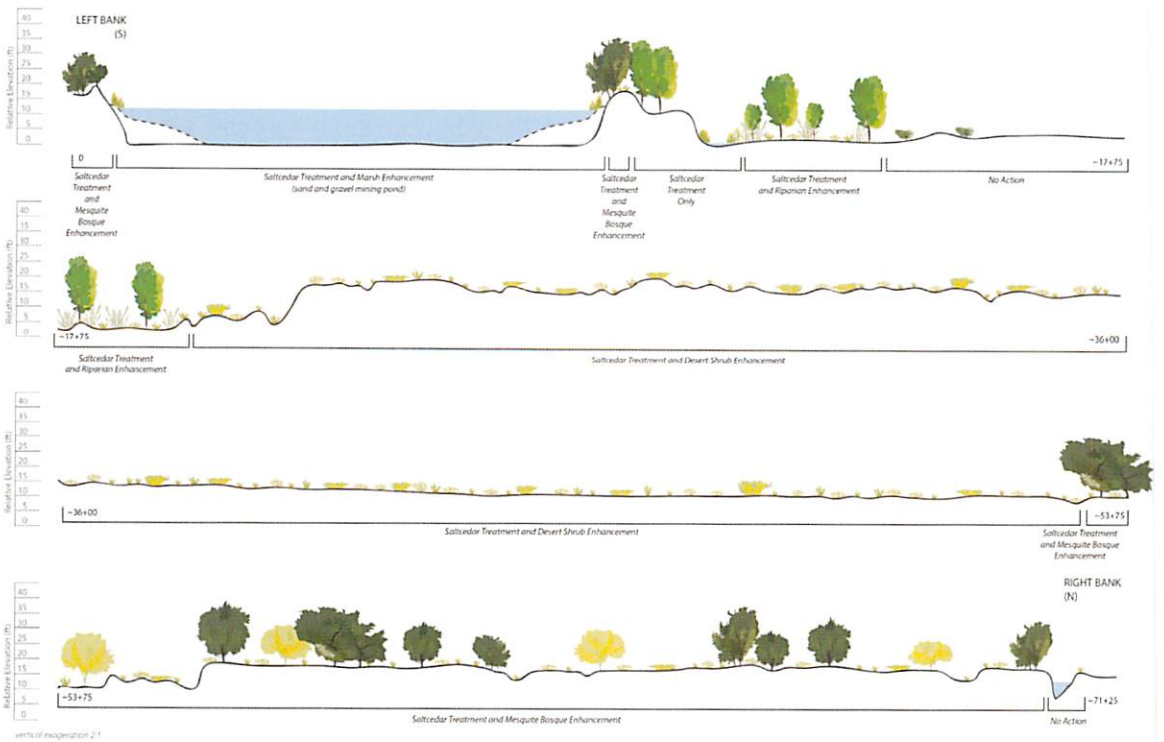


Illustration of anticipated vegetation conditions across the Figure 8 cross section with implementation of the Plan (see Volume 3).

No Action—The "No Action" vegetation management units are those areas with little to no saltcedar present. In some of these units, there is no saltcedar to remove. Where saltcedar is present, it occurs at sufficiently low density that removal would likely have little to no influence on flood-risk reduction. The greatest concentration of No Action units occurs in the upstream portion of the planning area, where there is relatively little vegetative cover due to lack of surface water and greater depths to groundwater. These areas need to be monitored for increased saltcedar growth to determine whether removal becomes warranted to reduce flood risk and whether any active enhancement of native vegetation may be warranted (*i.e.,* if no native vegetation is naturally recruiting or if secondary weeds become problematic). In addition to the No Action units that have been identified based on lack of saltcedar cover, there are likely other areas where "no action" is determined to be appropriate and desirable based on site-specific conditions and individual project goals. For example, No Action units of conserved saltcedar may be necessary to maintain the stability of the river bank at project locations, and reduce the potential for unintended geomorphic change. Conserved saltcedar can also provide a "hydraulic shield" from high flow events for downstream revegetation areas.

Example view of No Action units in the planning area (Photos by Stillwater Sciences)

Saltcedar Treatment Only—Saltcedar should be removed and treated with herbicide to reduce flood risk, and there should be sufficient native vegetation and appropriate biophysical conditions for native species to naturally ("passively") recolonize the area once saltcedar is removed. This unit type offers one of the most efficient and sustainable opportunities to reduce flood risk, since saltcedar would be removed from the floodway, while simultaneously enhancing native habitats without the effort and expense of active seeding and planting. These units should have at least 10–30% cover of native species, and were further screened to include only those areas thought to have good potential for natural recruitment of native species. Most Saltcedar Treatment Only units occur within the flood reset zone and in the downstream half of the planning area, where there is the greatest extent of native vegetation. Monitoring and maintenance of all saltcedar removal areas (regardless of vegetation management unit type) will be necessary to ensure long-term success and will likely be required for a minimum of five years following removal. Monitoring of all saltcedar removal areas should, at a minimum, evaluate the need for treatment of saltcedar re-sprouts or other problematic secondary weeds (*e.g.,* kochia) and how developing vegetation conditions may influence or conflict with flood risk reduction objectives. In Saltcedar Treatment Only units in particular, monitoring will also need to evaluate whether natural recruitment will be sufficient to replace removed saltcedar or whether active planting may be warranted.

Example view of Saltcedar Treatment Only units in the planning area (Photo by Stillwater Sciences)

Saltcedar Treatment and Riparian Enhancement—Saltcedar should be removed and treated with herbicide, and then planted with appropriate native cottonwood, willow, and other associated native riparian trees, shrubs, and herbs/forbs. These units include areas that are in need of habitat enhancement, are unlikely to support natural/passive recruitment of native species (since there are few or no native species present in the unit to provide a seed source), and likely have the physical conditions necessary to support planted riparian vegetation with minimal levels of maintenance.

Riparian Enhancement units are the most appropriate locations to efficiently and effectively contribute to the Plan's habitat mitigation and enhancement objectives because they will result in tall, complex, and dense vegetation conditions and will not contribute to the flood risk reduction objectives of the Plan. These units are most suitable in close proximity to the low-flow river channel and within the flood reset zone. To reduce the risk of future floods washing away plantings, units within the flood reset zone should incorporate an upstream "hydraulic shield" of conserved vegetation, even if it is saltcedar. This hydraulic shield may also preserve microclimate conditions in surrounding areas and benefit young native recruits (*e.g.*, functioning as a "nurse tree"), and maintain river bank stability. Given the importance of Riparian Enhancement units in mitigating habitat loss from saltcedar removal and enhancing habitat for southwestern willow flycatcher and western yellow-billed cuckoo, it may be desirable to increase the extent of the planning area outside of the flood reset zone that can sustain the associated cottonwood/willow vegetation. This could be done by excavating swales and channel features that increase the extent and frequency of flood inundation and/or decrease the depth to groundwater, thereby increasing the water supply for Riparian Enhancement plantings, as well as potential marsh vegetation.

Example views of Saltcedar Treatment and Riparian Enhancement unit before management (top, from the planning area) and hypothetically after (bottom, from the San Pedro River) (Photos by Stillwater Sciences)

Saltcedar Treatment and Desert Shrub Enhancement—Saltcedar should be removed and treated with herbicide to reduce flood risk, and then planted with appropriate native desert shrub, herbs/forbs, and trees (sparsely), and associated upland species. These units are farther from groundwater and more geomorphically stable than Riparian Enhancement units. Replacement of saltcedar with native desert shrubs will reduce flood risk, since desert shrubs do not impede high flows to the extent that saltcedar does, and discourage the establishment of secondary weeds if they are planted densely enough. In light of these benefits and the limited water availability in the planning area (which will likely be exacerbated in the future), replacement of removed saltcedar with native desert shrub vegetation is anticipated to be the most appropriate and sustainable enhancement habitat type for much of the planning area.

Although replacement of saltcedar with desert shrub vegetation will result in a notable change in vegetation and associated habitat structure across much of the planning area, it is important to note that very few of the Desert Shrub Enhancement units currently provide suitable habitat for the three listed bird species with potential to occur in the planning area. As a result, loss of nesting habitat for migratory birds is expected to be the primary impact associated with conversion of saltcedar to desert shrub habitat. These units present a trade-off between flood-risk reduction and loss of habitat structure, but the intent of replacing saltcedar with these shrubs is to help mitigate for some of that habitat loss, improve habitat for native pollinators, and improve foraging habitat for birds and other native wildlife, as well as prevent establishment of secondary weeds, and increase the extent of a native vegetation type that will be sustainable in the planning area as temperatures increase and water supply decreases.

Example views of Saltcedar Treatment and Desert Shrub Enhancement unit before management (top) and hypothetically after (bottom) (both photos from the planning area) (Photos by Stillwater Sciences)

Saltcedar Treatment and Mesquite Bosque Enhancement—Saltcedar should be removed and treated with herbicide to reduce flood risk, and then planted with appropriate native mesquite bosque species (e.g., mesquite, desert willow, paloverde, saltgrass). These units are located on terrace surfaces at the confluence of tributary washes, where they are anticipated to have less influence on flood conveyance. Mesquite bosque is a characteristic vegetation type of Sonoran Desert washes that tolerates more xeric conditions than cottonwood and willows, but it has been declining throughout southern Arizona. The size and structure of mesquite trees are similar enough to that of saltcedar that this unit type will not contribute to the flood-risk reduction goal of the Plan, unless planted mesquite trees are spaced sufficiently apart. Patches of densely planted mesquite trees, with understory shrub and herbaceous plants, within these units can also be used to balance flood risks with secondary weed risks and would also

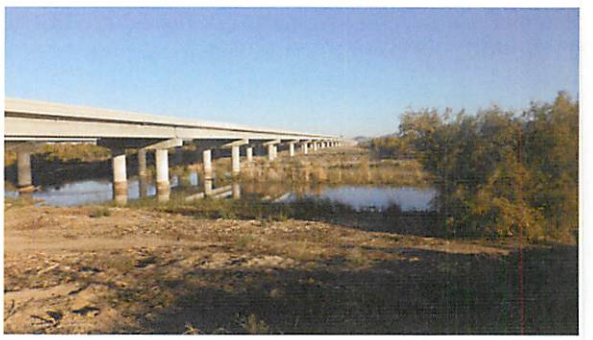
Example views of Saltcedar Treatment and Mesquite Bosque Enhancement unit before management (top, from the planning area) and hypothetically after (bottom, from the San Pedro River) (Photos by Stillwater Sciences)

improve habitat patchiness/diversity. Mesquite provides habitat for many native wildlife species, so this enhancement type would help mitigate habitat loss from saltcedar removal for some species and would improve native plant and wildlife diversity in the planning area.

Saltcedar Treatment and Marsh Enhancement—saltcedar should be removed and treated with herbicide to reduce flood risk, and then planted with native cattails, tules, and associated marsh species. These units are exclusively located along the shores of inundated gravel mining pits and will require shoreline grading and/or fill along the margins of the ponds to achieve suitable water supply and inundation conditions for marsh plants. Although they will require relatively expensive earthwork, Marsh Enhancement units have the potential to provide multiple benefits. All of the sand and gravel mining-pit ponds in the planning area are within the 100-year floodplain, and the shorelines of mining-pit ponds in the planning area are primarily vegetated with saltcedar. As such, saltcedar removal in these units should contribute to flood-risk reduction, and native marsh plants that would replace the saltcedar do not impede flood flows to the degree that saltcedar does. Enhanced marsh vegetation may also help improve water quality, by sequestering some pollutants that would otherwise reach the water table or Gila River, and is likely to directly benefit Yuma clapper rail. The potential for Marsh Enhancement may increase in extent as a result of future gravel mining and associated creation of open water features on private property in the planning area.

Example views of a Saltcedar Treatment and Marsh Enhancement unit before management (top) and hypothetically after (bottom) (both, from the planning area) (Photos by Stillwater Sciences)

Bridge Clearance—the "Bridge Clearance" vegetation management unit represents the required vegetation clearing within 200 feet of the Highway 85 bridge that has been routinely conducted by ADOT (most recently in late 2015). This management action applies to all vegetation types, except water. No other bridges in the planning area appear to warrant vegetation clearing at the time this document was completed.



View of the Bridge Clearance unit near the Highway 85 bridge in the planning area (Photo by Stillwater Sciences)

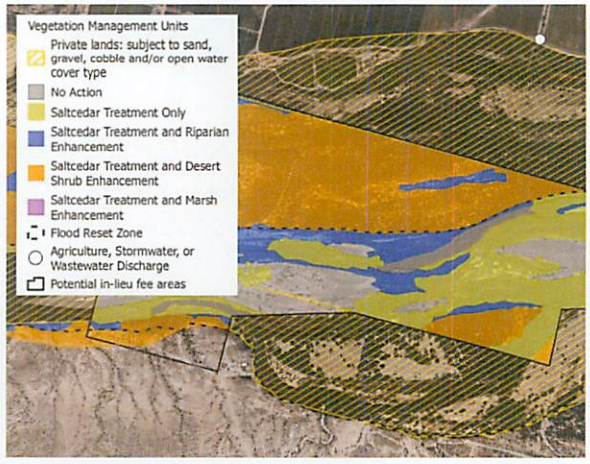
Planned/Completed Restoration—"Planned/Completed Restoration" vegetation management units are the three completed or planned restoration projects in the planning area. These include the District's completed 7-acre El Rio Educational Research and Development Project site located along the south side of the river on West Vineyard Avenue near the Bullard Avenue bridge, the District's completed Buck Fire Revegetation Project located along the northside of the river near the end of Miller Road, and the City of Buckeye's proposed 40-acre vegetation restoration and public access improvement project located adjacent to the Buck Fire project site.

View of the El Rio Educational Research and Development Project site in the planning area
(Photos by Stillwater Sciences)

Vegetation Management Units under Altered Land Use Conditions

The vegetation management units were based on biophysical suitability and developed without consideration for property boundaries and land ownership type. While an area is biophysically suitable for a particular vegetation management unit type regardless of ownership, that may change if the property owner alters the land use of the area. Approximately half of the planning area is privately owned. Due to the anticipated development surrounding the planning area, it is expected that much of this land could potentially be mined for sand and gravel resources in the future. Following mining, the vegetation management units described above are unlikely to be appropriate for the resulting biophysical conditions. While post-mining conditions may result in additional sand, gravel, cobble, and/or open water features, where No Action, Saltcedar Treatment Only, and Marsh Enhancement units may be most appropriate, they are otherwise very uncertain.

Given this uncertainty, an alternative view of the vegetation management units was considered, with privately owned parcels removed from vegetation management consideration. With private property excluded, No Action and Desert Shrub Enhancement units would be reduced by approximately 1,439 and 1,768 acres, respectively, though both of these units would still account for the greatest proportion of the planning area. The Saltcedar Treatment Only and other "enhancement" units would be proportionally less reduced, but it remains possible that private property that is mined will be reclaimed in ways similar to those described for the Desert Shrub, Mesquite Bosque, and Marsh enhancement units.

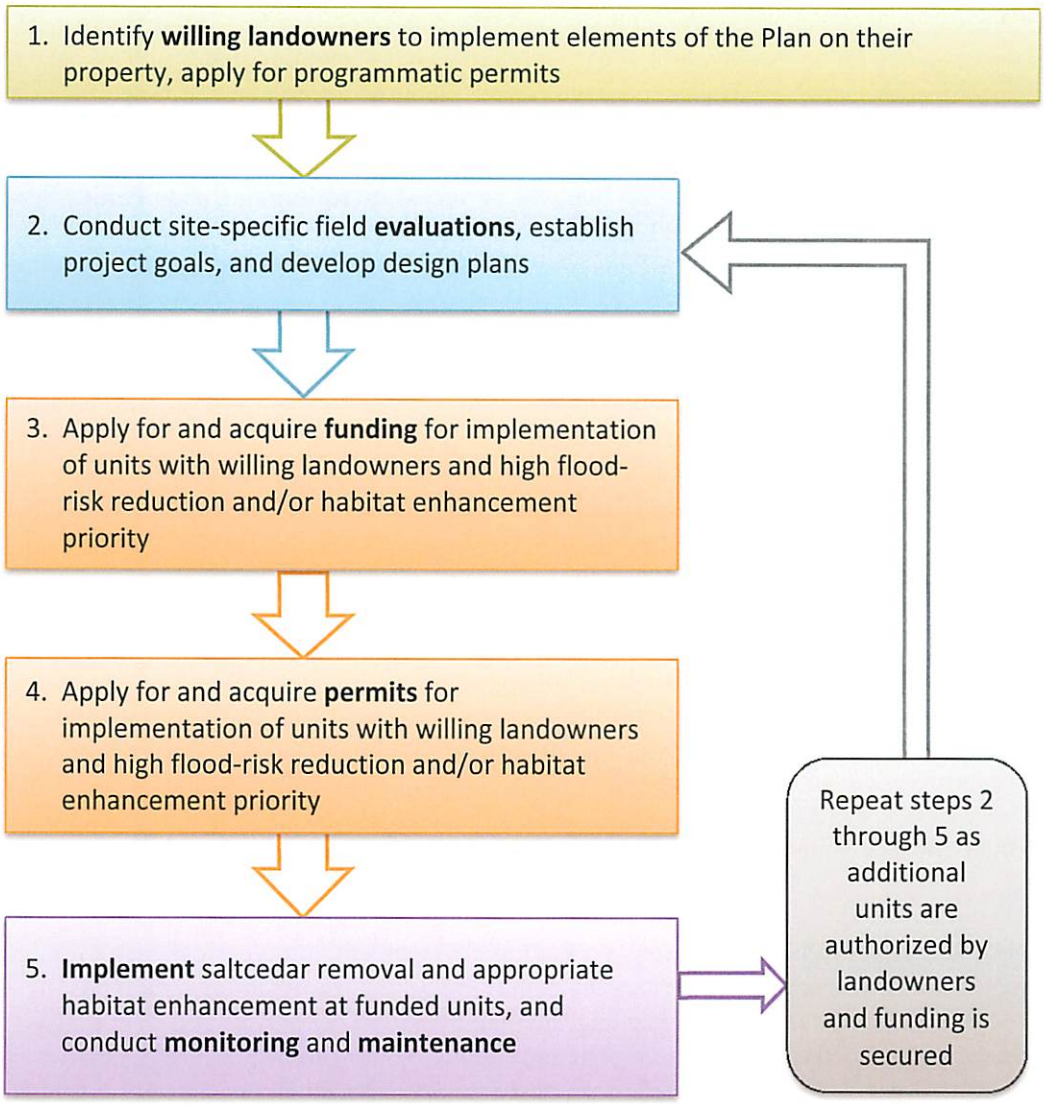


Excerpt of vegetation management units under altered land use conditions maps

VEGETATION MANAGEMENT ACTION IMPLEMENTATION ELEMENTS

Implementation Phasing

The Vegetation Management Plan will ultimately be implemented as a series of projects by a variety of project proponents, resulting in a mosaic of implemented units. Concerted effort by the District and its partners, including individual landowners, to implement the Plan will occur over decades, and is primarily dependent on identifying willing landowners, funding, and permits. Very generally, implementation of the Plan is anticipated to occur over a series of phases, some of which may co-occur and will be repeated as willing landowners are identified and funding is secured for more units.



Conceptual phases of Plan implementation (see Volume 3).

Willing Landowners—Vegetation management actions will only occur where landowners are willing to undertake the work themselves or where landowner permission has been granted for a separate project proponent (such as the District or a municipality) to undertake the work. Outside of the District's owned, leased, or easement areas, the District will conduct landowner outreach efforts to identify willing landowners. Landowners are anticipated to provide critical input to the design and implementation of Plan actions, based on a combination of what is agreeable to the landowner, will not conflict with landowner objectives or uses of the land, and will be feasible and appropriate given landowner knowledge of the area.

Site Assessment and Design—Units that are planned for implementation will first need to be evaluated in the field for site-scale opportunities, constraints, and overall feasibility and sustainability. Site assessment is also an essential component of successful project planning to develop realistic project objectives, and select appropriate saltcedar treatment methods and native species for revegetation, given the project budget and timeline. Site-specific designs may need to include: design plans for any excavation or earthwork; plan-view planting plans with associated planting specifications, such as species, propagule type, planting density, and any specific instructions for soil amendments or planting methods; irrigation design and specifications; and/or design plans for any public access or recreational improvements. Project designs will be helpful in developing the description of the project that will be necessary for funding and permit applications.

Site Prioritization—The Plan cannot be implemented in one contiguous effort as the willing landowners, permits, and funding are not yet in place, and because such an effort would potentially result in large-scale habitat loss. Instead, a phased approach will be used and relevant criteria should be considered to identify locations in the planning area that have the highest priority for vegetation management. Prioritization criteria may be subject to change.

Site Prioritization Criteria

1 - *Outside of the river channel and suitable habitat for protected species*
2 - *In the downstream half of the planning area where river flow is most impeded*
3 - *Benefits to the public*
4 - *Habitat enhancement opportunities*
5 - *On District-owned or otherwise protected land*

Funding Sources and Cost Estimates—Implementation of the Plan over the long-term will require substantial funding given the size of the planning area and the costs associated with saltcedar removal, revegetation, and maintenance. The availability of funding is anticipated to be a primary control on the amount of vegetation management that is conducted, and the timeframe in which it occurs. A variety of potential funding sources that fund invasive species removal and/or habitat enhancement activities in the planning area region are available for implementation of the Plan.

The anticipated number of acres of various vegetation management unit types can be multiplied by the average cost per acre of the activities that would be conducted in various unit types to develop rough cost estimates for implementing the Plan over a 5-year period. A 5-year time period ensures that saltcedar resprout treatment and routine monitoring, which are typically required for 3 to 5 years, are incorporated in the cost estimate. The rough estimated cost to implement the entire Plan over a 5-year period under current conditions is $110 million, and under altered land-use conditions (*i.e.*, not including private property) is $58 million. Ultimately, the Plan's phased approach will have considerable bearing on the final cost of implementation.

Permitting and Regulatory Compliance—Permitting refers to the processes and authorizations necessary for a proposed project to comply with relevant federal, state, and local laws or regulations. These regulations give authority to particular agencies to implement the regulation and are intended to ensure that a proposed project's potential impacts on the environment are avoided, minimized, or mitigated. There are a number of regulations that would apply to, and regulatory agencies that would be involved with, the permitting of Plan actions (with the exception of No Action units, which would not require any permits) because the planning area includes a river, wetlands, and is known to support federally endangered species and their habitat. Plan implementation will also involve actions, such as use of mechanized equipment within the ordinary high water mark of the Gila River, which would trigger the need to comply with certain environmental regulations.

Permits that May be Required

Clean Water Act Section 404 (USACE)
Clean Water Act Section 401 (ADEQ)
ESA Section 7 Biological Opinion (USFWS)
National Historic Preservation Act Section 106 (SHPO)
National Environmental Policy Act (USACE)
Stormwater Construction General Permit (ADEQ)
Pesticide General Permit (ADEQ)
Floodplain Use Permit (District, City)

Site Preparation—Implementation sites would need to be prepared in accordance with any site-specific plans that address access routes and staging areas, as well as saltcedar removal and habitat enhancement specifications, such as grading or amendments of surficial soils, conservation of upstream vegetation, establishment of irrigation methods, development of planting palettes, and surveys of sensitive wildlife and/or vegetation.

Salcedar Removal and Treatment Methods—Manual, mechanical, and chemical removal of saltcedar is needed to reduce flood risk and to provide sufficient space for the revegetation with native trees and shrubs, even after the tamarisk beetle colonizes the planning area. Planting of native species will be necessary to replace habitat loss from saltcedar removal and to promote the re-establishment of appropriate native plant species. There are many methods for removing and treating saltcedar. Mechanical saltcedar biomass removal followed by immediate herbicide application to the cut stumps, and subsequent foliar herbicide application to regrowth, is likely to be the best value in terms of cost versus efficacy, for the planning area. Mechanical removal may include root crown removal or above-ground biomass removal. Manual (*i.e.,* hand) removal may be necessary where access is limited or where native vegetation needs to be avoided. The focus on these methods does not exclude the use of other methods that may be appropriate for particular sites and conditions.

Examples of mechanical removal of saltcedar, placement of mulched biomass, and preservation of native riparian trees (top), and herbicide treatment on a cut saltcedar stump (bottom) (both views from the upper Gila River near Safford, AZ)
(Photos by Stillwater Sciences)

Native Plant Collection, Propagation, and Planting—Depending on individual site characteristics, the abundance of native species may be sufficient to provide natural recruitment of native plants after saltcedar is removed. The species that have been selected for the Plan are native to the region, will be able to persist in the physical conditions that do and are anticipated to occur at the unit locations, and will create the desired habitat conditions. It may be necessary, however, to alter or revise the suite of plant species used for habitat enhancement based on the results of site-specific assessment. For example, plants with higher tolerance for saline soils should be used if a site is ultimately found to have relatively saline soils. Site-specific assessments should also be used to determine appropriate revegetation techniques, plant-stock options, and soil amendment needs.

Benefits of Plantings

1 - Erosion control
2 - Replace/enhance wildlife and pollinator habitat
3 - Provide shade for recreation and wildlife
4 - Provide forage for wildlife
5 - Improve aesthetics
6 - Reduce re-establishment of saltcedar and other weeds

The District maintains a native plant nursery that can be used to collect local seed and cuttings, and propagate and grow many of the plants that will be needed for habitat enhancement. If demand exceeds the District's supply and capacity, seed and plants can be procured from other regionally-appropriate native plant nurseries.

Best Management Practices, Conservation Measures, and Maintenance—Implementation of the Plan will require several best management practices and conservation measures before, during, and/or after saltcedar removal and habitat enhancement to adequately avoid and minimize impacts to environmental resources and comply with general permit terms and conditions. Additional measures are likely to be required as a result of project-specific permit terms and conditions.

Best Management Practices

1 - Surveys for protected birds
2 - Cultural resources surveys
3 - No work around nests or during nesting season
4 - Crew environmental awareness training
5 - Biologist and/or cultural resources monitoring during implementation
6 - In-water or streambank work curtailment during rain events
7 - Native vegetation avoidance
8 - Adherence to a SWPPP
9 - Proper handling, storage, and clean-up of construction equipment and materials
10 - Herbicide application per ADEQ permit

Maintenance— Vegetation management units have been assigned and hydraulically modeled for flood risk reduction based on the expected height and density of the units at vegetation maturity. As such, maintenance, such as trimming, mowing, or clearing, is not anticipated to be needed to maintain the expected or desired level of flood risk reduction.

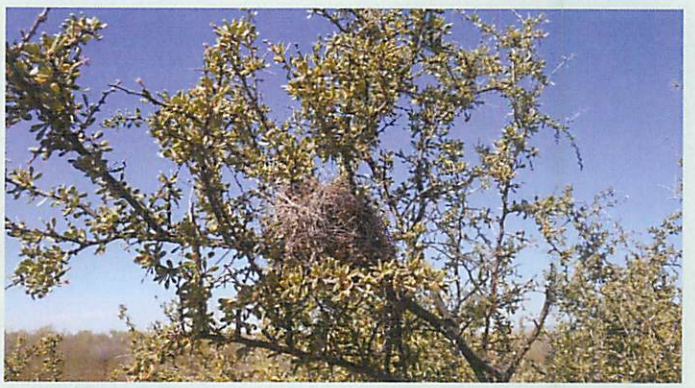
A three- to five-year commitment for spot spraying of saltcedar re-sprouts must be part of any successful treatment project. Monitoring of project sites will reveal re-sprouting saltcedar and should prompt the application of herbicide before the sprouts become too large.

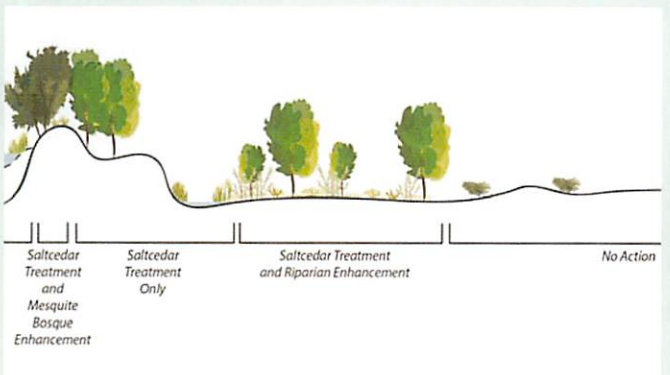
New plantings may require supplemental irrigation and/or soil amendments to ensure survival and success, and ill-suited species may need to be replaced if plant survival or native cover objectives are not being met. Site management, such as fencing to limit livestock grazing or unauthorized access, may be required at enhancement sites, as well irrigation equipment maintenance.

Monitoring and Adaptive Management—Pre-project and post-project monitoring of saltcedar treatment and habitat enhancement sites will be used to determine whether individual project objectives have been achieved. Specifically, monitoring will be needed to identify necessary maintenance activities, such as treatment of re-sprouting saltcedar and replacement of plantings. Monitoring will also be necessary to meet the terms and conditions of project permits, which typically require at least five years of annual monitoring. In light of the flood risk reduction objective of the Plan, monitoring of vegetation roughness characteristics (*e.g.*, height and density of developing vegetation) and inputting that information into hydraulic models may be needed to demonstrate if vegetation management alone is sufficiently reducing flood risk. Ideally, monitoring should also be used to understand the reasons for project success or failure, so that projects can be adaptively managed and future projects can benefit from this improved understanding. This may require as-built monitoring (to determine if a project was implemented as designed), shallow groundwater monitoring, flood inundation measurements, *etc.* and analysis that links such monitoring to planting survival.

FINAL TECHNICAL REPORT ◦ SEPTEMBER 2016

El Rio Vegetation Management Plan
Lower Gila River, Maricopa County, AZ
Volume 3: Vegetation Management Units and Implementation Elements





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Upper left: Subset of the vegetation management unit map produced for the planning area (created by Stillwater Sciences).

Top right: View of wolfberry shrubs (*Lycium andersonii*) with bird nest in the El Rio planning reach that is representative of the "Saltcedar Treatment and Mesquite Bosque Enhancement" vegetation management unit proposed by the Plan (photo taken 2/27/2015 by Stillwater Sciences).

Bottom left: Partial illustration of anticipated vegetation conditions after implementation of the El Rio Vegetation Management Plan (created by Stillwater Sciences).

Bottom right: View of Fremont cottonwood (*Populus fremontii*) trees in the El Rio planning reach that are representative of the "Saltcedar Treatment and Riparian Enhancement" vegetation management unit proposed by the Plan (photo taken 6/29/2015 by Stillwater Sciences).

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Appendices

Appendix A. Vegetation Management Unit Maps
Appendix B. Vegetation Management Unit Maps under Altered Land Use Conditions
Appendix C. Permitting Requirements

LIST OF ACRONYMS AND ABBREVIATIONS

Acronym or abbreviation	Definition
%	percent
ADEQ	Arizona Department of Environmental Quality
ADOT	Arizona Department of Transportation
AGFD	Arizona Game and Fish Department
APHIS	U.S. Department of Agriculture's Animal and Health Inspection Service
ASLD	Arizona State Land Department
AZ	Arizona
BLM	Bureau of Land Management
District	Flood Control District of Maricopa County
e.g.	"for example"
ESA	Endangered Species Act
et al.	"and others"
etc.	"and other things of the same class"
FEMA	Federal Emergency Management Agency
GIS	geographic information system
i.e.	"that is"
NEPA	National Environmental Policy Act
NRCS	Natural Resources Conservation Service
No.	number
NOI	Notice of Intent
NPDES	National Pollution Discharge Elimination System
OHWM	ordinary high water mark
pers. comm.	personal communication
Plan	Vegetation Management Plan
RGP	Regional General Permit
spp.	species (plural)
SRP	Salt River Project
SHPO	State Historic Preservation Office
SWPP	Stormwater Pollution Prevention Plan
TAC	Technical Advisory Committee
U.S.	United States
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFS	U.S. Forest Service
USFWS	U.S. Fish and Wildlife Service

UNIT CONVERSION FACTORS

Most values presented in this report are reported in the U.S. Customary Unit System. This table presents conversion factors of the commonly used U.S. Customary system units to metric units.

U.S. Customary Units	Conversion	Metric Units
in (inches)	*x* 2.54	cm (centimeters)
	x 25.4	mm (millimeters)
	x 25,400	um (micrometers)
ft (feet)	*x* 0.3048	m (meters)
mi (mile)	*x* 1.609	km (kilometers)
ac (acres)	*x 0.4047*	ha (hectares)

1 INTRODUCTION

1.1 Document Purpose

This technical report has been prepared as the second step to inform and facilitate the development of a science-based Vegetation Management Plan (Plan) for the El Rio reach of the lower Gila River in Maricopa County. This report has been prepared by Stillwater Sciences for the Flood Control District of Maricopa County (District), with input from District staff and a technical advisory committee (TAC; see Volume 2 for the list of TAC members). Specific objectives of the Plan, and this technical report in particular, are to:

- Provide a framework for reducing the extent of flooding under the predicted 100-year flow event (*i.e.*, the modeled 100-year floodplain in Figure 1) through saltcedar management, while maintaining and enhancing riparian habitat assets.
- Identify appropriate, ecologically sustainable, and spatially-explicit management actions, such as saltcedar treatment, revegetation with native plant species, or no action, based on biological and hydrological factors, as well as the reasonableness of costs, local community expectations, and other key considerations.
- Develop monitoring methods to evaluate progress toward Plan objectives, to apply adaptive management to enhance the likelihood of achieving those objectives, and increase understanding of flood and ecosystem interactions.
- Prepare for anticipated changes to the system, such as climate change, land-use changes, and colonization by the tamarisk beetle (*Diorhabda elongata* complex).
- Prepare for implementation of rapid, active ecological restoration and other management strategies for threatened, endangered, and other native wildlife species potentially displaced by saltcedar treatment activities, and to enhance pollinator habitat.
- Provide consideration of proper implementation techniques, implementation costs, permitting requirements, short- and long-term maintenance needs, water use/savings, and wildfire control.

The first step in the development of the Plan was to compile and collect baseline ecological and hydrological data for the El Rio reach. This effort is documented in Volume 2: Data Collection and Analysis. Together, the two technical reports compose the Vegetation Management Plan that describes appropriate types of actions and their locations, and considers permitting requirements, mitigation strategies, maintenance needs, monitoring and adaptive management needs, funding opportunities, and implementation costs.

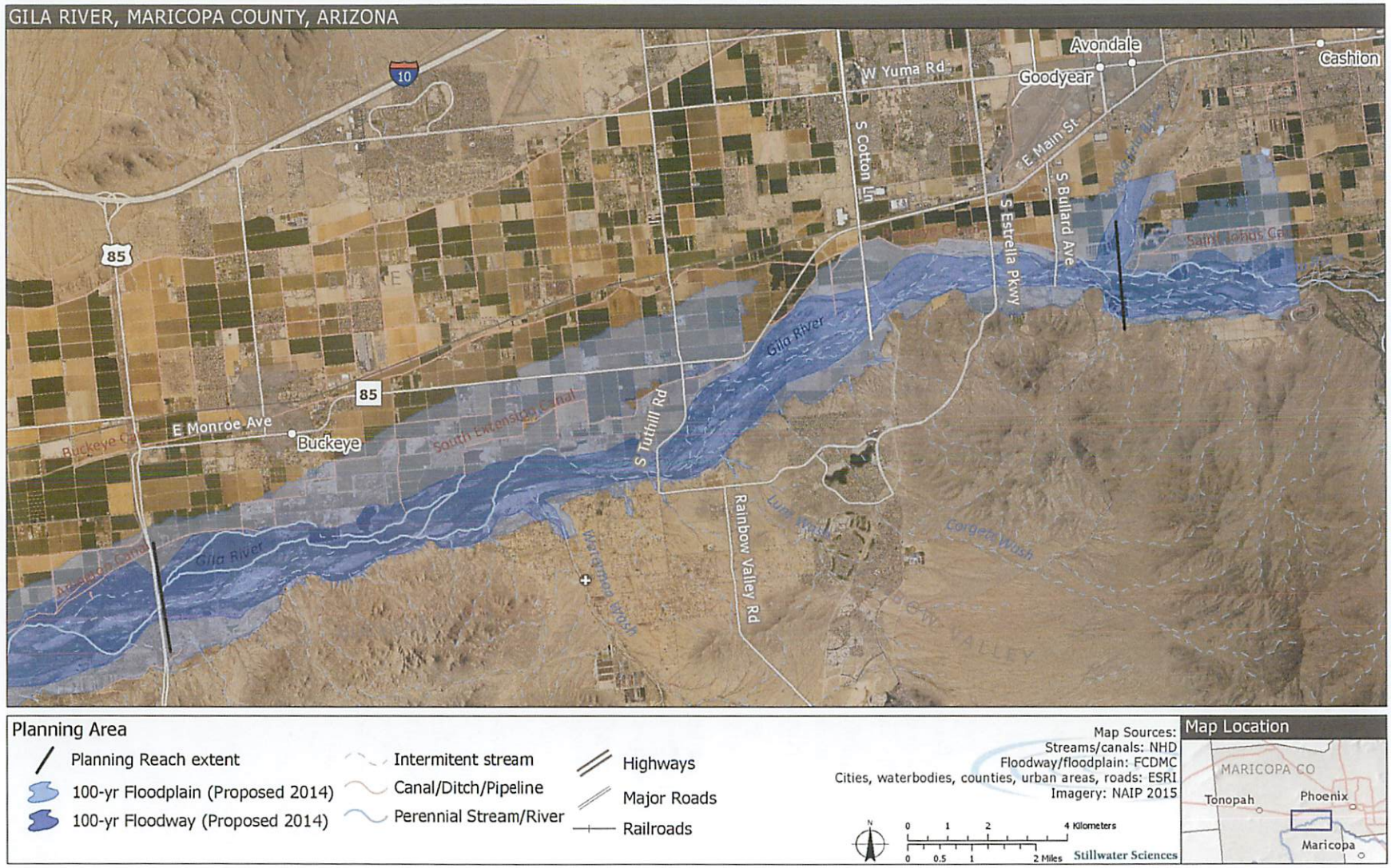


Figure 1. Location map of the planning area (source data from the District).

1.2 Planning Area

The El Rio reach of the lower Gila River, and the area addressed by the Plan, extends from the confluence of the Agua Fria River with the Gila River, downstream to Maricopa County Highway 85 bridge (Figure 1). This reach is approximately 17 miles long and 1 mile wide, and is referred to as the "planning area" throughout the Plan. The width of the planning area is defined by the extent of the 100-year floodway (Figure 1), which currently includes the non-developed corridor of the Gila River. The 100-year floodway typically defines the maximum amount of development encroachment allowed by the Federal Emergency Management Agency (FEMA) into the 100-year floodplain: development can occur within the 100-year floodplain so long as it and any associated mitigation does not result in changes to the floodway. The 100-year floodplain (also shown in Figure 1) is the area predicted to be inundated by a flow event that statistically has a one percent chance of occurring in any given year.

1.3 Overview of Findings and Recommendations from Volume 2

Volume 2 provides an assessment of ecohydrological conditions in the planning area and describes the implications of those conditions that informed the identification of the vegetation management actions and spatial units that are presented in this report. Volume 2 also introduced the planning area, the need for vegetation management, and the goals and objectives of the Plan: information that is not repeated in this report.

The salient findings and recommendations presented in Volume 2 are as follows:

- **Land uses**—Land ownership in the planning area is roughly split evenly between public and private entities (*i.e.*, 47% versus 53%), while many areas just outside the planning area are anticipated to be developed for residential and commercial uses in the future.
    - Most opportunities for Plan implementation will be found on the public-owned lands, of which the District, Bureau of Land Management (BLM), and Arizona Game and Fish Department (AGFD) collectively own about 3,990 acres. Much of the privately-owned land is anticipated to be used for gravel mining in the future. Conversion of portions of the floodway to open water features from gravel mining will potentially reduce flood risk and have implications on the types of vegetation management that are appropriate in and around gravel mining operations. As such, the Plan should incorporate flexibility in any recommended management action on and adjacent to the private lands. Additionally, implementation of the Plan should be done in coordination with planning recreational and scenic attractions for the community and adjacent residential developments.
    - Continue communication and coordination with other entities that have previously conducted vegetation-management-related activities in the planning area to ensure that future vegetation-management activities do not conflict with one another and, ideally, can be conducted in ways that save or share costs and increase mutual benefits.
- **Climate**—Predicted future increases in regional and local air temperatures, and the likely reduction in future water supply, will challenge local riparian habitat. Air temperature and drought tolerances for native plant species must be incorporated into the Plan when specifying appropriate species and locations for revegetation, but such specifications

must incorporate sufficient flexibility to address the implications of hotter and drier conditions in the future.

- **Flood hydrology and geomorphology**—The river corridor naturally experiences a wide variation of flows, punctuated episodically by short-duration but intensive high-flow events capable of dramatically repositioning the dominant channel and scouring large swaths of vegetation. Appropriate strategies for saltcedar treatment and native species revegetation within the flood reset zone (*i.e.,* that portion of the river corridor most frequently scoured during larger flood events) will be developed for the Plan. For example, to reduce the risk of future floods washing away plantings, revegetation within the flood reset zone should incorporate an upstream "hydraulic shield" of conserved vegetation, even if it is saltcedar (see Section 3.7 Site Preparation). Similarly, conservation of saltcedar within some portions of the flood reset zone will likely be necessary to reduce the potential for unintended bank instability and geomorphic changes from saltcedar removal. Management actions conducted soon after flood scour (or fires) can take advantage of newly cleared areas where much of the saltcedar biomass has been removed and more cost-effectively treat remaining saltcedar and/or revegetate with native species to promote their establishment prior to re-colonization by saltcedar or other invasive plants.
- **Ecological flows**—Baseflows in the planning reach are supplemented by a number of stormwater, wastewater, and agricultural return-flow canals.
    - The outfalls of several of these water sources support some of the largest and most diverse stands of native riparian vegetation in the planning area. While these inputs could be used to prioritize where saltcedar removal and habitat enhancement occurs, since plantings would have a higher likelihood of being successful, the volume, timing, and constancy of these water sources are highly subject to change in light of land-use changes outside the planning area. As residential development replaces agriculture, agricultural return flows will decrease while stormwater and wastewater discharges, which can be high in salinity, will increase. Vegetation management actions that are potentially dependent on these water supplies will need to evaluate and likely monitor water supply changes in the future.
    - Another potential source of water in the planning area is the Salt River Project (SRP), which regulates upstream water supply. It is recommended that discussions with SRP, as well as Buckeye Water Conservation and Drainage District, take place regarding the possibility of purchasing agricultural water rights when the associated agricultural activity ends, and transferring the water for restoration purposes. Discussions with SRP should also include the potential for storing water in the flood pool behind Roosevelt Dam and then releasing that water at a time that would facilitate natural recruitment of native riparian vegetation.
- **Soils**—Soil texture, salinity, and alkalinity levels in the vast majority of the planning area are within the tolerance ranges of most native woody riparian, desert wash, and upland plant species that would be appropriate for revegetation, and should not preclude the natural recruitment of these species. Given general plant soil requirements and tolerance levels, suitable areas for active restoration of many native riparian trees and shrubs include those with soils having non-saline to very slightly saline conditions, while areas with soils having slightly saline to strongly saline conditions are better suited for desert shrub species. Additional soil sampling may be necessary at sites where there are visual signs of potentially high soil salinity or other unforeseen soil characteristics. Where this

is the case, planting plans will need to incorporate native species with appropriate soil condition tolerances (salinity and other soil condition tolerance levels of native species are provided in Volume 2, Appendix E).

- **Groundwater**—Relative elevation above the low-flow, or baseflow, water surface in the river channel is a useful indicator of revegetation potential as native riparian plant species tend to occur in particular topographic positions relative to the river channel based largely on depth to groundwater and plant ecophysiological requirements and tolerances. Vegetation-transect surveys performed in support of Plan development found that native cottonwood and willow trees are most numerous upon surfaces within 2 to 10 feet above the low-flow channel water surface, and desert shrub vegetation is most numerous at relative elevations ranging from 5 to 18 feet. The location of the vegetation management units described in Chapter 2 were identified in part by these relative elevation/depth to groundwater preferences: areas under 7.5 feet were considered to be suitable for establishing native woody riparian trees, and areas above 7.5 feet were considered to be suitable for native desert shrub.
- **Vegetation**—Numerous considerations should be incorporated into the Plan:
    - Biocontrol of saltcedar by the tamarisk beetle will not be sufficient to reduce flood risk in the planning area within the timeframe desired because saltcedar defoliation and mortality from the beetle will not remove standing saltcedar biomass (*i.e.*, the remaining trunks and branches).
    - While removal of saltcedar will provide multiple benefits to the El Rio reach and surrounding lands, replacement of removed saltcedar with native vegetation will be necessary to mitigate lost habitat structure, reduce resprouting of saltcedar and establishment of secondary weeds, and offset impacts for regulatory compliance.
    - Recruitment potential of native trees, shrubs, and herbs is limited by water availability and high density of saltcedar cover, which together indicate that active planting will be needed to replace saltcedar with native species in most areas and instances.
    - The biophysical conditions (*e.g.*, relative elevations, soils types, and proximity to water supply) under which native plant species have been documented to occur should be used to help select sites for active revegetation, rather than just the current location of natives, which is likely to underestimate the area potentially suitable for revegetation.
    - The most appropriate vegetation types for revegetation in the planning area, based on existing species presence and regional vegetation types, are riparian cottonwood (*Populus fremontii*)/willow (*Salix* spp.), mesquite (*Prosopis* spp.) bosque, and native desert shrub. A mixture of these vegetation types, particularly where a multilayered canopy develops and a wide range of appropriate locally native tree, shrub, and herb species are incorporated, would enhance native vegetation and habitat diversity and quality for wildlife.
    - All existing native trees and shrubs, such as Fremont cottonwood, Goodding's willow, mesquite, palo verde (*Parkinsonia* spp.), creosote (*Larrea tridentata*), *etc.*, should be conserved, whenever feasible, and post-saltcedar-removal plantings should be planned to maximize native seed source and natural recruitment potential.
    - A variety of strategies will need to be developed that specifically optimize native plant revegetation, including: (1) developing a plan for managing standing dying/dead saltcedar following wildfire and tamarisk beetle colonization, (2)

protecting cottonwood and willow plantings from herbivory, (3) protecting remnant native vegetation from wildfires, (4) suppressing aggressive native plants such as arrowweed (*Pluchea sericia*) and seepweed (*Suaeda moquini*), and (5) planting highly competitive species, such as quailbush (*Atriplex lentiformis*), after less competitive desirable species, such as screwbean mesquite, have established.

  - Consider creation of a variety of swales and other features that reduce depths to groundwater and increase access to surface water to facilitate expansion and long-term sustainment of diverse open water/marsh and riparian woodland habitats, including: (1) low-flow side channels and side-channel pools that can expand perennial aquatic and riparian habitat, (2) high-flow backwater channels and embayment areas to facilitate development of open water/marsh habitats adjacent to restored riparian woodland, (3) high-flow ephemeral channels, or inundation channels, to support upper terrace mesquite woodlands, and (4) channel-side benches or terraces to increase inundation of cottonwood/willow plantings.
  - Flood-risk mitigation actives undertaken to improve the FEMA Community Rating System should be coordinated with riparian vegetation restoration plans to maximize their mutual benefits.

- **Wildlife**—Southwestern willow flycatcher (*Empidonax traillii extimus*), western yellow-billed cuckoo (*Coccyzus americanus*), and Yuma clapper rail (*Rallus longirostris yumanensis)*[1] are listed as threatened or endangered under the federal Endangered Species Act (ESA) and have been documented to occur or have potential to occur in the planning area. In addition, other migratory birds and native wildlife occur in the planning area.
  - The arrival of tamarisk beetle is anticipated to dramatically reduce the dense saltcedar cover that these birds and other wildlife species may currently use in the planning area. As such, it is necessary to quickly establish beetle-resilient native habitat for these species to use.
  - Saltcedar removal for vegetation management will similarly reduce the habitat available to these species. Therefore, replanting saltcedar-treatment areas with native vegetation types will be necessary to mitigate for the impacts of vegetation management.
  - To minimize the impacts of vegetation management, saltcedar removal and subsequent native revegetation should be conducted in phases, so that the amount of habitat removed is relatively small in any given year and there is time for native habitat to grow to sufficient height, complexity, and density to suitable provide habitat before additional saltcedar is removed.
  - Microscale (*i.e.*, approximately 3-foot resolution) habitat suitability models in the El Rio reach for southwestern willow flycatcher and western yellow-billed cuckoo can be used to specify the amount and location of suitable habitat that should be avoided be avoided during vegetation management or, if avoidance is not feasible, may be affected by vegetation management. The model parameters can also be used to define the structure that created habitat should be designed to

[1] Recent taxonomic studies have led to the Yuma clapper rail being reclassified as Yuma Ridgway's rail (*R. obsoletus yumanensis*) (http://blog.aba.org/2014/07/2014-aou-check-list-supplement-is-out.html). However, in this report we retain use of the older name for consistency with prior studies and usage by regulatory agencies.

achieve, and specify the amount and location of revegetation that may be necessary to mitigate for habitat loss, as well as help prioritize areas where habitat enhancement should be most beneficial to these species and facilitate regulatory compliance.

- Surveys for the listed bird species in the planning area (as well as other wildlife) can be used to: calibrate habitat suitability models; determine where suitable habitat occurs at vegetation management sites; identify measures that will be necessary to protect these species during vegetation management activities in suitable habitat area, such as pre-treatment surveys and avoiding certain work activities during the breeding season from early-May to late-September; and, if the surveys are repeated, document wildlife response to vegetation management and habitat enhancement.

2 VEGETATION MANAGEMENT UNITS AND ACTIONS

Vegetation management units are specific locations within the planning area where particular vegetation management actions, or combinations of actions, should be appropriate and sustainable, given the biophysical and land-use conditions in and around the planning area, and will promote the goals of the Plan—the removal of saltcedar, revegetation with appropriate locally native riparian and upland plant species, and, ultimately, flood-risk reduction throughout the El Rio reach. This chapter summarizes the methods used to identify the vegetation management units, presents the vegetation management unit maps, and describes generally the actions that would occur in different unit types.

2.1 Methods

The vegetation management units were identified in a geographic information system (GIS) based on data that were collected and described in Volume 2, and then reviewed and revised as needed based on interpretation of remote-sensing products and other knowledge of local conditions. In particular, the following GIS products were critical to the development of the vegetation management units:

- **Delineation of the flood reset zone** (Section 2.5.2 of Volume 2)—defined the portion of the Gila River floodway that is most likely to experience notable scour and deposition under future high flow events. This area should provide one of the most reliable sources of water for native riparian vegetation, since it is in close proximity to the river channel, but also presents greater risk of losing planted vegetation during a subsequent high flow event.
- **Soil salinity and texture** (Section 2.6 and Appendix B of Volume 2)—determined which species are likely to be appropriate to plant in particular areas (*e.g.*, those that can tolerate the soil salinity and texture conditions) and indicated where revegetation is likely to be more or less sustainable.
- **Relative elevation above the low-flow river channel** (Section 2.7 and Appendix C of Volume 2)—served as a proxy for groundwater depth and indicated general water supply availability. This information helped determine which species were likely to be appropriate to plant in particular areas (*e.g.*, those native species that have sufficient root growth rates and rooting depths to reach deeper groundwater levels during the driest part of the growing season).
- **Vegetation type** (Section 2.8 and Appendix D of Volume 2)—identified which areas should have sufficient existing native cover to facilitate natural recruitment, and which vegetation type is likely to be most appropriate to plant in any particular area.
- **Vegetation canopy height** (Section 2.8 and Appendix D of Volume 2)—provided an indication of areas that are currently productive (*i.e.*, are capable of supporting taller native woody species) and where native revegetation is likely to be more successful and sustainable. Vegetation canopy height also serves as an indicator of wildlife habitat availability. (Vegetation canopy height was derived and/or averaged across relatively broad areas and is not an indication of individual tree height.)

- **Habitat suitability of southwestern willow flycatcher and western yellow-billed cuckoo** (Sections 2.9.1 and 2.9.2, and Figures 13 and 14 in Volume 2)—indicated where existing biophysical conditions most likely provide suitable breeding habitat and, by extrapolation, where active revegetation with appropriate native species is most likely to create suitable habitat, and may be required as a part of regulatory compliance.

Table 1 summarizes how these GIS-based products were used to identify vegetation management unit types. The unit types are described in Section 2.2 below.

The map resulting from the GIS effort was reviewed to evaluate landscape position (*e.g.*, proximity to adjacent land uses and unit types, location on terraces, proximity to tributary washes, position relative to flood bottlenecks) and other conditions potentially influencing unit type suitability, such as natural recruitment potential, and revised accordingly. Many, but not all, of the individual vegetation management units have been reviewed in the field. They have also been incorporated into a hydraulic model (at the locations specified in Appendix A and the acres, heights, and densities indicated in Table 2) and determined to reduce (although not eliminate) flood risk to adjacent lands. It is important to note that land ownership or parcel boundaries were not used during the selection of vegetation management unit types or locations and, as such, units on private property in particular will be subject to change based on future uses of those lands. Section 2.2.9 describes some of the changes that may be appropriate given future land use conditions on private property.

Table 1. GIS information used to identify vegetation management unit types.

Unit Type No.	Unit Type Name	Summary Description	Primary Existing Vegetation Types	GIS Assessment Criteria
1	No Action	• No saltcedar removal, habitat enhancement, or any other activity for flood-risk reduction • Monitored to determine if/when saltcedar removal may become necessary	• Cobble/gravel/sand • Saltcedar (low-density) • Agriculture • Canal/ditch • Developed • Water • Planted (mesquite) • Desert shrub • Mesquite	None

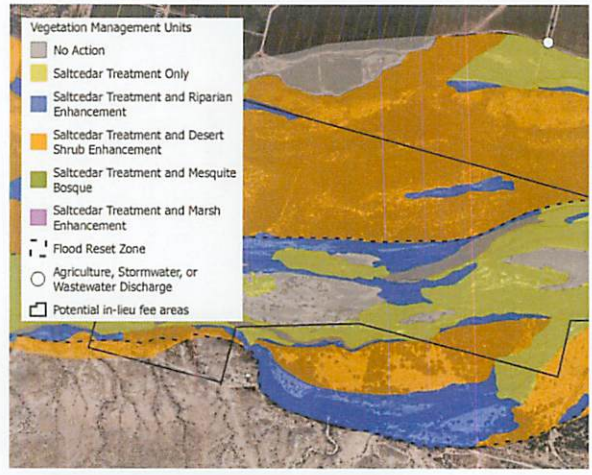
2	Saltcedar Treatment Only	• Mechanical and/or manual saltcedar biomass removal and treatment with herbicide, with herbicide retreatment as necessary
		• Native species expected to recruit and expand naturally; no planting or seeding
			• Desert shrub
			• Marsh
			• Saltcedar/Mesquite
			• Saltcedar/Arrowweed
			• Saltcedar/Cottonwood
			• Saltcedar/Cottonwood/Willow
			• Saltcedar/Willow
				• Canopy height used as an indication of unit productivity and potential for sustainable enhancement
				• Southwestern willow flycatcher habitat modeling used as an indication of where active planting may be required to enhance habitat and mitigate for impacts
				• Potential for natural recruitment assessed, using the following criteria:
				  o Within 50 feet of water
				  o Under 7.5 feet relative elevation
				  o Canopy height above 15 feet
				  o Non-saline soils

3	Saltcedar Treatment and Riparian Enhancement	• Mechanical and/or manual saltcedar biomass removal and treatment with herbicide, with herbicide retreatment as necessary • Planting of native cottonwood, willow, and associated riparian species	• Saltcedar (medium- and high-density) • Disturbed • Marsh • Desert shrub	• Under 7.5 feet relative elevation • Canopy height used as an indication of vegetation productivity (whether native or not) in each unit and potential for sustainable native enhancement • Flood Reset Zone used to distinguish level of risk to enhancement investment • For areas outside Flood Reset Zone, influence from agricultural return flow used to identify appropriate locations

Unit Type No.	Unit Type Name	Summary Description	Primary Existing Vegetation Types	GIS Assessment Criteria
4	Saltcedar Treatment and Desert Shrub Enhancement	• Mechanical and/or manual saltcedar biomass removal and treatment with herbicide, with herbicide retreatment as necessary • Planting of native desert shrub and associated upland species	• Saltcedar (medium- and high-density) • Disturbed • Desert shrub • Mesquite	• Primarily above 7.5 feet relative elevation • Flood Reset Zone used to distinguish level of risk to enhancement investment • Landscape position used to decide between this type and Unit Type 5, with flood-prone areas assigned as this type
5	Saltcedar Treatment and Mesquite Bosque Enhancement	• Mechanical and/or manual saltcedar biomass removal and treatment with herbicide, with herbicide retreatment as necessary • Planting of native mesquite, palo verde, and associated mesquite bosque species	• Saltcedar (medium- and high-density) • Disturbed • Desert shrub • Mesquite	• Primarily outside Flood Reset Zone • Above 7.5 feet relative elevation • Landscape position used to decide between this type and Unit Type 4, with tributary terraces and non-flood-prone areas assigned as this type • Canopy height used as an indication of vegetation productivity (whether native or not) in each unit and potential for sustainable native enhancement
6	Saltcedar Treatment and Marsh Enhancement	• Mechanical and/or manual saltcedar biomass removal and treatment with herbicide, with herbicide retreatment as necessary • Surface grading to create appropriate gradients and inundation depths • Planting of native cattails, tules, and associated marsh species	• Saltcedar (medium- and high-density) • Disturbed • Water	• Outside Flood Reset Zone • Within 50 feet of water's edge (includes water vegetation types, and upland vegetation types)
7	Bridge Clearance	• Vegetation clearing within 200 feet of the Highway 85 bridge, as required by Arizona Department of Transportation (ADOT)	• All except Water	• Within 200 feet of the Highway 85 bridge (clearance around other bridges in the planning area is not required)
8	Planned/ Completed Restoration	• Locations of previously implemented restoration projects and restoration projects planned for the foreseeable future from the project proponents	• Not applicable	• Not applicable

2.2 Vegetation Management Units

The vegetation management units for the 8,787-acre planning area are depicted in Appendix A and summarized in Table 2 (see map excerpt at right). Although the unit maps in Appendix A and the acres in Table 2 appear very precise, it is important to note that the level of specificity in unit boundaries is a reflection of the underlying GIS data. Unit boundaries should, in fact, be thought of as approximations and the extent and boundaries of activities actually undertaken as a part of the Plan will need to be determined based on site-specific field evaluations.



Excerpt of vegetation management unit maps (see Appendix A for complete map tiles)

Table 2. Vegetation management unit types recommended for the planning area.

Unit Type No.	Unit Type Name	Area Inside Flood Reset Zone (acres)	Area Outside Flood Reset Zone (acres)	Total Area (acres)	Percent of Planning Area	Anticipated Vegetation Height at Maturity (feet)	Anticipated Woody Plant Density at Maturity [A]
1	No Action [B]	1,924	1,119	3,043	35%	0–10	None–Moderate
2	Saltcedar Treatment Only [B]	395	214	609	7%	0–90	Sparse–Dense
3	Saltcedar Treatment and Riparian Enhancement	586	163	749	9%	40–90	Dense
4	Saltcedar Treatment and Desert Shrub Enhancement	1,470	2,163	3,633	41%	2–8	Sparse–Moderate
5	Saltcedar Treatment and Mesquite Bosque Enhancement	4	566	570	6%	20–40	Moderate–Dense
6	Saltcedar Treatment and Marsh Enhancement	14	63	77	1%	5–10	Sparse [C]
7	Bridge Clearance	4	20	24	<1%	0	None
8	Planned/ Completed Restoration [D]	6	76	82	1%	6–90	Sparse–Dense

Table footnotes:

[A] Sparse = >6 feet of space between woody plant canopies; Moderate = 0–6 feet of space between woody plant canopies; Dense = overlapping woody plant canopies (*i.e.*, woody plants present in overstory and understory).

[B] As described in more detail below, this unit type encompasses a variety of underlying vegetation conditions and, as a result, there is a greater range of potential vegetation heights and densities following vegetation management.
[C] This unit type would be enhanced primarily with herbaceous, rather than woody, plant species.
[D] As described in more detail below, this unit type could result in variable vegetation conditions depending upon the project goals and methods.

The activities that are anticipated to be appropriate for these units, and that form the basis for the unit type numbers and names, are summarized in the sections below. In total, the vegetation management units entail approximately 5,000 acres of saltcedar removal in the planning area, which would be implemented in numerous phases and individual projects. Most removed saltcedar would be replaced with native riparian, mesquite, desert shrub, or marsh vegetation communities. Figure 2 illustrates current vegetation conditions across a typical cross section in the planning area, and Figure 3 illustrates how those conditions are anticipated to change with implementation of the vegetation management units and maturity of native vegetation.

Additional implementation considerations, details, and recommendations are provided in Chapter 3. These activities and details, like the unit extents and boundaries, will need to be evaluated and revised as necessary based on site-specific field evaluations of physical and biological conditions, land use, and other factors. Similarly, while vegetation management unit types and locations have been selected with consideration for future climate, water supply, tamarisk beetle, and land-use conditions in mind, there are bound to be changes within and near the planning area over the next several decades that will necessitate revisions to the vegetation management units. It is important to note that most of the privately owned property in the planning area is anticipated to be used for gravel mining, the demand for which will increase as the lands outside of the planning area are developed. In areas where gravel mining occurs and open-water features are created, vegetation management will be determined primarily by the mining operation's reclamation plan. Section 2.2.9 describes how vegetation management units may need to be changed given potential future gravel mining on private property.

Figure 2. Illustration of current vegetation conditions across a typical cross section in the planning area.

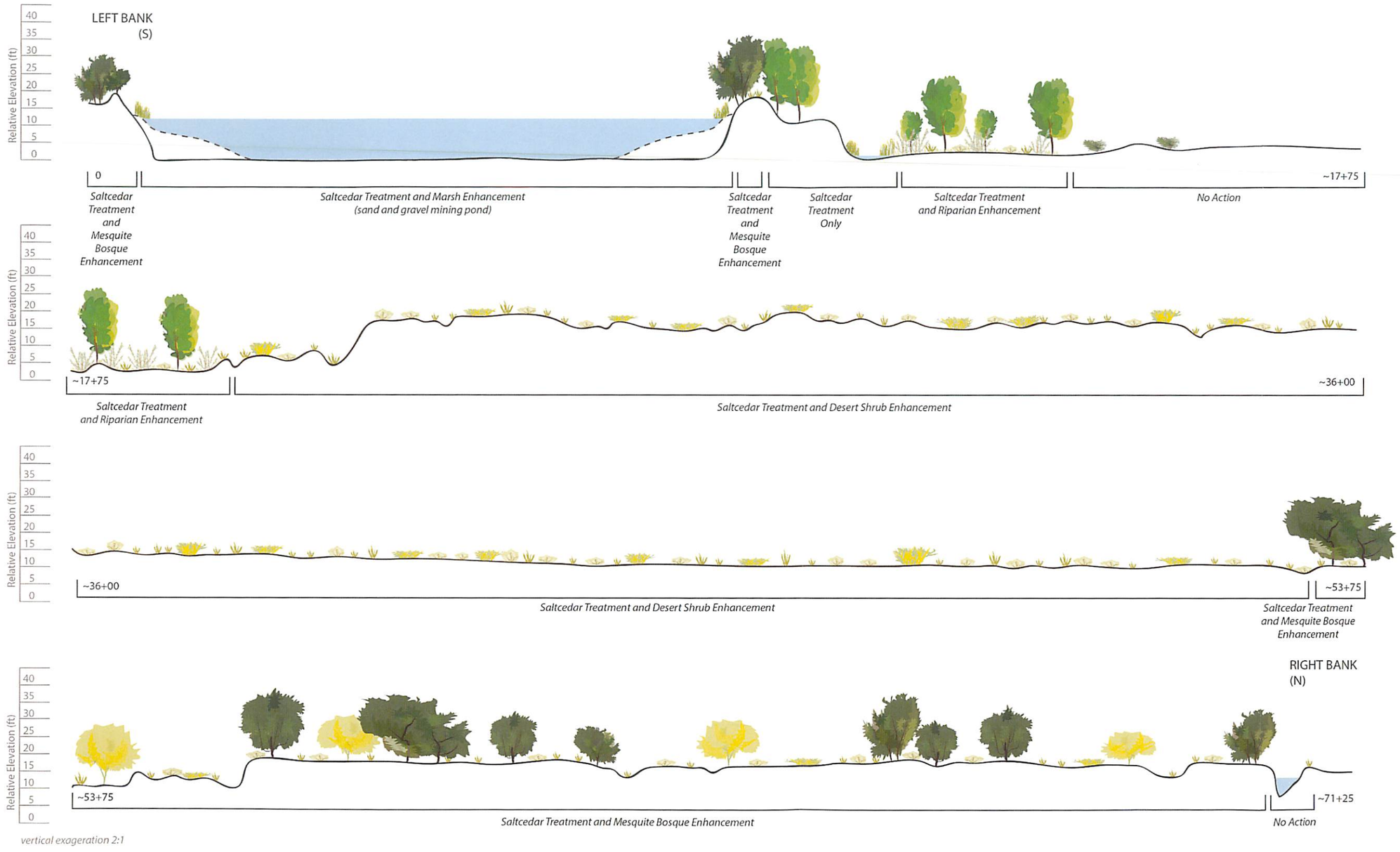
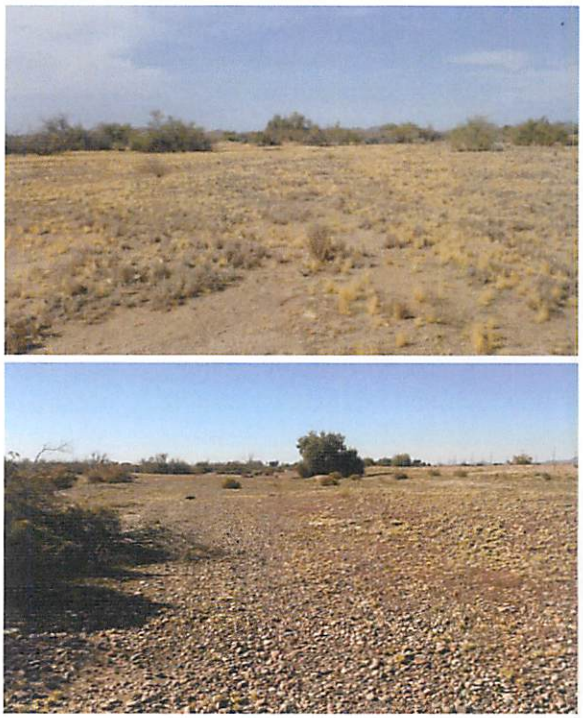


Figure 3. Illustration of anticipated vegetation conditions across the Figure 2 cross section with implementation of the Plan.

2.2.1 No Action

The "No Action" vegetation management (Type 1) units are those areas with little to no saltcedar present (see photos below). These units include several different mapped vegetation types, but primarily consist of areas that were mapped as cobble/gravel/sand, low density saltcedar, agriculture, water, canal/ditch, or developed in the 2015 vegetation map of the planning area (see Section 2.8 in Volume 2 for descriptions of vegetation map types). In some of these units, there is no saltcedar to remove. Where saltcedar is present, it occurs at sufficiently low density that removal would likely have little to no influence on flood-risk reduction. It is in such units—No Action units with low density saltcedar—that saltcedar treatment is anticipated to be efficiently accomplished by the tamarisk beetle once it colonizes the area. There are 3,042 acres of No Action units, which account for 35% of the planning area (see Table 2 and Appendix A), with the greatest concentration occurring in the upstream portion of the planning area, where there is relatively little vegetative cover due to lack of surface water and greater depths to groundwater. Figure 3 and the photos below illustrate anticipated typical conditions in No Action units following vegetation management.



Example views of No Action units in the planning area (Photos by Stillwater Sciences)

Although there is currently little to no saltcedar in most No Action units and, as a result, saltcedar removal to reduce flood-risk is not warranted, these areas need to be monitored to identify whether saltcedar is increasing in these units to such an extent that active removal becomes warranted. During development of the 2015 vegetation map of the planning area, parts previously mapped as cobble strand (the equivalent of cobble/gravel/sand) were found to be the primary locations of recent saltcedar recruitment. As such, and in light of the fact that tamarisk beetle may not colonize the planning area until 2018/2019, periodic monitoring of No Action units should be conducted to determine whether saltcedar treatment becomes needed in these units to reduce flood risk, and whether any active enhancement of native vegetation may be warranted (*i.e.,* if no native vegetation is naturally recruiting or if secondary weeds become problematic). If saltcedar treatment does become warranted in the future, the methods described above in Section 2.1 should be used to identify an appropriate alternative vegetation management unit type for the area.

In addition to the No Action units that have been identified based on lack of saltcedar cover, there are likely to be other areas where "no action" is determined to be appropriate and desirable based on site-specific conditions and individual project goals. In particular, No Action will be necessary for areas that are occupied by protected species (as determined by site surveys) or to provide sufficient buffers around occupied habitat to avoid affecting the species (necessary buffer sizes

vary by species and would likely need to be determined in coordination with USFWS). No Action units of conserved saltcedar may also be necessary to maintain the stability of the river bank at project locations, and reduce the potential for unintended geomorphic change (*e.g.*, Graf 1981). Conserved saltcedar can also provide a "hydraulic shield" from high flow events for downstream revegetation areas (see Section 3.7 for additional details). These same areas can also act as a buffer around native vegetation to maintain microclimate conditions during nearby saltcedar removal activities. There may also be areas where native vegetation is of sufficient density that no action is determined to be appropriate, but such areas will be few and small in the planning area (see Section 2.2.2 below).

2.2.2 Saltcedar Treatment Only

"Saltcedar Treatment Only" vegetation management (Type 2) units are those areas where saltcedar should be removed and treated with herbicide to reduce flood risk (see Section 3.8 for a more detailed discussion of saltcedar removal methods), and there should be sufficient native vegetation and appropriate biophysical conditions for native species to naturally ("passively") recolonize the area once saltcedar is removed. This unit type offers one of the most efficient and sustainable opportunities to reduce flood risk, since saltcedar would be removed from the floodway, while simultaneously enhancing native habitats without the effort and expense of active seeding and planting. These units primarily include areas mapped as desert shrub, marsh, mesquite, saltcedar/arrowweed, saltcedar/cottonwood, saltcedar/cottonwood/willow, or saltcedar/willow in the 2015 vegetation map of the planning area and, as such, should have at least 10–30% cover of native species (see photo below), and were further screened to include only those areas thought to have good potential for natural recruitment of native species. Criteria indicating good natural recruitment potential included 10–30% cover of native species, close proximity to water, low relative elevation, non-saline soil, and high canopy height (see Table 1; Nissen *et al.* 2009, Sher *et al.* 2010). There are 609 acres of Saltcedar Treatment Only units accounting for 7% of the planning area (see Table 2 and Appendix A), with most occurring within the flood reset zone and in the downstream half of the planning area, where there is the greatest extent of native vegetation. Figure 3 and the photo below illustrate anticipated typical conditions in most Saltcedar Treatment Only units following vegetation management.

Example view of Saltcedar Treatment Only units in the planning area (Photo by Stillwater Sciences)

Despite the GIS screening conducted to identify Saltcedar Treatment Only units, there is still uncertainty over whether or not the amount of native cover in these units will be sufficient for native species to recruit and establish naturally after saltcedar is removed, particularly in light of the modified duration, extent, and magnitude of water availability in the planning area. As such, these units will need to be further evaluated for natural recruitment potential in the field. If a saltcedar removal only unit is found to have low or no natural recruitment potential, then it should be changed to one of the active enhancement unit types described below using the methods described in Section 2.1 and site-specific field evaluation. In addition, this evaluation should also include the potential for saltcedar removal to undermine river bank stability (see Section 3.3 for additional discussion).

Monitoring and maintenance of all saltcedar removal areas (regardless of vegetation management unit type) will be necessary to ensure long-term success and will likely be required for a minimum of five years following removal. Monitoring of all saltcedar removal areas should, at a minimum, evaluate the need for treatment of saltcedar resprouts or other problematic secondary weeds (*e.g.*, kochia [*Bassia scoparia*]) and how developing vegetation conditions may influence or conflict with flood risk reduction objectives. In Saltcedar Treatment Only units in particular, monitoring will also need to evaluate whether natural recruitment will be sufficient to replace removed saltcedar or whether active planting may be warranted. Monitoring and maintenance activities are described in more detail in Sections 3.11 and 3.12.

2.2.3 Saltcedar Treatment and Riparian Enhancement

"Saltcedar Treatment and Riparian Enhancement" vegetation management (Type 3) units are those areas where saltcedar should be removed and treated with herbicide, and then planted with appropriate native cottonwood, willow, and other associated riparian plants (Table 3). These units primarily include areas mapped as saltcedar or disturbed that are less than 7.5 feet in relative elevation from the low-flow river channel, or areas mapped as saltcedar/cottonwood, saltcedar/cottonwood/willow, or saltcedar/willow that have low potential for natural recruitment. The 7.5 feet relative elevation threshold for riparian plantings comes from the ecohydrological fieldwork and assessment conducted for the Plan (see Volume 2). This work determined that relative elevation above the low-flow water surface in the river channel is an appropriate proxy for depth to groundwater[2], which is more challenging to measure, and documented that native riparian trees are most numerous within 2 to 10 feet above the low-flow channel water surface. The use of the 7.5 feet relative-elevation threshold results in most of the Riparian Enhancement units being located within the flood reset zone. Outside of the river's flood reset zone, proximity to other water sources, such as agricultural return flows, was also used to identify units. As such, they include areas that are in need of habitat enhancement, unlikely to support natural/passive recruitment of native species (since there are little to no native species present in the unit to provide a seed source), and likely have the physical conditions necessary to support planted riparian vegetation with minimal levels of maintenance.

Example views of Saltcedar Treatment and Riparian Enhancement unit before management (top, from the planning area) and hypothetically after (bottom, from the San Pedro River) (Photos by Stillwater Sciences)

[2] The relationship between relative elevation and depth to groundwater, however, apparently shifts in the upper half of the El Rio reach between approximately the crossings of the Tuthill Rd and Bullard Ave. bridges, where the depth to groundwater is seemingly greater based on a general lack of vegetation. For this reason, riparian enhancement units were not identified in this portion of the planning area, as there is insufficient water supply to sustain the tree and shrub species included in riparian enhancement vegetation.

Table 3. Riparian Enhancement species recommended for the planning area. [A]

Common name	Scientific name	Propagule type	Comments [B]
Trees			
Fremont cottonwood	*Populus fremontii*	Pole cutting	Foundation species
Goodding's willow	*Salix gooddingii*	Pole cutting	Foundation species; attracts pollinators
Shrubs			
Seep willow	*Baccharis salicifolia*	Pole cutting	High salinity tolerance; attracts pollinators
Emory baccharis	*Baccharis emoryi*	Nursery container or seed	Attracts pollinators
Spiny hackberry	*Celtis ehrenbergiana*	Nursery container/seed	Attracts pollinators
Burrobush	*Hymenoclea monogyra*	Nursery container/seed	
Coyote willow	*Salix exigua*	Pole cutting	Under-represented in the planning area; attracts pollinators
Herbs/Forbs/Vines			
Missouri gourd	*Cucurbita foetidissima*	Nursery container/ plug or seed	Attracts pollinators
Sacred thorn-apple	*Datura wrightii*	Nursery container/ plug or seed	Attracts pollinators
Desert saltgrass	*Distichlis spicata*	Nursery container/plug	High salinity tolerance
Fringed twinevine	*Funastrum cynanchoides*	Nursery container/plug	Monarch butterfly host plant
Alkali muhly	*Muhlenbergia asperfolia*	Nursery container/plug	High salinity tolerance
Alkali sacaton	*Sporobolus airoides*	Nursery container/ plug or seed	High salinity tolerance

Table footnotes:
[A] This is not an exhaustive list of species that may be appropriate; vegetation management sites should be evaluated to develop planting lists that are suitable for site conditions and will achieve project goals.
[B] Pollinator and monarch butterfly host plants are based on NAPPC and Pollinator Partnership (no date) and The Xeres Society and NRCS (2012). Salinity tolerances are based on NRCS (2002).

There are 749 acres of Riparian Enhancement units, which account for 7% of the planning area (see Table 2 and Appendix A). Characteristic native plant species that may be appropriate for planting at Riparian Enhancement units, depending on site-specific conditions and project goals, are listed in Table 3 (which is by no means exhaustive), along with the propagule type that is likely to be the most cost-effective for the species. Figure 3 and the photos above illustrate anticipated typical conditions in Riparian Enhancement units following vegetation management.

Riparian habitat in the planning area could support southwestern willow flycatcher and is identified as critical habitat for western yellow-billed cuckoo – protection for both of these species is provided under the ESA. These birds, as well as other migratory birds (which are protected under the federal Migratory Bird Treaty Act), now use saltcedar for nesting in the absence of native trees and shrubs. As such, saltcedar that is removed in areas that could provide habitat for these birds will need to be replaced with equivalently tall and dense native vegetation

to mitigate for any habitat loss. As a result, and because both southwestern willow flycatcher and western yellow-billed cuckoo require tall, complex, and dense riparian vegetation that is close to water, Riparian Enhancement units will not contribute to the flood risk reduction objectives of the Plan. Due to their close proximity to water, however, they are the most appropriate locations to efficiently and effectively contribute to the Plan's habitat mitigation and enhancement objectives. While there will be some temporal loss of habitat between saltcedar removal and the establishment of sufficiently tall and dense native vegetation, the incremental, phased implementation of the Plan through multiple smaller project is anticipated to minimize this loss.

Given the importance of Riparian Enhancement units in mitigating habitat loss from saltcedar removal and enhancing habitat for southwestern willow flycatcher and western yellow-billed cuckoo, it may be desirable to increase the extent of the planning area outside of the flood reset zone that can sustain the associated cottonwood/willow vegetation. This could be done by excavating swales and channel features that increase the extent and frequency of flood inundation and/or decrease the depth to groundwater, thereby increasing the water supply for Riparian Enhancement plantings, as well as potential marsh vegetation. Such features include: (1) low-flow side channels and side-channel pools; (2) high-flow backwater channels and embayment areas; (3) high flow ephemeral channels; and (4) channel-side benches or terraces. These features have not been incorporated into the vegetation management units, as it will require additional site-specific assessment (see Section 3.3) to determine where such excavation would be feasible and appropriate. The location of such features could be further informed by flycatcher and cuckoo microscale habitat suitability models to identify where such features would be optimally located for those species.

The native riparian plants that provide nesting habitat for these bird species and additional wildlife require nearly constant access to water and are precluded from much of the planning area as a result of reduced water availability. As a result, much of the planning area that is likely to be suitable for Riparian Enhancement is within close proximity to the low-flow river channel and within the flood reset zone. To reduce the risk of future floods washing away plantings, Riparian Enhancement units within the flood reset zone should incorporate an upstream "hydraulic shield" of conserved vegetation, even if it is saltcedar (see Section 3.7). This hydraulic shield may also preserve microclimate conditions in surrounding areas and benefit young native recruits (*e.g.*, by functioning as a "nurse tree"), and maintain river bank stability. In addition, Riparian Enhancement plantings within the flood reset zone should consist primarily of pole cuttings, which are less expensive than container plantings, to minimize loss of investment. It is anticipated that revegetation in Riparian Enhancement units will require three to five years to become sufficiently established to withstand typical high flow events.

Outside of the flood reset zone, native riparian vegetation occurs almost exclusively along or at the downstream end of agricultural return flow and stormwater canals, where there is sufficient water availability. These features were used, in part, to identify Riparian Enhancement units, but are also subject to change as land use around the planning area changes. Therefore, the long-term reliability of agricultural return flow frequency, duration, and magnitude should be evaluated for Riparian Enhancement units outside of the flood reset zone. Without such flows, these units, as well as some of those within the flood reset zone, would require one to three years of irrigation for planting roots to reach groundwater (see Section 3.7).

2.2.4 Saltcedar Treatment and Desert Shrub Enhancement

"Saltcedar Treatment and Desert Shrub Enhancement" vegetation management (Type 4) units are those areas where saltcedar should be removed and treated with herbicide to reduce flood risk, and then planted with appropriate native desert shrub and associated upland species (Table 4). These units primarily include areas mapped as disturbed and saltcedar that are above 7.5 feet in relative elevation from the low-flow river channel (as such, these areas are farther from groundwater and more geomorphically stable than Riparian Enhancement units), or areas mapped as desert shrub that have low potential for natural recruitment. Replacement of saltcedar with native desert shrubs will reduce flood risk, since desert shrubs do not impede high flows to the extent that saltcedar does, and discourage the establishment of secondary weeds if they are planted densely enough. In light of these benefits and the limited water availability in the planning area (which will likely be exacerbated in the future), replacement of removed saltcedar with native desert shrub vegetation is anticipated to be the most appropriate and sustainable enhancement habitat type for much of the planning area.

Example views of Saltcedar Treatment and Desert Shrub Enhancement unit before management (top) and hypothetically after (bottom) (both photos from the planning area) (Photos by Stillwater Sciences)

There are 3,634 acres of Desert Shrub Enhancement units, which account for 41% of the planning area (see Table 2). Native species that may be appropriate for planting at Desert Shrub Enhancement units, depending on site-specific conditions and project goals, are listed in Table 4 (which is by no means exhaustive), along with the propagule type that is likely to be the most cost-effective for the species. Figure 3 and the photos above illustrate anticipated typical conditions in Desert Shrub Enhancement units following vegetation management.

Desert shrub vegetation in the planning area is very sparse, with open area surrounding nearly every shrub. Mimicking this low density in Desert Shrub Enhancement units would maximize the flood-risk reduction benefits of this unit type, but sparse plantings, particularly after saltcedar removal may have disturbed the ground surface, may facilitate the establishment of problematic secondary weeds. When seeded very densely, native shrubs can be effective at reducing saltcedar resprouting and preventing the establishing of secondary weeds, as demonstrated by the District's Buck Fire restoration area within the planning area. Initial plantings at high densities and allowing densities to reach a natural equilibrium may be one approach to balancing these trade-offs. The trade-offs between low- and high-density planting of native shrubs and occasional trees should be evaluated on a site-by-site basis to develop an appropriate balance between flood-risk reduction, secondary weed establishment, and habitat mitigation.

As with riparian plantings, Desert Shrub Enhancement that is conducted within the flood reset zone should incorporate an upstream "hydraulic shield" of conserved vegetation (see Section 3.7)

to reduce the risk of future floods washing away the plantings. Fortunately, planting of some desert shrub species, and *Atriplex* species in particular, can be efficiently conducted by seeding, which can reduce the costs associated with Desert Shrub Enhancement units.

Table 4. Desert Shrub Enhancement species recommended for the planning area. [A]

Common name	Scientific name	Propagule type	Comments
Shrubs			
Fourwing saltbush	*Atriplex canescens*	Seed	High salinity tolerance
Quailbush	*Atriplex lentiformis*	Seed	High salinity tolerance
Spiny hackberry	*Celtis ehrenbergiana*	Nursery container or seed	Attracts pollinators
Sweetbush	*Bebbia juncea*	Nursery container or seed	Attracts pollinators
Brittlebush	*Encelia farinosa*	Nursery container or seed	Attracts pollinators
Rabbitbrush	*Ericameria nauseosa*	Nursery container or seed	Attracts pollinators
Burrobush	*Hymenoclea monogyra*	Nursery container or seed	
Creosote bush	*Larrea tridentata*	Nursery container or seed	Attracts pollinators
Sandpaper plant	*Petalonyx thurberi*	Nursery container or seed	
Wirelettuce	*Stephanomeria pauciflora*	Nursery container or seed	
Herbs/Forbs/Vines			
Desert sand verbena	*Abronia villosa*	Seed	Attracts pollinators
Needlegrass	*Achnatherum* spp.	Seed	
Mojave milkweed	*Asclepias nyctaginfolia*	Seed	Monarch butterfly host plant
Grama grass	*Bouteloua* spp.	Seed	
East Mojave buckwheat	*Eriogonum fasciculatum*	Seed	Attracts pollinators
Salt heliotrope	*Heliotropium curassavicum*	Seed	Attracts pollinators
Mojave lupine	*Lupinus sparsiflorus*	Seed	Attracts pollinators
Adonis blazingstar	*Mentzelia multiflora*	Seed	Attracts pollinators
Parry's beardtongue	*Penstemon parryi*	Seed	Attracts pollinators
Desert senna	*Senna covesii*	Seed	Attracts pollinators
Globemallow	*Sphaeralcea ambigua*	Seed	Attracts pollinators
Trees (very sparse; only a minor component of this unit)			
Desert willow	*Chilopsis linearis*	Nursery container	Plant only a very few plants per acre; attracts pollinators
Mexican paloverde	*Parkinsonia aculeata*	Nursery container	Plant only a very few plants per acre; attracts pollinators
Blue paloverde	*Parkinsonia florida*	Nursery container	Plant only a very few plants per acre; attracts pollinators

Table footnotes:
[A] This is not an exhaustive list of species that may be appropriate; vegetation management sites should be evaluated to develop planting lists that are suitable for site conditions and will achieve project goals.

Although replacement of saltcedar with desert shrub vegetation will result in a notable change in vegetation and associated habitat structure (in many areas, Desert Shrub Enhancement units will be much more sparsely planted and with shorter plants than the saltcedar that is there now; see Figures 2 and 3) across much of the planning area, it is important to note that very few of the Desert Shrub Enhancement units currently provide suitable habitat for the three listed bird species with potential to occur in the planning area. (Microscale habitat suitability models for southwestern willow flycatcher and western yellow-billed cuckoo could be used to refine some of the Desert Shrub Enhancement units to further exclude potential habitat for these species.) As a result, loss of nesting habitat for migratory birds is expected to be the primary impact associated with conversion of saltcedar with desert shrubs. Desert Shrub Enhancement units present a trade-off between flood-risk reduction and loss of habitat structure, but the intent of replacing saltcedar with these shrubs (*in lieu* of leaving bare ground or only seeding of grasses and herbs) is to help mitigate for some of that habitat loss (particularly if trees are incorporated at low density in some areas), improve habitat for native pollinators, and improve foraging habitat for birds and other native wildlife, as well as prevent establishment of secondary weeds, and increase the extent of a native vegetation type that will be sustainable in the planning area as temperatures increase and water supply decreases.

2.2.5 Saltcedar Treatment and Mesquite Bosque Enhancement

"Saltcedar Treatment and Mesquite Bosque Enhancement" vegetation management (Type 5) units are those areas where saltcedar should be removed and treated with herbicide to reduce flood risk, and then planted with appropriate native mesquite bosque species (Table 5). These units include areas currently mapped as desert shrub, disturbed, mesquite, and saltcedar that are primarily outside the flood reset zone, and above 7.5 feet in relative elevation above the low-flow river channel (as such, these areas are farther from groundwater and more geomorphically stable than Riparian Enhancement units).

Example views of Saltcedar Treatment and Mesquite Bosque Enhancement unit before management (top, from the planning area) and hypothetically after (bottom, from the San Pedro River) (Photos by Stillwater Sciences)

Mesquite bosque is a characteristic vegetation type of Sonoran Desert washes and rivers that tolerates more xeric conditions than cottonwood and willows, but it has been declining throughout southern Arizona, including almost all of the Gila and Salt rivers (Foldi 2014). The size and structure of mesquite trees (*Prosopis* spp.) is similar enough to that of saltcedar that this unit type will not contribute to the flood-risk reduction goal of the Plan, unless planted mesquite trees are spaced sufficiently apart. However, mesquite provides habitat for many native wildlife species, including cavity-nesting avian species and arboreal reptile species (Rice et al. 1984), so this enhancement type would help mitigate habitat loss from saltcedar removal for some species (although not necessarily for southwestern willow

flycatcher or Yuma clapper rail). Additionally, Mesquite Bosque Enhancement may improve native plant and wildlife diversity in the planning area.

Table 5. Mesquite Bosque Enhancement species recommended for the planning area. [A]

Common name	Scientific name	Propagule type	Comments/Notes
Trees			
Western honey mesquite	*Prosopis glandulosa*	Nursery container or seed	Attracts pollinators
Screwbean mesquite	*Prosopis pubescens*	Nursery container or seed	Fairly tolerant of saline soils; low presence in planning area
Velvet mesquite	*Prosopis velutina*	Nursery container or seed	Attracts pollinators
Spiny hackberry	*Celtis ehrenbergiana*	Nursery container or seed	Attracts pollinators
Desert willow	*Chilopsis linearis*	Nursery container or seed	Plant only very few plants per acre
Mexican paloverde	*Parkinsonia aculeata*	Nursery container or seed	Plant only very few plants per acre; attracts pollinators
Blue paloverde	*Parkinsonia florida*	Nursery container or seed	Plant only very few plants per acre; attracts pollinators
Yellow paloverde	*Parkinsonia microphylla*	Nursery container or seed	Plant only very few plants per acre; attracts pollinators
Shrubs			
Catclaw acacia	*Acacia greggii*	Nursery container or seed	Attracts pollinators
Fourwing saltbush	*Atriplex canescens*	Seed	High salinity tolerance
Quailbush	*Atriplex lentiformis*	Seed	High salinity tolerance
Brittlebush	*Encelia farinosa*	Nursery container or seed	Attracts pollinators
Creosote bush	*Larrea tridentata*	Nursery container or seed	Attracts pollinators
Wolfberry	*Lycium* spp.	Nursery container or seed	Attracts pollinators
Herbs/Forbs/Vines			
Desert saltgrass	*Distichlis spicata*	Nursery container/plug	High salinity tolerance
Basin wildrye	*Leymus cinereus*	Nursery container/ plug or seed	
Vine mesquite	*Panicum obtusum*	Nursery container/ plug or seed	
Big galleta	*Pleuraphis rigida*	Nursery container/ plug or seed	
Desert senna	*Senna covesii*	Seed	Attracts pollinators
Alkali sacaton	*Sporobolus airoides*	Nursery container/ plug or seed	High salinity tolerance
Tobosa grass	*Hilaria mutica*	Nursery container/ plug or seed	

Table footnotes:
[A] This is not an exhaustive list of species that may be appropriate; vegetation management sites should be evaluated to develop planting lists that are suitable for site conditions and will achieve project goals.

There are 571 acres of Mesquite Bosque Enhancement units, which account for 6% of the planning area (see Table 2 and Appendix A). These are distributed throughout the planning area, and are generally outside of the flood reset zone and on terrace surfaces at the confluence of tributary washes, where they are anticipated to have less influence on flood conveyance. Native species that may be appropriate for planting at Mesquite Bosque Enhancement units, depending on site-specific conditions and project goals, are listed in Table 5 (which is by no means exhaustive), along with the propagule type that is likely to be the most cost-effective for the species. Figure 3 and the photos above illustrate anticipated typical conditions in Mesquite Bosque Enhancement units following vegetation management.

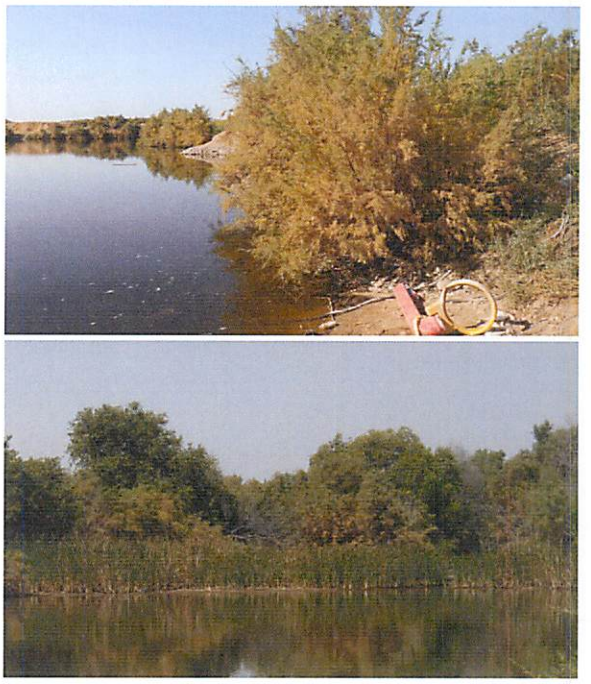
As with desert shrubs, mesquite vegetation in the planning area is generally sparse, with open area surrounding most trees and shrubs. Mimicking this low density in Mesquite Bosque Enhancement units would not achieve the density and cover of most of the saltcedar that it replaces, but appears to be a naturally sustainable density for the planning area. Sparse plantings, particularly after saltcedar removal may have disturbed the ground surface, may facilitate the establishment of problematic secondary weeds. To reduce this potential, Mesquite Bosque Enhancement units should include denser seeding or planting of understory shrub and herbaceous plants, which do not impede high flows to the extent that saltcedar or native trees do. Patches of densely planted mesquite trees within these units could also be used to balance flood risks with secondary weed risks and would also improve habitat patchiness/diversity. The trade-offs between low- and high-density planting of mesquite bosque vegetation should be evaluated on a site-by-site basis to develop an appropriate balance between flood-risk reduction, suppression of secondary weed establishment, habitat mitigation, and native plant and wildlife diversity. In addition, in light of the extensive woodland habitat requirements of the western yellow-billed cuckoo, mitigation for saltcedar loss should be planned in consideration of the slow growth of mesquite trees and the density of restored mesquite bosque suitable for foraging preferred by the cuckoo.

2.2.6 Saltcedar Treatment and Marsh Enhancement

"Saltcedar Treatment and Marsh Enhancement" vegetation management (Type 6) units are those areas where saltcedar should be removed and treated with herbicide to reduce flood risk, and then planted with native cattails, tules, and associated marsh species (Table 6). These units primarily include areas mapped as saltcedar, disturbed, and non-Gila River channel water that are outside the flood reset zone but within 50 feet of water. As such, these units are exclusively located along the shores of inundated gravel mining pits and will require shoreline grading and/or fill along the margins of the ponds to achieve suitable water supply and inundation conditions for marsh plants. Although the greatest extent of existing marsh vegetation occurs within the low-flow river channel, these areas were considered to be inappropriate for active enhancement, since they are highly likely to be scoured and altered under high flow events. Rather, these areas are primarily categorized as Saltcedar Treatment Only units.

There are 77 acres of Marsh Enhancement units, which account for 1% of the planning area (see Table 2 and Appendix A). Native species that may be appropriate for planting at Marsh Enhancement units, depending on site-specific conditions and project goals, are listed in Table 6 (which is by no means exhaustive), along with the propagule type that is likely to be the most cost-effective for the species. Figure 3 and the photos below illustrate anticipated typical conditions in Marsh Enhancement units following vegetation management.

Although they will require relatively expensive earthwork, Marsh Enhancement units have the potential to provide multiple benefits. All of the sand and gravel mining-pit ponds in the planning area are within the 100-year floodplain, and the shorelines of mining-pit ponds in the planning area are primarily vegetated with saltcedar. As such, saltcedar removal in these units should contribute to flood-risk reduction, and native marsh plants that would replace the saltcedar do not impede flood flows to the degree that saltcedar does. The flood-risk reduction benefits of Marsh Enhancement are limited primarily by the small extent of these units. The potential for Marsh Enhancement may increase in extent; however, as a result of future gravel mining and associated creation of open water features on private property in the planning area (see Section 2.2.9).



Example views of a Saltcedar Treatment and Marsh Enhancement unit before management (top) and hypothetically after (bottom) (both, from the planning area) (Photos by Stillwater Sciences)

Enhanced marsh vegetation may also help improve water quality, by sequestering some pollutants that would otherwise reach the water table or river, particularly if a diverse assemblage of vegetation is used (Weller et al. 2015). The habitat that is created at Marsh Enhancement units—shallowly inundated shorelines with dense cover of cattails and tules—is likely to directly benefit Yuma clapper rail, which has been observed in the planning area (Wilcox and Wade 2014) and uses marsh habitat. If dense shrub vegetation is included in Marsh Enhancement units then they could also directly benefit southwestern willow flycatcher (if present) due to the proximity to water. Lastly, marsh habitat enhancement at the mining pits near Buckeye would contribute to public recreational and educational uses that are being planned in that area.

To maximize these benefits, and minimize potential conflicts between wildlife habitat and human uses, several design considerations should be included for Marsh Enhancement units. Where feasible, the creation of marsh "islands" within the mining-pit ponds should be constructed to protect created marsh habitat from human disturbance, and the wildlife that uses the habitat from predators. Relatively shallow areas within the mining-pit ponds should be used to limit the amount of fill and costs needed to create islands, but such areas would need to be an adequate distance from the shore to limit predator access to the island. Any constructed island, as well as shoreline grading or fill placement along the shore should be carefully designed to ensure appropriate inundation depths and duration to support native marsh species. To further enhance the created marsh habitat, low density plantings of riparian trees and shrubs should be planted along the upland boundary of the marsh, where/if there are relatively short distances to groundwater to support such species. Native trees and shrubs would also enhance the public access experience, and should be planned and planted accordingly (*i.e.,* with the knowledge that the shade provided by trees and tall shrubs is likely to attract more concentrated use). Most marsh species should be initially planted from container stock/plugs, but relatively low planting densities may be appropriate since these species should spread rapidly under appropriate inundation conditions.

Table 6. Marsh Enhancement species recommended for the planning area. [A]

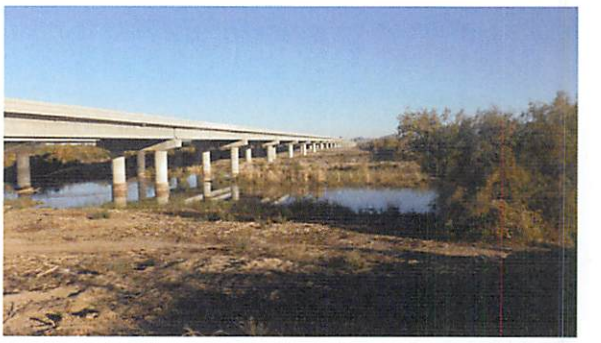
Common name	Scientific name	Propagule type	Comments/Notes
Herbs/Forbs/Vines			
Cosmopolitan bulrush	*Bolboschoenus* (formerly *Scirpus*) *maritimus*	Nursery container/plug	
Common spikerush	*Eleocharis palustris*	Nursery container/plug	
Rushes	*Juncus* species	Nursery container/plug	
Hardstem bulrush	*Schoenoplectus* (formerly *Scirpus*) *acutus*	Nursery container/plug	High salinity tolerance
Chairmaker's bulrush	*Schoenoplectus americanus*	Nursery container/plug	High salinity tolerance
California bulrush	*Schoenoplectus californicus*	Nursery container/plug	High salinity tolerance
Southern cattail	*Typha domingensis*	Seed	
Broadleaf cattail	*Typha latifolia*	Seed	
Shrubs			
Seep willow	*Baccharis salicifolia*	Pole cutting	High salinity tolerance; attracts pollinators
Coyote willow	*Salix exigua*	Pole cutting	Under-represented in the planning area; attracts pollinators
Trees			
Fremont cottonwood	*Populus fremontii*	Pole cutting	Plant only very few plants per acre
Goodding willow	*Salix gooddingii*	Pole cutting	Plant only very few plants per acre; attracts pollinators

Table footnotes:
[A] This is not an exhaustive list of species that may be appropriate; vegetation management sites should be evaluated to develop planting lists that are suitable for site conditions and will achieve project goals.

Given the benefits of Marsh Enhancement for Yuma clapper rail and, potentially, southwestern willow flycatcher, it may be desirable to increase the extent of the planning area that can sustain marsh vegetation. As with Riparian Enhancement units, this could be done by excavating swales that support open water, the location of which could be informed by habitat suitability modeling. Given the potential for additional sand and gravel mining in the planning area, and resulting open water features, however, it will likely be more cost efficient for Marsh Enhancement to be incorporated into future gravel mining reclamation plans (see City of Buckeye 2015), since the open water features created by mining can sustain marsh vegetation and are at low risk of being scoured by flood flows. See Section 2.2.9 for additional discussion of potential conditions under altered land use conditions on private property in the planning area.

2.2.7 Bridge Clearance

The "Bridge Clearance" vegetation management (Type 7) unit represents the required vegetation clearing within 200 feet of the Highway 85 bridge that has been routinely conducted by ADOT (most recently in late 2015; see photo at right). This management action applies to all vegetation types, except water. No other bridges in the planning area appear to warrant vegetation clearing at the time this report was completed. There are 24 acres of the Bridge Clearance unit, which account for less than 1% of the planning area (see Table 2 and Appendix A).

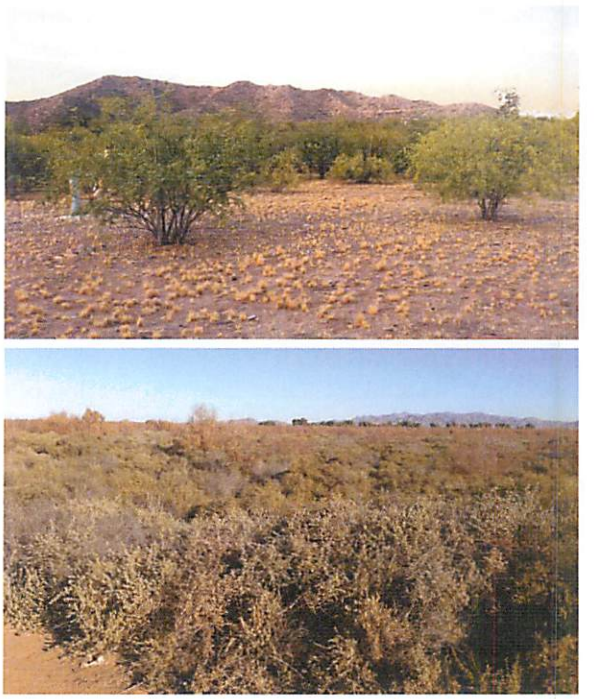


View of the Bridge Clearance unit near the Highway 85 bridge in the planning area (Photo by Stillwater Sciences)

2.2.8 Planned/Completed Restoration

"Planned/Completed Restoration" vegetation management (Type 8) units are completed or planned restoration projects. The locations of three project sites are shown as "Restoration Unit" areas on map tiles 1 and 6 presented in Appendix A. In total, there are 83 acres of Planned/Completed Restoration units, which account for 1% of the planning area (see Table 2 and Appendix A).

The three Planned/Completed Restoration unit sites include the District's completed 7-acre El Rio Educational Research and Development Project site located along the south side of the river on West Vineyard Avenue near the Bullard Avenue bridge (see top photo at right), the District's completed Buck Fire Revegetation Project located along the northside of the river near the end of Miller Road (see bottom photo at right), and the City of Buckeye's proposed 40-acre vegetation restoration and public access improvement project located adjacent to the Buck Fire project site. The District's El Rio Educational Research and Development Project entailed removal of saltcedar and strategic plantings of native, mixed-density plots, consisting primarily of velvet mesquite, to determine how many plants are necessary to suppress regrowth of saltcedar. The District's 35-acre Buck Fire Revegetation Project entailed replacement of burned saltcedar with native desert shrub vegetation, consisting primarily of saltbush

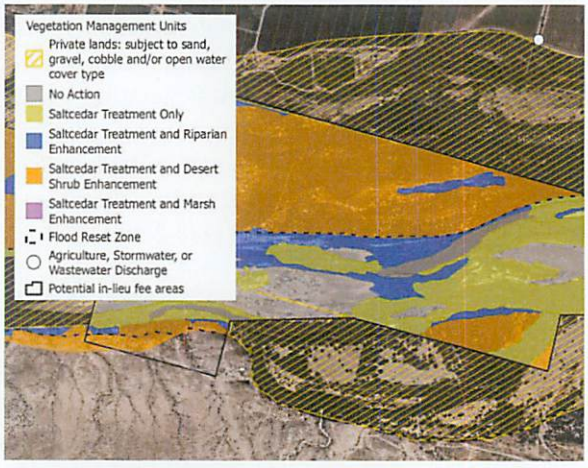


View of the El Rio Educational Research and Development Project site (top) and the District's Buck Fire Revegetation Project (bottom) in the planning area (Photos by Stillwater Sciences)

varieties (*Atriplex* spp.). The City of Buckeye's restoration plan for their 40-acre parcel has proposed implementation in 2016 to entail removal of the dense saltcedar stands followed by planting of native vegetation appropriate for that higher floodplain surface (City of Buckeye, pers. comm., 2015).

2.2.9 Vegetation management units under altered land use conditions

As mentioned previously, the vegetation management units described above were based on biophysical suitability and developed without consideration for property boundaries and ownership type. While an area is biophysically suitable for a particular vegetation management unit type regardless of ownership, that may change if the property owner alters the land use of the area. Approximately half of the planning area is privately owned. Due to the anticipated development surrounding the planning area, it is expected that much of this land could potentially be mined for sand and gravel resources in the future. Following mining, the vegetation management units described above, depicted in Appendix A, and summarized in Table 2, are unlikely to be appropriate for the resulting biophysical conditions. While post-mining conditions may result in additional sand, gravel, cobble, and/or open water features, where No Action, Saltcedar Treatment Only, and Marsh Enhancement units may be most appropriate, they are otherwise very uncertain. Given this uncertainty, an alternative view of the vegetation management units is summarized in Table 7 and depicted in maps presented in Appendix B, with privately owned parcels removed from vegetation management consideration (see map excerpt above).



Excerpt of vegetation management units under altered land use conditions maps (see Appendix B for complete map tiles)

The total areas of each of the vegetation management units presented above in Table 2 are reduced when excluding the privately owned parcels in the planning area (see Table 7). The greatest differences would occur with the No Action and Desert Shrub Enhancement units, with a reduction of approximately 1,439 and 1,768 acres, respectively. Though, both of these units would still account for the greatest proportion of the planning area. The Saltcedar Treatment Only and other "enhancement" units would be proportionally less reduced.

It does remain possible that areas eventually mined will be reclaimed according to their reclamation plan, which could very well include actions similar to those described for the Desert Shrub, Mesquite Bosque, and Marsh enhancement units (see City of Buckeye 2015).

Table 7. Vegetation management unit types under altered land use conditions.

Unit Type No.	Unit Type Name	Area Inside Flood Reset Zone (acres)	Area Outside Flood Reset Zone (acres)	Total Area (acres)	Percent of Entire Planning Area	Total Area Percent of Planning Area not Including Private Lands
1	No Action	1,311	293	1,604	18%	34%
2	Saltcedar Treatment Only	272	22	294	3%	6%
3	Saltcedar Treatment and Riparian Enhancement	439	57	496	6%	11%
4	Saltcedar Treatment and Desert Shrub Enhancement	691	1,174	1,865	21%	40%
5	Saltcedar Treatment and Mesquite Bosque Enhancement	3	282	285	3%	6%
6	Saltcedar Treatment and Marsh Enhancement	14	4	18	<1%	<1%
7	Bridge Clearance	3	18	21	<1%	<1%
8	Planned/ Completed Restoration	6	76	82	1%	2%
9	Private Lands (subject to sand, gravel, cobble and/or open water cover types) [A]	1,666	2,457	4,123	47%	--

Table footnotes:
[A] Parcel information provided by the District. The quantities provided here and the parcel boundaries depicted in the maps presented in Appendix B should be considered approximate.

3 VEGETATION MANAGEMENT ACTION IMPLEMENTATION ELEMENTS

3.1 Implementation Phasing

The Vegetation Management Plan will ultimately be implemented as a series of projects by a variety of project proponents, and result in a mosaic of implemented units. Concerted effort by the District and its partners, including individual landowners, to implement the Plan will occur over decades, and is primarily dependent on identifying willing landowners (see Section 3.2), funding (see Section 3.5), and permits (see Section 3.6). Very generally, implementation of the Plan is anticipated to occur over a series of phases, as illustrated in Figure 4, some of which may co-occur and will be repeated as willing landowners are identified and funding is secured for more and more units.

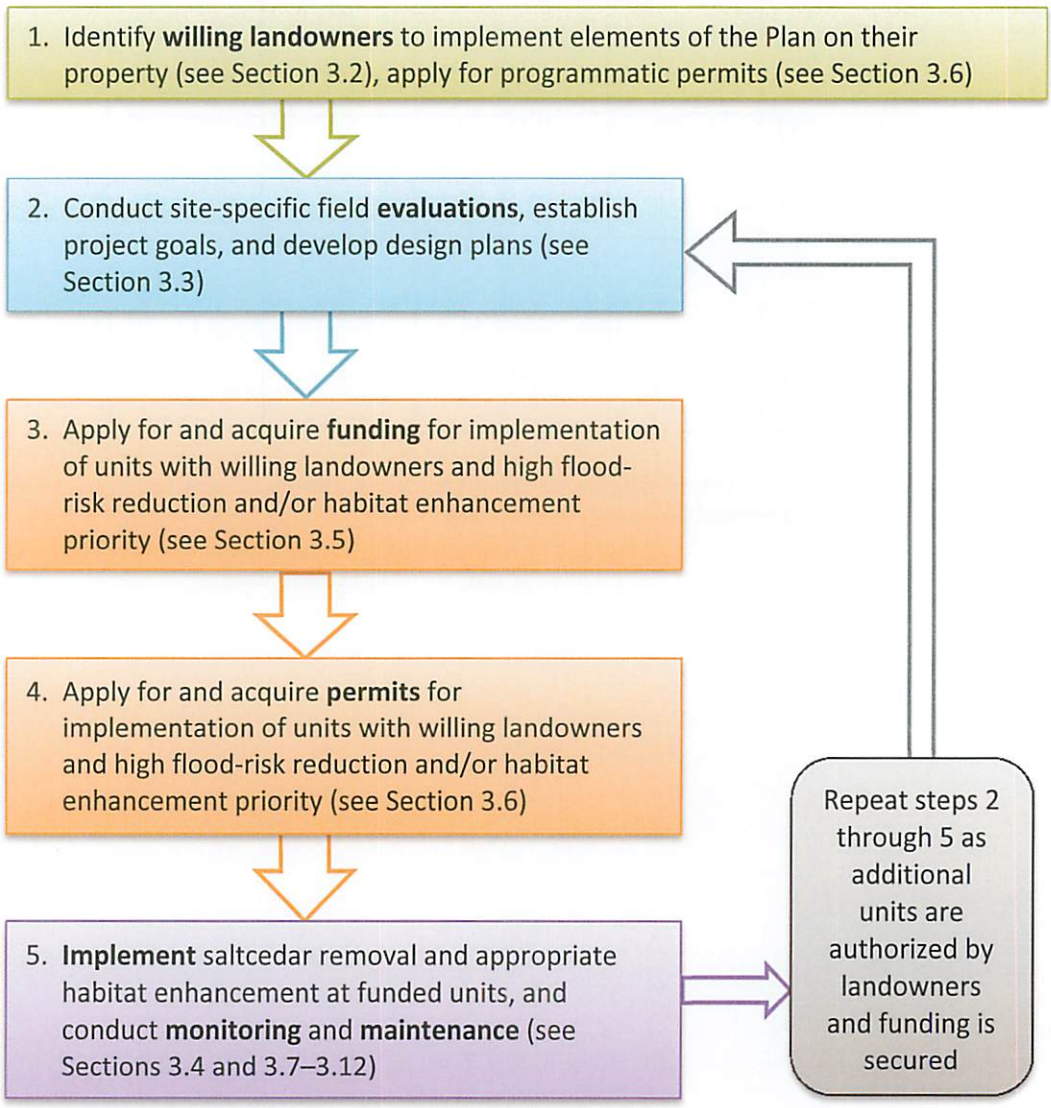


Figure 4. Conceptual phases of Plan implementation.

3.2 Willing Landowners

The District, many private landowners, BLM (whose lands in the planning area are controlled by the U.S, Fish and Wildlife Service's [USFWS] Division of Realty), Arizona State Land Department (ASLD), AGFD, and Maricopa County Parks and Recreation Department all own and manage land in the planning area (see Figure 3 and Appendix A in Volume 2). Vegetation management actions will only occur where landowners are willing to undertake the work themselves or where landowner permission has been granted for a separate project proponent (such as the District or a municipality) to undertake the work. Outside of the District's owned, leased, or easement areas, the District will conduct landowner outreach efforts to identify willing landowners. Landowners are anticipated to provide critical input to the design and implementation of Plan actions, based on a combination of what is agreeable to the landowner, will not conflict with landowner objectives or uses of the land, and will be feasible and appropriate given landowner knowledge of the area.

District and other publically owned lands present priorities for Plan implementation. Plan implementation is consistent with the objectives of many of these lands, such as off-setting impacts to endangered species, and habitat enhancement would be protected from long-term land use change. This would meet the requirements of some funding sources and/or permits that lands where saltcedar removal and/or habitat enhancement occur be placed under conservation easement or otherwise protected. Acquiring permission from federal and state landowners may trigger the need for additional permits, such as a Special Use Permit, and approvals.

Most of the privately owned property in the planning area is anticipated to be used for gravel mining, where long-term vegetation management will be determined primarily by the mining operation's reclamation plan. Such reclamation plans offer opportunities to incorporate the habitat enhancement prescribed in the Plan as well as enhance recreational and scenic attractions for future adjacent communities. For example, the City of Buckeye has developed draft reclamation guidelines for sand and gravel mining operations in the vicinity of the city to promote the environmental, recreational and economic assets of the Gila River for the City, and balance sand and gravel mining, developments, the environmental, and resident quality of life (City of Buckeye 2015).

3.3 Site Assessment and Design

The vegetation management units were identified primarily by mapping, with limited ground-truthing of some areas. As such, any units that are planned for implementation will first need to be evaluated in the field for site-scale opportunities, constraints, and overall feasibility and sustainability. Site assessment is also an essential component of successful project planning (*e.g.*, Dreesen and Fenchel 2009, Sher *et al.* 2010).

For Saltcedar Treatment Only units, site assessment needs to include, at a minimum, the information necessary to select the most appropriate and feasible saltcedar treatment methods, such as:

- Saltcedar age, density, and cover
- Access routes and accessibility issues for heavy equipment and long-term monitoring and maintenance activities, including landowner access and geographic barriers

- Site topography, ditches, and other features
- Presence, cover, density, and diversity of native vegetation that should be avoided during mechanical and/or herbicide treatment and may contribute to natural revegetation of the site following saltcedar removal[3] (see Section 3.8 for more detail on removal methods)
- Presence, cover, and diversity of other noxious weeds to determine risk of secondary weed establishment and need for measures to reduce their spread
- Site land-use history, including flood, fire, herbivory, and potential for hazardous materials to occur (modified from Dreesen and Fenchel 2009, Sher et al. 2010)
- An evaluation of channel stability in the project area, as well as upstream, downstream, and across the channel, to understand potential geomorphic consequences of saltcedar removal

It may also be prudent or required to conduct pre-treatment surveys for endangered species and/or their habitat, as well as other native wildlife. Such baseline surveys can determine whether saltcedar removal needs to be avoided during any particular time periods, determine whether other protective measures may be needed to avoid impacts to wildlife, identity the habitat elements that are most critical to the wildlife community of the El Rio ecosystem and how saltcedar removal affects that community, and provide a way to evaluate project success. Evaluating areas of saltcedar removal will be important during permitting; regulatory agencies will need information on presence of endangered species and/or suitable habitat for those species, and may use site assessment results to determine potential future conditions.

Site assessment may reveal that Saltcedar Treatment Only is not appropriate for that location (*e.g.*, there is not sufficient native vegetation to naturally recolonize the site after saltcedar removal), and that subsequent habitat enhancement will be necessary. The relatively high number of acres of habitat enhancement units (see Table 2) indicates that, with the exception of a few areas, most units in the planning area are not anticipated to support natural recruitment sufficient to adequately revegetate saltcedar treatments sites and, as such, that habitat enhancement will be necessary.

In units where habitat enhancement will occur, site assessment should also include the following elements to determine which vegetation type will be most appropriate and sustainable at each site:

- Hydrology/water availability, including surface flow patterns, depths to groundwater (which can be measured with relatively inexpensive shallow monitoring wells), and water chemistry
- Existing and historical (to the extent feasible) presence and distribution of native plants to guide planting palettes.
- Potential for excavation or grading to improve water availability and make the site more conducive to revegetation success

[3] Nissen *et al.* (2009) and Sher *et al.* (2010) recommend criteria for determining natural recruitment potential of a site, including: 10% native cover at mesic sites with favorable hydrology; 25% native cover at arid sites; saltcedar treatment method and intensity; and amount of livestock grazing and/or recreation.

- Sampling for soil conditions (*e.g.*, texture, salinity, nutrients), to determine the need for soil amendments
- Evaluation of channel stability and channel dynamics, to understand risk to habitat enhancement areas and identify the need for a "hydraulic shield" of conserved saltcedar (see Section 3.7) or other measures that may be necessary to reduce the risk of habitat enhancement plantings being scoured or damaged from high flow events
- Potential for installing irrigation infrastructure
- Need for fencing or other protective measures to prevent herbivory, damage, and vandalism (modified from Dreesen and Fenchel 2009, Sher *et al.* 2010)

Based on this evaluation, it may be prudent to continue with implementation as planned, or to reassign the unit to a different category (*e.g.,* to No Action, if implementation is infeasible). Ultimately, the site assessment should generate the information and understanding necessary to develop realistic project objectives, and select appropriate saltcedar treatment methods and species for revegetation, given the project budget and timeline. For example, soil sampling may indicate the presence of saline soils and the need to revise the planting palette to focus on species that can tolerate such soils (see species tables [Tables 3–6 and Appendix E] in Chapter 2 for notes on more saline soil-tolerant species).

The results of the site assessment will need to be incorporated into site-specific designs for the unit(s). For Saltcedar Treatment Only units, no plans may be necessary, other than delineating areas that may need to be avoided and/or specifying the saltcedar removal or herbicide application methods that may be necessary. Where habitat enhancement occurs, site-specific designs may need to also include: design plans for any excavation or earthwork; plan-view planting plans with associated planting specifications, such as species, propagule type (*e.g.,* seed or container stock size), planting density, and any specific instructions for soil amendments or planting methods; irrigation design and specifications; and/or design plans for any public access or recreational improvements. In addition to being vital to the correct implementation of activities in a unit, project designs, particularly at the conceptual or 30% design level, will be helpful in developing the description of the project that will be necessary for funding and permit applications (see Sections 3.5 and 3.6).

3.4 Site Prioritization

As illustrated in Section 3.1, the Plan cannot be implemented in one contiguous effort because landowner permission, permits, and funding are not in place to do so, and it would potentially result in large-scale habitat loss. The following criteria, which are subject to change, should be considered to identify locations in the planning area that are the highest priority for vegetation management:

- **On District-owned land.** Until additional landowner outreach can be conducted and permission for vegetation management granted, District-owned land will be the highest priority for implementing vegetation management activities.
- **Outside of the Gila River ordinary high water mark (OHWM) and suitable habitat for endangered species.** Until the necessary surveys are conducted and permits acquired, it will be necessary to implement vegetation management activities in areas where they will not conflict with federal, state, and local regulations. This criterion conflicts with the

District-owned land criterion, however, as all District-owned land is expected to be within the OHWM of the river. As such, all relevant permits will be required (see Section 3.6).

- **In the downstream half of the planning area.** Saltcedar stand density is greater in the downstream half of the planning area. Also, groundwater depths are shallower and water supply greater in this portion of the planning area and, as a result, habitat enhancement activities will have a greater likelihood of being successful and sustainable in the long-term.
- **Where there are benefits to the public.** Vegetation management projects that improve aesthetics and recreational and education opportunities for the public will have additional benefit, relative to cost, and help increase public support for vegetation management.
- **Where suitable habitat for endangered species is lacking but could be sustainably supported.** This would ensure that conflicts with endangered species are avoided, and will be critical to offsetting impacts to endangered species habitat elsewhere by creating habitat where there is none. Such habitat creation will also provide resiliency against the impacts to habitat that are anticipated with the arrival of the tamarisk beetle. Evaluating this criterion will require reach- and/or site-scale habitat surveys.
- **Where riparian and mesquite bosque habitat can be created and/or enhanced.** Both of these habitat types will be effective at off-setting the loss of habitat structure that is anticipated from the tamarisk beetle as well as the temporal loss of habitat from saltcedar removal projects.
- **Where saltcedar removal and/or habitat enhancement can be done most efficiently.** There may be areas that present opportunities for conducting vegetation management activities more efficiently than others. For example, some areas may be more readily accessed by the equipment necessary for vegetation, or have water rights and/or infrastructure for irrigation.

Conversely, the following areas should be de-prioritized for vegetation management:

- **Where there is existing suitable habitat for endangered species.** Areas of relatively high native vegetation cover or saltcedar that provide suitable habitat conditions for southwestern willow flycatcher, western yellow-billed cuckoo, or Yuma clapper rail should be de-prioritized as these areas may be supporting these species and can provide refuge while saltcedar removal occurs elsewhere and habitat enhancement plantings develop. Evaluating this criterion will require reach- and/or site-scale habitat surveys.
- **Where there is little to no saltcedar present.** These areas will not contribute to the flood risk reduction goal and the current absences of saltcedar or other vegetation suggests that conditions will not be conducive to the establishment and growth of habitat enhancement plantings.

These criteria will be used to identify an initial pilot project site for implementing and testing the concepts included in the Plan. The pilot project will be an important opportunity to test the feasibility and effectiveness of saltcedar removal methods and habitat enhancement types. In addition, the pilot project, and similar efforts, will be helpful in demonstrating to permitting agencies, funders, and the public how native species respond and habitat enhancement performs in mitigating for habitat loss.

3.5 Funding Sources and Cost Estimates

Implementation of the Plan will require substantial funding given the size of the planning area (8,787 acres) and the costs associated with saltcedar removal, revegetation, and maintenance. The availability of funding is anticipated to be a primary control on the amount of vegetation management that is conducted, and the timeframe in which it occurs. Examples of potential funding sources for implementation of the Plan, that fund invasive species removal and/or habitat enhancement activities in the planning area region, are listed in Table 8.

Table 8. Examples of funding sources for implementation of the Plan.

Funding Group/Agency	Eligible Applicants	General Deadline	Typical Funding Amount	Website
Arizona State Forestry Invasive Plant Grants	Units of local government, non-profit organizations, and public educational institutions; individuals may also apply if they work with one of these groups	November	$10,000–20,000	https://azsf.az.gov/grants/forest-health/ipg https://azsf.az.gov/invasive-plant-grants
Arizona Water Protection Fund	Any person, organization, local/state/tribal agency, or political subdivision of Arizona may submit an application. Federal agencies are not eligible to receive funding from the Arizona Water Protection Fund; however, funding can be awarded to projects on federal lands.	May	Variable	http://www.azwpf.gov/
Conservation Stewardship Program (NRCS)	Individuals, legal entities, joint operations or Indian tribes.		Up to $200,000	http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/csp/
Environmental Quality Incentives Program (NRCS)	Agricultural producers and owners of non-industrial private forestland and Tribes.		Up to $450,000	http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/eqip/
Environmental Solutions for Communities (National Fish and Wildlife Foundation)	Non-profit 501(c) organizations, state government agencies, local governments, municipal governments, educational institutions (eligible for BLM, U.S. Forest Service [USFS] and USFWS funds only), Indian tribes, and BLM field units (eligible for BLM funds only)	December	$25,000–100,000	http://www.nfwf.org/environmentalsolutions/Pages/2016RFP.aspxM
Five Star and Urban Waters Restoration Grant Program	Non-profit 501(c) organizations, state government agencies, local governments, municipal governments, Indian tribes and educational institutions	February	$20,000–50,000	http://www.nfwf.org/fivestar/Pages/home.aspx

Funding Group/Agency	Eligible Applicants	General Deadline	Typical Funding Amount	Website
Heritage Fund Program (AGFD)	Federal government, any federal department or agency; Indian tribes; all departments, agencies, boards, commissions and political subdivisions of the state of Arizona; counties; school districts; charter schools; cities; towns; and all municipal corporations.	September	$500–200,000	http://azgfdportal.az.gov/Wildlife/HeritageFund/Program
Landscape Conservation Cooperative Network (Bureau of Reclamation, USFWS)	Variable	Variable	$10,000–100,000	http://lccnetwork.org/
North American Wetland Conservation Act Small Grants (USFWS)	Non-profit organizations, state and local governments	November	up to $75,000	http://www.fws.gov/birds/grants/north-american-wetland-conservation-act/small-grants.php
Partners for Fish and Wildlife (USFWS)	Private, city, and county (*i.e.,* not federal or state) landowners	Anytime	Variable	http://www.fws.gov/partners/index.html
Walton Family Foundation Freshwater Conservation Initiative	Any; interested organizations must first send a brief letter of inquiry; only solicited proposals are accepted. Letter should describe the organization, the proposed project, relevance to the initiative, and an estimate of the funds that would be requested	Anytime	Variable	http://www.waltonfamilyfoundation.org/grants/grant-proposals
Water Bank Program (NRCS)	Landowner of eligible land for which enrollment is sought for at least two years preceding the date of the agreement	February	Variable by crop type	http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/programs/financial/?cid=stelprdb1047790

Table 9 is a compilation of the estimated cost per acre for various activities that may be conducted as a part of the Plan. These costs are based on a variety of applicable sources and reflect wide ranges in cost as a result of differences in project conditions, methods, timeframes, year the work was undertaken, *etc.* No efforts were made to normalize these compiled costs for conditions that may be encountered during the implementation of the Plan, other than to exclude distinguishable, irrelevant activities and costs.

Table 9. Estimated costs per acre of various Plan implementation activities.

Activity	Cost per Acre	Cost Basis
Saltcedar Clearing and Grubbing	$442	Selective clearing of medium brush and trees, with biomass left on site, from the 2010 Tres Rios Restoration Phase 3 Project
	$690	Clearing and grubbing for river enhancement from Stantec's 2015 Apache del Bosque project cost estimates
	$950	Mechanical removal of saltcedar, with biomass left on site, from bids received by Maricopa County in 2014
	$1,000	Clearing and grubbing of typical desert scrub landscape areas, from various District projects
	$1,208	Selective clearing of heavy wet brush and trees, with biomass left on site, from the 2010 Tres Rios Restoration Phase 3 Project
	$1,640	Clearing and grubbing from the 2008 Tres Rios Restoration Project Phase 2 pricing schedule
	$1,960	Saltcedar removal/mulching, with biomass left on site, from the Gila Watershed Partnership's 2015 upper Gila River restoration project
	$2,450	Clearing and grubbing of saltcedar from the 2007 El Rio R&D pricing table
	$2,600	Mechanical removal of saltcedar, with biomass left on site, from bids received by Maricopa County in 2014
	$3,600	Clearing and grubbing of dense vegetation from Stantec's 2015 Buck Fire project cost estimates
	$3,614	Clearing and grubbing of saltcedar from the Buck Fire 2008 O&M costs pricing table
	$6,000	Clearing and chipping of mesquite bosque-type vegetation, from various District projects
	$7,475	Mechanical removal of saltcedar, with biomass left on site, from bids received by Maricopa County in 2014
	$9,512	Selective tree and shrub removal using dozer and brush rake, with bio-mass left on site, from the 2010 Tres Rios Restoration Phase 3 Project
	$9,514	Selective tree and shrub removal using tractor with a rotary mower, with biomass left on site, from the 2010 Tres Rios Restoration Phase 3 Project
	$9,882	Complete clear and grub of medium trees, to 10" diameter, with biomass left on site, from the 2010 Tres Rios Restoration Phase 3 Project
	$3,909	***Average***
Grading/ Hauling	$5,000	General estimate for relatively minor site grading
	$2,060	Hauling excavated or borrow material from the 2010 Tres Rios Restoration Phase 3 Project

Activity	Cost per Acre	Cost Basis
Native Planting/ Revegetation [A]	$120	Seeding of saltbush and alkali sacaton at 13.6 pounds per acre from Bosque del Apache National Wildlife Refuge (Taylor and McDaniel 2004)
	$464	Planting of mesquite bosque from bids received by Maricopa County in 2014
	$900	Pole plantings, 100 per acre, from Bosque del Apache National Wildlife Refuge (Taylor and McDaniel 2004)
	$2,266	*Atriplex* plantings from the 2015 El Rio Enhancements Alternatives Valuation Report
	$2,316	Planting costs from the El Rio 2007 R&D pricing table
	$2,700	Tallpot container plantings on 3-foot centers from Bosque del Apache National Wildlife Refuge (Taylor and McDaniel 2004)
	$3,000	Native desert hydroseeding, including soil prep, amendments, and a final mulch cover, from various District projects
	$3,860	Planting and hydroseeding from the 2008 Buck Fire pricing table
	$4,500	Planting on levees from Stantec 2015 unit cost estimates
	$5,121	Cost of planting in coarse soils from the 2015 El Rio Enhancements Alternatives Evaluation Report
	$6,000	Riparian habitat mitigation costs from 2003from the Pima County Office of Sustainability and Conservation
	$7,000	Mitigation costs from 2003 from the Pima County Office of Sustainability and Conservation
	$7,035	Wetland marsh plantings from the 2015 El Rio Enhancements Alternatives Evaluation Report
	$7,575	Mesquite bosque planting costs from the 2015 El Rio Enhancements Alternatives Evaluation Report
	$8,000	Revegetation costs from 1990 from the Pima County Office of Sustainability and Conservation
	$9,400	Hydroseeding, pole planting, planting nursery plants, graded to from basins and furros, water from irrigation district and groundwater (Maricopa County Chicken Ranch) from 1991 from the Pima County Office of Sustainability and Conservation
	$9,586	Wetland and riparian forest plantings from the Tres Rios Restoration Project Phase 2 2008 pricing schedule
	$10,000	"Marginal" habitat mitigation costs from 2003 from the Pima County Office of Sustainability and Conservation
	$10,915	Wetland plantings from the Tres Rios Restoration Project Phase 2 2008 pricing schedule
	$11,215	Protect in place, diversion and control of water, clear and grubbing, vegetation removal, excavation and debris removal (Tres Rios Phase III Environmental Restoration Project from the 2010 Project Direct Summary)
	$11,609	Cost of cottonwood and willow plantings from the 2015 El Rio Enhancements Alternatives Evaluation Report
	$12,400	Mesquite bosque tall-pot plantings at approximately 90 trees/acre, with no irrigation system, from various District projects

Activity	Cost per Acre	Cost Basis
Native Planting/ Revegetation (cont.) A	$12,500	Fencing, irrigation system installation, hydroseeding, planting, nursery stock, 1-year maintenance contract (Southeast Mesa Detention Basin) from 1998 from the Flood Control District of Maricopa County
	$15,500	Site revegetation, monitoring, water, and maintenance from 2003 from the Pima County Office of Sustainability and Conservation for Santa Cruz River restoration; includes in-kind assistance (fencing and other activities, volunteer assistance) and low-cost measures (seeding, no irrigation)
	$18,783	Cost of plantings from the El Rio 2007 R&D pricing table
	$20,000	"Good" habitat mitigation costs from 2003 from the Pima County Office of Sustainability and Conservation
	$25,000	Mitigation costs from 2003 from the Pima County Office of Sustainability and Conservation
	$25,000	Site revegetation, half was hydroseeding (Maricopa County) from 1990 from the Pima County Office of Sustainability and Conservation
	$26,100	Revegetation, irrigation system (Town of Gilbert Riparian Preserve) from 2003 from the Pima County Office of Sustainability and Conservation
	$37,500	Irrigation installation, roadway, and landscaping (Pima County project) from 2003 from the Pima County Office of Sustainability and Conservation
	$75,000	Mitigation costs from Stantec based on 2015 prices from AGFD
	$12,624	***Average***
Hydroseeding	$1,500	Assuming low seed application rate and lower mulch cover (H. Cooper, pers. comm., 2015)
	$2,000	Cost of hydroseeding on levee slopes from 2015 from Stantec
	$3,500	Assuming high seed application rate and high mulch cover (H. Cooper, pers. comm., 2015)
	$4,356	Costs of hydroseeding on levee slopes from bids received by Maricopa County in 2014
	$4,027	Costs of hydroseeding upland flood terrace from the Tres Rios Restoration Project Phase 2 2008 pricing schedule
	$3,077	***Average***
Herbicide Application/ Maintenance	$1,125	Herbicide application after biomass removal of saltcedar based on 2014 bids received by Maricopa County
	$1,202	Six months of maintenance from the El Rio R&D 2007 pricing table
	$1,500	Herbicide application after biomass removal of arundo from 2013 from southern California
	$1,950	Maintenance, management, on-going monitoring costs from 2003 from the Pima County Office of Sustainability and Conservation
	$1,444	***Average***

Activity	Cost per Acre	Cost Basis
Monitoring	$25	General estimate for pedestrian surveys for saltcedar growth/ resprouting
	$792	General estimate for protocol-level surveys for endangered birds
	$600	General estimate for vegetation monitoring and associated reporting
	$472	***Average***

Table footnotes:
[A] The District already maintains a native plant nursery which will provide most of the plants, cuttings, and seeds needed for revegetation, therefore, costs associated with nursery development, operations, and maintenance are not included here.

In Table 10, the acres of vegetation management unit types from Tables 2 and 7 are multiplied by the costs per acre of relevant activities from Table 9, to provide a cost comparison of different unit types and a very coarse cost estimate for implementing the entire Plan under both current and altered land use conditions, over a 5-year period. A 5-year time period was used to ensure that saltcedar resprout treatment and routine monitoring (*i.e.*, to determine need for saltcedar resprout treatment and document revegetation success), which are typically needed or required for 3 to 5 years, were incorporated in the cost estimate. Costs associated with permitting are provided in Appendix C. Costs associated with additional monitoring (*e.g.*, post-project wildlife surveys to document species response to vegetation management) and site maintenance other than saltcedar resprout treatment are not incorporated in the costs in Table 10, as the need for and cost of such activities would be site and/or project-specific.

It is important to note, as described in Section 3.1 above, that Plan implementation will not proceed in a continuous and comprehensive manner for the entire area, but rather as a phased mosaic of individual projects implemented opportunistically as conditions permit (see Figure 4). This aspect of Plan implementation will have considerable bearing on the ultimate cost of implementation, but there is too much uncertainty in implementation phasing to incorporate such phasing into cost estimates at this time.

Table 10. Estimated cost of Plan implementation over 5 years.

Unit Type	Acres	Acres Under Altered Land Use	Relevant Activities	Activity Cost / Acre / Year	Number of Years to Implement	Estimated Cost	Estimated Cost under Altered Land Use Condition
No Action	3,042	1,603	Monitoring [A]	$498	5 years	$4,190,670 [A]	$2,016,900 [B]
Saltcedar Treatment Only	609	294	Saltcedar clearing and grubbing, biomass left on-site	$3,967	1 year	$2,415,903	$1,166,298
			Herbicide application/ maintenance	$1,444	4 years	$3,517,584	$1,698,144
			Monitoring	$498	5 years	$1,516,410	$732,060
			Subtotal over 5 year period	*$5,909 per acre*		$7,449,897	$3,596,502
Saltcedar Treatment and Riparian Enhancement	749	496	Saltcedar clearing and grubbing, biomass left on-site	$3,967	1 year	$2,971,283	$1,967,632
			Cottonwood and willow plantings [C]	$14,609	1 year	$10,942,141	$7,246,064
			Herbicide application/ maintenance	$1,444	4 years	$4,326,224	$2,864,896
			Monitoring	$498	5 years	$1,865,010	$1,235,040
			Subtotal over 5 year period	*$20,518 per acre*		$20,104,658	$13,313,632
Saltcedar Treatment and Desert Shrub Enhancement	3,634	1,865	Saltcedar clearing and grubbing, biomass left on-site	$3,967	1 year	$14,416,078	$7,398,455
			Planting and hydroseeding [D]	$4,315	1 year	$15,680,710	$8,047,475
			Herbicide application/ maintenance	$1,444	4 years	$20,989,984	$10,772,240
			Monitoring	$498	5 years	$9,048,660	$4,643,850
			Subtotal over 5 year period	*$10,224 per acre*		$60,135,432	$30,862,020
Saltcedar Treatment and Mesquite Bosque Enhancement	571	284	Saltcedar clearing and grubbing, biomass left on-site	$3,967	1 year	$2,265,157	$1,126,628
			Mesquite bosque plantings [E]	$15,400	1 year	$8,793,400	$4,373,600
			Herbicide application/ maintenance	$1,444	4 years	$3,298,096	$1,640,384
			Monitoring	$498	5 years	$1,421,790	$707,160
			Subtotal over 5 year period	*$21,309 per acre*		$15,778,443	$7,847,772

Unit Type	Acres	Acres Under Altered Land Use	Relevant Activities	Activity Cost / Acre / Year	Number of Years to Implement	Estimated Cost	Estimated Cost under Altered Land Use Condition
Saltcedar Treatment and Marsh Enhancement	77	17	Saltcedar clearing and grubbing, biomass left on-site	$3,967	1 year	$305,459	$67,439
			Grading/fill [F]	$5,000	1 year	$385,000	$85,000
			Wetland marsh plantings [G]	$7,035	1 year	$541,695	$119,595
			Herbicide application/ maintenance	$1,444	4 years	$444,752	$98,192
			Monitoring	$498	5 years	$191,730	$42,330
			Subtotal over 5 year period	*$17,944per acre*		$1,868,636	$412,556
***Grand Total* (5-year cost for entire planning area)**						$109,527,736	$58,049,382

Table footnotes:

[A] Cost based on a total of 1,683 acres, which is the amount of No Action area throughout the entire planning area that is vegetated and would, thus, mostly likely need monitoring to determine if saltcedar treatment and/or habitat enhancement becomes necessary over time. Cost per acre is general estimate for pedestrian surveys for saltcedar growth/resprouting.

[B] Cost based on a total of 810 acres, which is the amount of No Action area in the planning area not including private parcels that is vegetated and would, thus, mostly likely need monitoring to determine if saltcedar treatment and/or habitat enhancement becomes necessary over time. Cost per acre is general estimate for pedestrian surveys for saltcedar growth/resprouting.

[C] Cost of cottonwood and willow plantings from the 2015 El Rio Enhancements Alternatives Evaluation Report plus initial hydroseeding based on various District projects; cost includes materials from a nursery (*i.e.*, container stock).

[D] Cost of planting and hydroseeding from the Buck Fire pricing table (from 2008, adjusted for inflation); cost includes materials from a nursery (*i.e.*, container stock and seed).

[E] Cost of mesquite bosque planting from various District project, assuming initial hydroseeding and tall-pot plantings at approximately 90 plants/acre; cost includes materials from a nursery (*i.e.*, container stock).

[F] Cost of relatively minor grading from various District projects.

[G] Cost of wetland marsh plantings from the 2015 El Rio Enhancements Alternatives Evaluation Report; cost includes materials from a nursery (*i.e.*, container stock and seed).

3.6 Permitting and Regulatory Compliance

This section summarizes the permits and regulatory compliance documentation that is likely to be required for implementation of the Plan. Additional permitting and compliance information is provided in Appendix C.

Permitting refers to the processes and authorizations necessary for a proposed project to comply with relevant federal, state, and local laws or regulations. These regulations give authority to particular agencies to implement the regulation and are intended to ensure that a proposed project's potential impacts on the environment are avoided, minimized, and/or mitigated. There are a number of regulations that would apply to, and regulatory agencies that would be involved in, the permitting of Plan actions (with the exception of No Action units, which would not require any permits) due to the facts that the planning area includes a river, wetlands, and is known to support federally endangered species and their habitat. In addition, implementation of the Plan involves actions, such as mechanized equipment within the ordinary high water mark of the Gila River, which would trigger the need to comply with certain environmental regulations.

Table 11 lists the regulations that are relevant to Plan implementation, the agency with authority for the regulation, the way(s) in which a regulation is likely to be triggered by the Plan activities, and the documentation that must be prepared to be issued a permit or demonstrate compliance with the regulation. These permits and required documentation are discussed in greater detail in Appendix C. An important basis for the permitting of the Plan or individual portions of the Plan will be the type of permit that is acquired from the U.S. Army Corps of Engineers (USACE) for Section 404 permitting. One option is a Regional General Permit (RGP)[4] that would cover implementation of the Plan, regardless of the project proponent. Another option is that individual project proponents apply for an Individual Permit or coverage under a Nationwide Permit, such as No. 27 for habitat restoration, for implementing individual portions of the Plan. The pros and cons of both approaches are discussed in Appendix C. Unless otherwise noted, the permits listed in Table 11 would be required regardless of whether a project occurs on private or public property, and whether it is federally funded or not.

There are many factors that influence the schedule and timeline for preparing and acquiring the permits listed in Table 11, which are described in more detail in Appendix C. In general, individual project permitting via a Nationwide Permit from USACE should take approximately 10 to 14 months, including drafting of the project description and associated maps, site assessment for threatened and endangered species habitat, delineation of USACE jurisdiction, USACE review and comments, consultation with USFWS (including preparation of a Biological Assessment [BA]) and SHPO (including a cultural resources survey report) for the project site, and acquisition of other required permits. Permitting via a RGP from USACE should take approximately one to six months, with most of the time spent addressing USFWS and SHPO requirements.

[4] There are RGPs for nonnative invasive plant removal, but currently none for Arizona. The District is currently working to have an RGP established that would cover at least Maricopa County.

Table 11. Summary of the permits that may be required to implement the Plan.

Regulation (Permit)	Agency [A]	Triggers for Regulation	Required Documentation
Clean Water Act Section 404 (Nationwide Permit or Regional General Permit)	USACE	Working below the ordinary high water mark of a river and/or within adjacent wetlands	• Regional General Permit request letter (if RGP is available) • Individual or Nationwide Permit application (if RGP is not available) • Project description • Delineation of USACE-jurisdictional waters, including wetlands • All of the documentation listed below
ESA Section 7 (Biological Opinion)	USFWS	Potential to affect a federally listed species or its habitat	• Biological Assessment, which may necessitate a habitat assessment, habitat suitability modeling, and/or protocol-level surveys for endangered species.
National Environmental Policy Act (Record of Decision)	USACE	Potential for a federal action, permit, or funding to result in significant impacts to environmental resources [B]	• Environmental Impact Statement or Environmental Assessment • Waived for Nationwide Permit and RGP
National Historic Preservation Act Section 106 (SHPO Concurrence)	SHPO	Potential to affect historic and culturally significant resources	• Cultural resources report, which may necessitate cultural resource surveys and/or construction monitoring
Clean Water Act Section 401 (State Water Quality Certification)	ADEQ	Need for a 404 permit from USACE	• 401 Certification application
AZ Pollutant Discharge Elimination System (Stormwater Construction General Permit)	ADEQ	Construction activities disturbing one or more acres of land	• Notice of Intent (NOI) • Stormwater Pollution Prevention Plan (SWPPP)
Pesticide General Permit	ADEQ	Herbicide use	• Pesticide General Permit application
Floodplain Regulations for Maricopa County (Floodplain Use Permit)	District or local municipality	Construction of buildings, earthwork and other improvements within designated floodplains	• Floodplain Use Permit application • Floodplain development checklist • "No-rise" engineering analysis

Table footnotes:

[A] USACE=U.S. Army Corps of Engineers, ADEQ = Arizona Department of Environmental Quality, USFWS=U.S. Fish and Wildlife Service, SHPO=Arizona State Historic Preservation Office.

[B] If a project is not on federal property, federally funded, and a federal permit is not required, then compliance with the National Environmental Policy Act (NEPA) is not required.

These schedules assume that the project description would not change materially during the course of the permitting phase or after permits have been acquired. If such changes occur, permitting can take much longer. It is likely that consultation with USFWS will be the "critical path" item under any permitting scenario, as the consultation process can take up to 135 days (this review period is fairly standard for USFWS but can take longer depending on agency priorities and/or the level of controversy surrounding the project). In addition, consultation with USFWS may require that season-specific surveys for endangered species be conducted, which can greatly influence the permitting schedule.

Development of an RGP could take two to three years, but could streamline the subsequent approval of covered projects to one to six months. This schedule includes negotiations with USACE for RGP development, terms, and conditions; preparation of a National Environmental Policy Act (NEPA) compliance document and circulation for public review; consultation with USFWS and SHPO; and acquisition of other program-level permits. Once an RGP is in place, USACE would be made aware of individual project implementation with a project-specific summary letter, site-specific delineation of USACE jurisdiction, and a site-specific biological resources assessment, if necessary. The RGP would need to be renewed every five years, but with much less effort than the original RGP.

As noted above, consultation with USFWS and/or adequately addressing potential impacts of Plan implementation on endangered species is likely to be one of the most critical and time-consuming aspects of permitting. Habitat suitability modeling of the planning area for southwestern willow flycatcher and western yellow-billed cuckoo could greatly facilitate the USFWS consultation process (the relatively small patches of marsh habitat that can be utilized by Yuma clapper rail can be identified from vegetation maps and, as such, habitat suitability modeling is not considered to be warranted at this time). Habitat models for each species incorporating factors such as vegetation composition and structure (*e.g.*, canopy height), landscape context, topography, and distance to water can be used to evaluate the current baseline quantity (acreage) and quality of suitable habitat for each species, predict potential loss of habitat due to saltcedar removal and potential gain of habitat resulting from habitat enhancement. The model results would be improved through model calibration using occupancy data for these species in the El Rio reach, although such data are currently limited. In addition preliminary model results could be used to prioritize which portions of the planning area should be included in species-specific surveys to obtain more data for calibration or validation of the models.

Consultation with SHPO has the potential to be similarly arduous to that with USFWS, but it is anticipated that much of the planning area has low potential for cultural resources because of the extent of historical flooding and associated scour and deposition in the Gila River floodway.

3.7 Site Preparation

Implementation sites would need to be prepared in accordance with any site-specific plans (see Section 3.6). In general, little site preparation should be necessary for Saltcedar Treatment Only units, other than establishing access routes and staging areas for equipment and supplies, and fencing or flagging areas that need to be avoided.

Staging areas for equipment and materials should be located in developed and/or unvegetated areas, to the extent feasible, and far enough away from the wetted river channel or other waterbodies to avoid risk of contamination if a spill or fuel leak occurs.

Existing paved and unpaved roads should be used for access to the extent practical. Where it is necessary to establish new access routes to provide vehicle access for transporting crews, equipment, and materials, native vegetation should be avoided to the extent feasible. Ideally new access routes can be established by removing saltcedar on the way to the project site, and with little to no surface grading, as this increases the risk of secondary weed infestations. Access routes should be planned for long-term access for maintenance and monitoring, but may need to be fenced to prevent unauthorized access and damage.

Where habitat enhancement occurs, a number of other site preparation activities may also be necessary to ensure the long-term success and sustainability of the enhancement effort. Saltcedar biomass will need to be mulched, burned, or otherwise removed, and secondary weed management may be necessary (Sher *et al.* 2010). Soil surface manipulations may be needed to prepare the seedbed, including the addition of soil amendments, and site fencing may be needed if there are risks of herbivory (Sher *et al.* 2010).

Where habitat enhancement occurs within the flood reset zone, it may be prudent to conserve upstream vegetation, even if it is saltcedar, to provide a hydraulic shield from high flow events for the downstream enhancement area (see Figure 5 below for an example). The goal of the shield would be to buffer new plantings in downstream or laterally adjacent enhancement areas from the scouring effects of high flows. The "hydraulic shield" may also reduce negative effects from saltcedar removal by maintaining microclimate conditions and protecting existing habitat that is occupied by a protected species. Once enhanced areas are sufficiently established and can withstand moderate to high flow events, the saltcedar in the hydraulic shield could then be removed, if it is has not already been colonized or killed off by tamarisk beetle. It is anticipated that revegetated areas in Riparian Enhancement units will require three to five years to become sufficiently established to withstand typical high flow events. It may also be prudent to preserve all or some saltcedar along regularly inundated streambanks to prevent streambank erosion and other unintended morphological changes following saltcedar removal (Nissen *et al.* 2009).

Grading or excavation, where determined to be appropriate and desired, would be designed to create planting surfaces or off-channel features that would allow the roots of planted trees and shrubs to reach groundwater more quickly, and increase their survival and long-term establishment. Such areas may also provide surface moisture conditions that are suitable for southwestern willow flycatcher nesting habitat. Identification of these areas will have been confirmed by local groundwater and soil sampling during site assessment and design. In these areas, a small to mid-sized excavator would be used to dig trench- or swale-like features prior to revegetation. Such features would typically be less than 3 feet deep (as measured below the ground surface), 100 feet long (as measured parallel to the river), and 25 feet wide (as measured perpendicular to the river), but large enough to support an adequate planting zone. Unless otherwise required, excavated material should remain on-site and be spread out around the grading area to create natural-looking topography and reduce costs. Earthwork could occur concurrently with saltcedar removal, in order to expedite implementation.

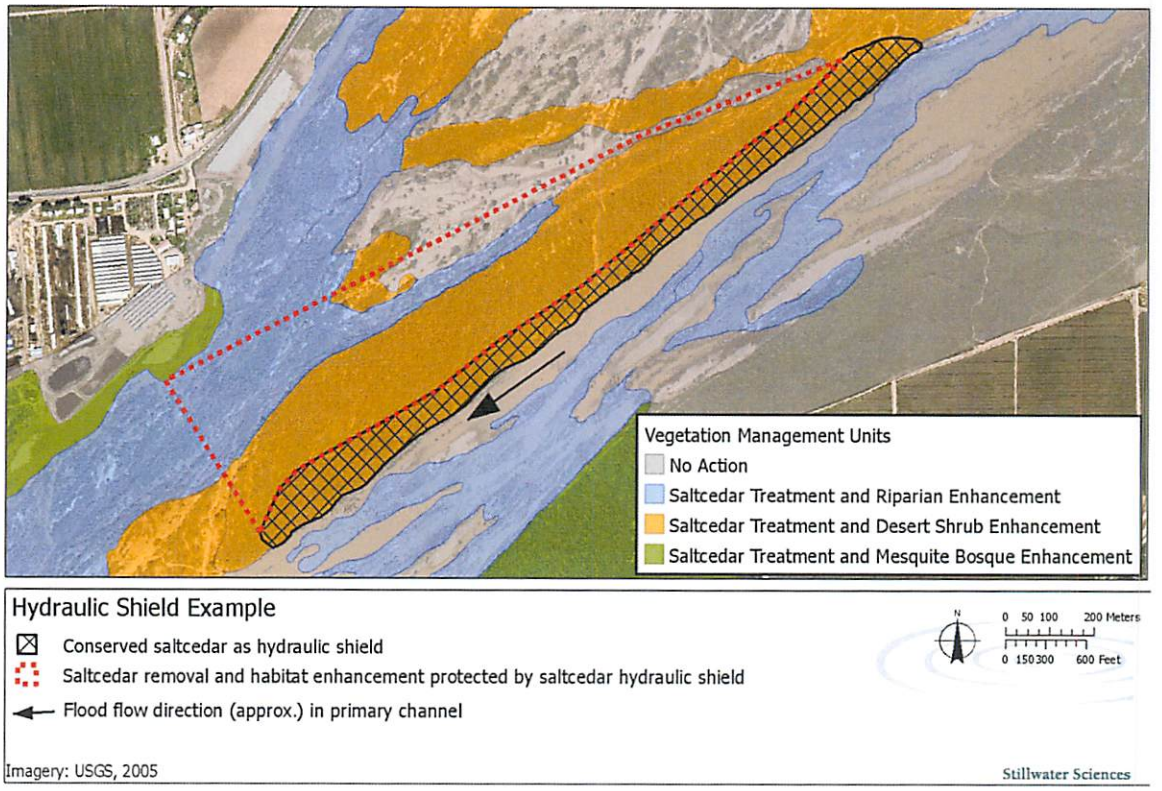


Figure 5. Conceptual example of saltcedar stands conserved along the geomorphically active river channel to provide a "hydraulic shield" for enhancement activities within the flood reset zone.

Ideally plantings will be installed directly into the capillary fringe of the water table and during the onset of either winter or early spring after buds form but before they open to minimize the amount of irrigation that may be necessary. In fact, where cuttings or container stock of perennial species are planted into the water table, or plantings are annual species or dependent only on seasonally available water, planting during the rainy season may preclude the need for irrigation altogether. Where that is not the case, enhancement sites, particularly where grading to reduce the distance to groundwater is not appropriate or feasible, may require at least 3 years of irrigation to allow plants to establish a sufficient root structure and canopy to be self-sufficient. There are a number of considerations in determining appropriate irrigation methods for a site, which is made more challenging in the planning areas since pumping water from the river channel for irrigation is not likely to be allowed. Such considerations include (but are not limited to): accessibility for water trucks (which may be the most cost effective approach if only an initial watering will be needed); proximity to the flood reset zone, where irrigation infrastructure could be scoured away or damaged during high flow events; risk of theft or vandalism; need for an electrical supply to power irrigation pumps or timers. Where irrigation is needed but ultimately determined to be infeasible, the planting palette should be revised to a more xeric vegetation community or habitat enhancement should be relocated someplace more conducive to long-term plant establishment. Dreesen and Fenchel (2009) provide a comparison of various irrigation methods, and Sher *et al.* (2010) provide recommendations for irrigation magnitude and frequency, for revegetation following saltcedar removal.

If not already established or conducted during the site assessment (see Section 3.3), baseline surveys should be conducted as part of site preparation. A wildlife inventory and/or endangered species surveys can help determine if saltcedar removal needs to be avoided during any particular time periods, determine whether other protective measures may be needed to avoid impacts to wildlife, identity habitat elements most critical to the wildlife community of the El Rio ecosystem and how saltcedar removal affects that community, and provide a way to evaluate project success. An additional component of site preparation should include the establishment of long-term vegetation monitoring plots that can be used to identify any naturally recruiting species, particularly secondary weeds, as well as quantify vegetation and habitat development following habitat enhancement.

3.8 Saltcedar Removal and Treatment Methods

In the long-term, the tamarisk beetle is a biological control agent that is likely to act as a cost-effective way of reducing the current extent of saltcedar and limiting re-infestation in the future after it has naturally entered[5] the El Rio reach. While the tamarisk beetle is expected to cause mortality of much of the saltcedar in the planning area, it will not remove the remaining standing biomass, which will continue to contribute to flood risk. As such, biomass removal by chipping or burning will still be necessary in some portions of the planning area to reduce flood risk sufficiently.

In the short-term, however, removal of saltcedar via manual, mechanical, and chemical methods is needed to reduce flood risk and to provide sufficient space for the revegetation of native trees and shrubs. Revegetation using native species will be necessary to replace habitat losses from saltcedar removal and to promote the re-establishment of native plant species. There are many methods for removing and treating saltcedar (*e.g.*, Tamarisk Coalition 2008). Because one of the primary objectives of saltcedar removal in the planning area is to reduce flood risk, biomass removal is an essential component. As such, foliar application of herbicides without any associated biomass removal, which can be one of the most cost-efficient means of saltcedar treatment (Parker *et al.* 2005), is not discussed in detail here. In addition, to effectively bring about saltcedar mortality, foliar treated trees must be left in place for at least two years (Tamarisk Coalition 2008); this precludes the flood-risk reduction benefits of treatment and increases fire risk. In addition, controlled burns are not recommended for standing/living saltcedar biomass removal since the plant regrows vigorously after fires and there would be fire risks to native vegetation and nearby land uses (Nissen *et al.* 2009). Incidental wildfires, however, as well as floods, present an opportunity for cost-effective foliar herbicide application on resprouts after most of the saltcedar biomass has been removed by the wildfire or flood.

[5] Per the U.S. Department of Agriculture's (USDA) Animal and Health Inspection Service (APHIS), any unauthorized human-assisted movement of the tamarisk beetle, particularly into designated critical habitat of southwestern willow flycatcher and western yellow-billed cuckoo (the latter of which includes the El Rio reach), may constitute a violation of the ESA, which could result in criminal punishment and/or fines, as well as the Plant Protection Act, which could result in criminal penalties and/or fines of up to $250,000 (APHIS 2010).

Mechanical saltcedar biomass removal followed by immediate herbicide application to the cut stumps, and subsequent foliar herbicide application to regrowth, is likely to be the best value in terms of cost versus efficacy, for the planning area, most of which can be accessed by the heavy equipment necessary for mechanical removal (*i.e.*, there are not very many steep slopes or banks) (see photos below). Mechanical removal may include root crown removal or above-ground biomass removal. Manual (*i.e.,* hand) removal may be necessary where equipment access is limited or where native vegetation needs to be avoided (although some mechanical methods are able to work around native vegetation successfully – see photo at right). The focus on these methods does not mean, however, that other or additional methods may not be appropriate for particular sites and conditions. Parker *et al.* (2005) and Tamarisk Coalition (2008) both provide comparisons of various saltcedar removal methods. Regardless of the method used, costs are high (see Section 3.5) and revegetation is likely to be necessary for sustained, long-term control of saltcedar. As such, sites with the greatest potential for natural recruitment and/or revegetation success, as well as potential for flood-risk reduction, should be prioritized for saltcedar removal (Parker *et al.* 2005). Herbicide application or mechanical methods may also be needed to control secondary weeds that often increase following treatment of saltcedar, such as Russian thistle (*Salsola tragus*) (see Section 3.11).

Examples of mechanical removal of saltcedar, placement of mulched biomass, and preservation of native riparian trees (top), and herbicide treatment on a cut saltcedar stump (bottom) (both views from the upper Gila River near Safford, AZ) (Photos by Stillwater Sciences)

Root crown removal is the extraction of saltcedar trees and their root crown by either root plowing and raking or by extraction of the entire plant and is approximately 85% effective (Tamarisk Coalition 2008). This approach is extremely disruptive to the soil, can promote establishment of secondary weeds, and results in a large amount of biomass that must be subsequently mulched or burned. Mulching of that biomass could range from $400 to $800 per acre, while burning could range from $50 to $150 (Tamarisk Coalition 2008). Plowing and raking methods also destroy native vegetation, although extraction that plucks individual trees from the ground does not. As such, post-treatment revegetation is nearly always necessary to re-stabilize the soil, replace removed native vegetation, and suppress secondary weeds. Extraction can be used to remove saltcedar trees on steep slopes, as the equipment can reach over such slopes to "pluck" out individual trees, or where ground disturbance may be necessary anyhow to facilitate revegetation. Theoretically, root crown removal should eliminate the need for herbicide, since the entire tree and roots are removed, but herbicides treatments are still necessary because any remaining root pieces and buried stems can easily resprout and re-infest cleared areas (Nissen *et al.* 2009).

Cut stump (*i.e.*, above-ground removal) methods involve cutting and/or mulching the above-ground portions of the shrubs/trees and then immediately applying an herbicide to the cut stumps. These methods are typically 85% effective on its own (Tamarisk Coalition 2008), but should include follow-up foliar applications of herbicide to saltcedar resprouts for at least three years. Like the extraction methods discussed previously, cutting methods using chainsaws, loppers, and hand saws (where access is limited or where native vegetation needs to be avoided) result in a large amount of biomass. Large trunks and branches that are manually removed should be relocated outside of the ordinary high water mark of the river, to further reduce flood risk, and reduced by means of mulching or prescribed burning. Mulching of that biomass could range from $400 to $800 per acre, while burning could range from $50 to $150 (Tamarisk Coalition 2008). Prescribed burning of debris piles must be overseen by professional crews when air, moisture, and wind conditions are appropriate. Local fire departments may perform these burns as training exercises. All local and/or state air quality permits must be obtained prior to any debris pile burning. Alternatively, an excavator equipped with a mulching head attachment (*e.g.,* Torrent EX30 Brush Cutter) can be used to directly mulch standing saltcedar. Mulched saltcedar material (*i.e.,* wood chips) should be left on-site as it offers multiple benefits, such as reducing wind- and water-induced erosion of surficial soils, conserving soil moisture loss to aid reseeding efforts, and retarding the growth of secondary weeds (Tamarisk Coalition 2008, Dreesen and Fenchel 2009). Although saltcedar removal can reduce fire risk, leaving mulch on-site may merely redistribute the fuel for fires and not remove it (Bateman *et al.* 2012) and, if exceedingly deep, mulch has been observed to suppress vegetation cover and, to a lesser extent, plant species richness (Finch *et al.* 2004).

Cut saltcedar stumps should be immediately treated with herbicide, and saltcedar resprouts should be treated with foliar and/or cut-stump herbicide applications as needed. Herbicides should include triclopyr (trade names include Garlon and Element), imazapyr (trade names include Arsenal, Habitat, Stalker, Chopper, and Polaris), and perhaps glyphosate (trade names include Roundup, Rodeo, and Aquamaster), which have all been reported to be effective on saltcedar (USFS 2014). Solutions of these herbicides, at the concentrations and rates suggested for saltcedar (*e.g.,* Tamarisk Coalition 2008, Nissen *et al.* 2009, Johnson *et al.* 2010, Ferrell *et al.* 2012, DiTomaso *et al.* 2013), should be applied to cut saltcedar stumps, or basal bark by hand "painting", or to resprouting stems by backpack sprayer. Herbicide solutions should be mixed with a color dye to determine which trees have been treated and reduce potential for overspray. Generally, herbicide should be applied until the cut saltcedar surface is thoroughly wet but not to the point of runoff to reduce damaging or killing non-target species. Ferrell *et al.* (2012) and Tamarisk Coalition (2008), among others, provide detailed discussions of appropriate herbicide types, concentrations, and application timing. Application of herbicide should be closely supervised and comply with the conditions of a Pesticide General Permit from the Arizona Department of Environmental Quality (ADEQ).

3.9 Native Plant Collection, Propagation, and Planting

Depending on individual site characteristics, the abundance of native species may be sufficient to provide natural recruitment of native plants after saltcedar is removed (see Section 3.3). This premise is the basis of many of the Saltcedar Treatment Only units (see Section 2.2.2). However, with the exception of a few areas, most units in the planning area are not anticipated to support natural recruitment sufficient to adequately revegetate saltcedar treatments sites and, as such, that habitat enhancement will be necessary. Planting after saltcedar removal will be necessary in many areas to: (1) stabilize banks and control erosion; (2) replace and enhance wildlife and pollinator

habitat; (3) provide shade for recreation and wildlife; (4) provide forage for wildlife; (5) improve aesthetics; and (6) reduce re-establishment of saltcedar and other weeds (Taylor and McDaniel 2004 as cited in Parker *et al.* 2005, Sher *et al.* 2010). In addition, native plant communities also provide ecosystem services to people, communities, and the economy, and planting native species will improve ecosystem diversity, maintain genetic diversity of native seed banks, and support wildlife and pollinator habitat.

The plant species likely to be appropriate for various vegetation management units are listed in Chapter 2 (see Tables 3–6). These species have been selected because they are native to the region, will be able to persist in the physical conditions that do and are anticipated to occur at the unit locations, and will create the desired habitat conditions. For example, dense plantings of the riparian herb, grass, shrub, and tree species in Table 3 can create suitable habitat for southwestern willow flycatcher when close enough to a water source. The species listed in Chapter 2 also include those that will provide habitat and food sources for pollinators.

It may be necessary to alter or revise the suite of plant species used for habitat enhancement based on the results of site-specific assessment (see Section 3.3). For example, plants with higher tolerance for saline soils should be used if a site is ultimately found to have relatively saline soils (examples of such species are noted in the Chapter 2 tables [Tables 3–6]). It is also possible that site assessment could determine that a site is not likely to successfully support any kind of habitat enhancement and should only be considered for saltcedar removal.

When planting is necessary, seed and planting stock should, ideally, be locally collected. This will be challenging or impossible for some species, however, given the lack of native plant diversity in the planning area. When it is necessary to collect seeds and planting stock from other areas in the region, the genotype of the source plants should be considered so that material is collected from plants that have the greatest chance to successfully persist in the relatively hot and dry conditions in the planning area (Whitham *et al.* 2006, Lojewski *et al.* 2009, Grady *et al.* 2011). Habitat enhancement areas could incorporate experimental plantings of cottonwood and willow from hotter or drier areas, which may show a difference in health, vigor, and establishment success, to promote riparian habitat resiliency to climate and water availability changes in the future (Whitham *et al.* 2006, Lojewski *et al.* 2009, Grady *et al.* 2011).

The District maintains a native plant nursery that can be used to collect local seed and cuttings, and propagate and grow many of the plants that will be needed for habitat enhancement. The nursery should establish cottonwood and willow coppicing sources (ideally from seed so that genetic diversity is maximized) so that pole cuttings can be collected from the nursery rather than from vegetation in the field. If demand exceeds the District's supply and capacity, seed and plants can be procured from other regionally-appropriate native plant nurseries.

Specific revegetation techniques play a role in where particular plant species can be successfully established. Table 12, which is modified from Parker *et al.* (2005), provides a comparison of various revegetation methods and plant-stock options for riparian restoration projects. The advantages versus costs of these methods will need to be assessed given individual site conditions and project objectives, and it is likely that a combination of methods will be necessary. When determining revegetation methods and plant stock type, the equipment necessary for planting should be considered, as this varies by stock type. For example, long augers or rotary hammer drills may be needed for pole plantings; waterjets or similar hydraulic methods for nursery stock planting may require site-specific water rights; and access for large drilling or hydroseeding

equipment may be limited by ditches, arroyos, levees, soft sand, or steep slopes. In addition, the presence of cut or burned saltcedar stumps can flatten equipment tires if the tires are not foam-filled (Dreesen and Fenchel 2009).

Table 12. Comparison of revegetation methods for riparian restoration projects (adapted from Parker *et al.* [2005][A]).

Method	Timing	Effectiveness	Comments
Controlled flooding: flood areas when seeds from desirable species are present	When native or desirable seeds are available on site (generally late spring/early summer)	20–47% survival after 2 years; could be used to cost-effectively revegetate large portions of the planning area	• May not be possible in the planning area, due to upstream flow storage, or only occasionally available if flow releases can be negotiated for above-average water year types. • Will also facilitate recruitment of saltcedar and necessitate monitoring and saltcedar treatment.
Pole plantings: cutting stems of willows and cottonwoods from established trees and planting into water table or capillary fringe	During plant dormancy (generally December–January)	90% survival, with supplemental water as-needed	• Native source material may be limited in the planning area and coppicing trees may need to be established specifically for pole cuttings. • Cuttings should ideally be 0.5–3 inches in diameter for *S. exigua*, and 2–8 inches in diameter for *S. gooddingii* and *P. fremontii* to survive harsh conditions and sufficiently long to be planted into capillary fringe. Long cuttings planted deeply are also better able to withstand flood flows (Dreesen and Fenchel 2009). • Planting density will depend on presence of native vegetation and objectives of enhancement, but for wildlife benefit, density should be at least 100 trees and shrubs per acre.
Nursery stock: planting container stock into dug/augured holes	Ideally during late fall/early winter, at beginning of rainy season, to reduce need for supplemental water	90% survival if water table is less than 5 feet from the soil surface, and with supplemental water as-needed	• Native plant nurseries must be given adequate notice to propagate species and quantity needed for individual projects. • Projects need to consider the costs vs. benefits of different stock sizes, and the cost of labor and equipment that may necessary for planting different stock sizes (Dreesen and Fenchel 2009). • Screwbean mesquite is best propagated by long-stem deep plantings (up to 5 feet deep from 0.3×2.5 foot tall pots) that require minimal to no irrigation (Dreeson and Fenchel 2008).

Method	Timing	Effectiveness	Comments
Seeding: hand, broadcast, or hydroseeding of native plant seeds	In anticipation of winter and/or monsoon rains (Dreesen and Fenchel 2009)	Depends on species and conditions; can take 3 or more years to determine if seeded plants successfully establish (Sher *et al.* 2010)	• Limited to species that readily germinate from seed and for which an adequate supply of seed can be obtained. • Can be most cost-effective option for large areas. • Can be combined with pole and nursery stock plantings to promote understory development and increase species diversity. • If dense enough and timed correctly, seeding can be sufficient to suppress saltcedar resprouting.
Rainfall harvest: excavate long, shallow V-shaped water catchment and line sides with plastic; plant seedlings at the bottom of the catchment	Construction: before rains Planting: during monsoon season	Results are comparable to previous methods	• Effective in areas with a deep water table or where moderate salinity levels are present in the soil. • An alternative to grading or excavating to improve water supply

Table footnotes:
[A] Table adapted from Parker *et al.* (2005), which was specific to riparian revegetation. As such, methods, timing, and effectiveness may be different for desert shrub, mesquite bosque, and marsh enhancement projects.

Most plantings in the planning reach are likely to benefit from soil amendment techniques to condition the soil. The need for such amendments should be evaluated during the site assessment (see Section 3.3). Such amendments could include: soil ripping by heavy equipment or by hand to improve compacted soils; use of amended topsoil or fertilizers during plantings; and/or beneficial mycorrhiza by inoculating planting areas with soil from areas where the desired species are already established.

3.10 Best Management Practices and Conservation Measures

The following measures are likely to be necessary before, during, and/or after saltcedar removal and habitat enhancement to adequately avoid and minimize impacts to environmental resources and comply with general permit terms and conditions. Additional measures are likely to be required as a result of project-specific permit terms and conditions.

1. A nesting survey for southwestern willow flycatcher, western yellow-billed cuckoo, and/or Yuma clapper rail by a surveyor with a scientific permit may be necessary prior to saltcedar removal in suitable nesting habitat for one or all of those species (USFS 2014).
2. Similarly, surveys for historical and/or cultural resources by a cultural resource specialist may be necessary prior to saltcedar removal in areas with potential for such resources to be present. Based on the results of such surveys, additional protection and/or mitigation measures may be necessary.

3. Where a nest is found, a no-treatment buffer of 0.25 mile may be necessary around the nest(s) (USFS 2014).
4. Saltcedar treatment and other potentially disturbing activities will be limited to outside of the southwestern willow flycatcher and western yellow-billed cuckoo nesting period (April through September) when within occupied or suitable habitat (USFS 2014).
5. Migratory birds other than the flycatcher may also nest in saltcedar from generally between March through August, and saltcedar treatment during this period should be avoided if possible (USFS 2014).
6. If avoidance of the migratory bird nesting period is not feasible, a qualified biologist can begin migratory bird surveys prior to the nesting season, sampling twice per week throughout the construction period. Nests that do not contain eggs or young can be removed from the planning area. Nests that do contain eggs or young can be flagged for avoidance during removal and enhancement, and removed from the planning area once birds fledge.
7. A qualified biologist may need to develop an environmental awareness training program for all on-site implementation personnel before they begin work on the project. Training should include a discussion of the avoidance and minimization measures that are being implemented to protect biological resources as well as the terms and conditions of project permits.
8. A qualified biologist and/or cultural resources specialist may be required to monitor saltcedar treatment activities during construction when working near sensitive biological and/or cultural resources to avoid risk of impacts.
9. In-water or streambank work may be curtailed during rain events, and revegetation should begin as soon as possible after saltcedar treatment to prevent erosion (Nissen *et al.* 2009).
10. Native vegetation should be avoided to the extent practical (Nissen *et al.* 2009).
11. Litter, debris, unused materials, flagging, equipment, and supplies should be removed regularly from work areas and deposited at an appropriate disposal or storage site.
12. A SWPPP should be established prior to the onset of construction activities and the BMPs in the SWPPP should be implemented as required by the conditions of a National Pollution Discharge Elimination System (NPDES) permit to prevent silt runoff from the construction site.
13. Stockpiling of construction materials such as portable equipment, vehicles, and supplies, including chemicals, should be restricted to designated staging areas that are away from waterbodies. Proper spill prevention and cleanup equipment should be maintained in all refueling areas, and any spills of hazardous materials should be cleaned up immediately and reported to the appropriate resource agencies within 24 hours.
14. Equipment should be adequately washed before moving it to other work sites to prevent the spreading of weed species.
15. Vehicles should be confined to established access routes, staging areas, and work areas, and such areas should be limited to the minimum necessary to achieve the project goals to avoid soil compaction.
16. Application of herbicide should be closely supervised and in compliance with the conditions of an ADEQ Pesticide General Permit and USFWS (2007) recommended protection measures.

3.11 Maintenance

A three to five year commitment for spot spraying of saltcedar resprouts must be part of any successful treatment project (Dreesen and Fenchel 2009, Sher *et al.* 2010). Monitoring of project sites (see Section 3.12) will reveal resprouting saltcedar and should prompt the application of herbicide before the sprouts become too large.

While the mulching practices described in Section 3.8 are intended to minimize establishment of other secondary weeds, there is potential for secondary weed problems to occur, which would trigger the need for additional herbicide treatment of established and/or spreading invasive perennial weeds. Weeds known to be problematic for vegetation management projects in the region include Canada thistle (*Cirsium arvense*), cheatgrass (*Bromus tectorum*), diffuse knapweed (*Centaurea diffusa*), hoary cress or whitetop (*Cardaria draba*), kochia (*Bassia scoparia*), leafy spurge (*Euphorbia esula*), perennial pepperweed (*Lepidium latifolium*), purple loosestrife (*Lythrum salicaria*), Russian knapweed (*Acroptilon repens*), and Russian thistle (*Salsola tragus*) (CHIP 2008). Annual weeds generally do not preclude native plant establishment but large, dense stands can limit seeding of native species and the survival and growth of small containerized stock (Tamarisk Coalition 2008, Dreesen and Fenchel 2009, Sher *et al.* 2010). If possible, annual weeds should be prevented from going to seed at the end of the first growing season after treatment to reduce weed seed in the soil seed bank before reseeding with native species. Once established, secondary weed treatment can require several years of herbicidal control (Dreesen and Fenchel 2009).

Although one of the objectives of the Plan is to produce vegetation conditions that are self-sustaining in the long-term, and some mortality of plantings is expected, there is the potential that new plantings may require supplemental irrigation and/or soil amendments to ensure survival and success, and ill-suited species may need to be replaced if plant survival or native cover objectives are not being met. Site management, such as fencing to limit livestock grazing or unauthorized access, may be required at enhancement sites, as well irrigation equipment maintenance.

Vegetation management units have been assigned and hydraulically modeled for flood risk reduction based on the expected height and density of the units at vegetation maturity. As such, maintenance, such as trimming, mowing, or clearing, is not anticipated to be needed to maintain the expected or desired level of flood risk reduction.

3.12 Monitoring and Adaptive Management

At a minimum, monitoring of saltcedar treatment and habitat enhancement sites will be needed to identify necessary maintenance activities. Monitoring will identify the location and extent of saltcedar resprouting and determine the need for saltcedar re-treatment. Resprout monitoring and treatment are generally recommended for at least three years. Monitoring at habitat enhancement sites should also document the survival of plantings and determine the need for replacement plantings, alternative species, or alternative planting locations. Survival monitoring is generally recommended for at least three years as well, which is generally the amount of time it takes to determine if plantings have become established. In light of the flood risk reduction objective of the Plan, monitoring of vegetation roughness characteristics (*e.g.*, developing vegetation height and density) and inputting that information into hydraulic models may be needed to demonstrate if vegetation management alone is sufficiently reducing flood risk.

Monitoring will also be necessary to meet the terms and conditions of project permits, which typically require at least five years of annual monitoring. In addition to identifying maintenance needs, permit compliance monitoring is likely to require evaluation of whether implementation-related impacts and loss of habitat from saltcedar removal are being adequately replaced by habitat enhancement plantings. Baseline measurements of the amount of saltcedar present pre-project and the amount of saltcedar removed are likely to be necessary for permit compliance monitoring. For example, it may be necessary to compare the amount of suitable flycatcher nesting habitat that is affected by the project, and the extent of habitat recovery that occurs over the five-year monitoring period. Permit compliance monitoring may require or recommend that surveys for southwestern willow flycatcher, western yellow-billed cuckoo, and Yuma clapper rail be conducted to help evaluate how they respond to habitat enhancement efforts.

Ultimately, post-project monitoring should be used to determine whether individual project objectives have been achieved. This may be accomplished by either maintenance or permit compliance monitoring, but additional monitoring metrics may be needed depending on the specific project objectives. For example, if the objectives are to increase water availability, enhance wildlife habitat, and reduce wildfire risk, three associated monitoring metrics would need to be established and pre- and post-treatment monitoring conducted to determine if the objectives are met. Table 13, which is modified from Parker *et al.* (2005), provides several examples of project objectives and potential associated monitoring metrics. It is important to note that most of these metrics would need to be measured before the project (*i.e.*, baseline monitoring) as well as after in order to determine if project objectives have been achieved. Monitoring plans should be developed before the project starts so that any necessary baseline or pre-project data can be gathered.

Table 13. Potential monitoring metrics to determine if project objectives have been achieved (adapted from Parker *et al.* [2005][A]).

Project Objective	Data to Collect Before and After Project
Reduce/eliminate saltcedar cover	• Measure and/or map saltcedar canopy cover; • Count/density of saltcedar resprouts (after project only); and/or • Establish and take photopoints
Reduce flood risk	• Measure and/or map woody plant cover; • Measure and/or estimate hydraulic roughness of site vegetation; and/or • Model flood hydraulics of site reflecting the changing vegetation conditions
Restore native plant community	• Measure diversity/abundance of native species; • Measure and/or map cover of native species; and/or • Establish and take photopoints
Restore wildlife habitat	• Measure key vegetation for focal wildlife species (focal species are likely to include southwestern willow flycatcher, western yellow-billed cuckoo, and/or Yuma clapper rail, but could include others, such as northern Mexican gartersnake (*Thamnophis eques megalops)* and narrow-headed gartersnake (*Thamnophis rufipunctatus*) depending on site conditions and project objectives) • Survey for focal wildlife species
Increase water supply	• Measure groundwater and surface water levels • Measure water quality

Table footnotes:
[A] Table adapted from Parker *et al.* (2005), which was specific to riparian revegetation. As such, methods, timing, and effectiveness may be different for desert shrub, mesquite bosque, and marsh enhancement projects.

Again, most of the metrics in Table 13 would need to be measured before the project as well as after. Baseline (*i.e.*, pre-project) monitoring will not only be critical in determining if project objectives have been achieved, but can also help determine which project objectives are appropriate for a site. For example, baseline monitoring of vegetation can help determine if suitable habitat for wildlife may be present (and whether BMPs or other protective measures may be necessary; see Section 3.10) and provide a point of comparison as vegetation conditions change as a result of saltcedar removal and habitat enhancement. Baseline vegetation monitoring plots that are surveyed each year can be used to determine what was there before restoration, if saltcedar is resprouting, which secondary weeds may be establishing, and how habitat enhancement plantings perform. Similarly, a pre-project inventory of wildlife (*e.g.*, endangered species, other birds, reptiles, *etc.*) can be conducted at project sites to provide a baseline of what species are there before saltcedar removal and how wildlife responds to habitat enhancement. For projects undertaken as a part of this Plan, repeat monitoring to identify how developing vegetation conditions may influence or conflict with flood risk reduction objectives will also be necessary. The kind of evidence that can be established from repeat vegetation and wildlife monitoring may be critical to long-term funding and permitting, to demonstrate how projects implemented under the Plan are performing. If projects are not performing as anticipated in project permits or funding proposals, then repeat monitoring can help identify what changes to project specifications (*e.g.*, saltcedar removal methods, habitat enhancement planting species or methods, *etc.*) can be made to ensure they perform as desired. Installation of groundwater monitoring wells will also be an important component of baseline monitoring at some project sites, to determine depths to groundwater and what plant species will be able to persist at the site.

Ideally, monitoring should also be used to understand the reasons for project success or failure, so that projects can be adaptively managed and future projects can benefit for this improved understanding (Parker *et al.* 2005, Nissen *et al.* 2009). This may require as-built monitoring (to determine if a project was implemented as designed), shallow groundwater monitoring, flood inundation measurements, *etc.* and analysis that links such monitoring to planting survival. Adaptive management monitoring can also be used to, among other things: compare the effectiveness of treatment and revegetation methods to inform future restoration efforts; evaluate patterns of saltcedar defoliation and mortality following tamarisk beetle colonization; and determine how species are responding to habitat enhancement and/or tamarisk beetle colonization.

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Appendix A

Vegetation Management Units Maps

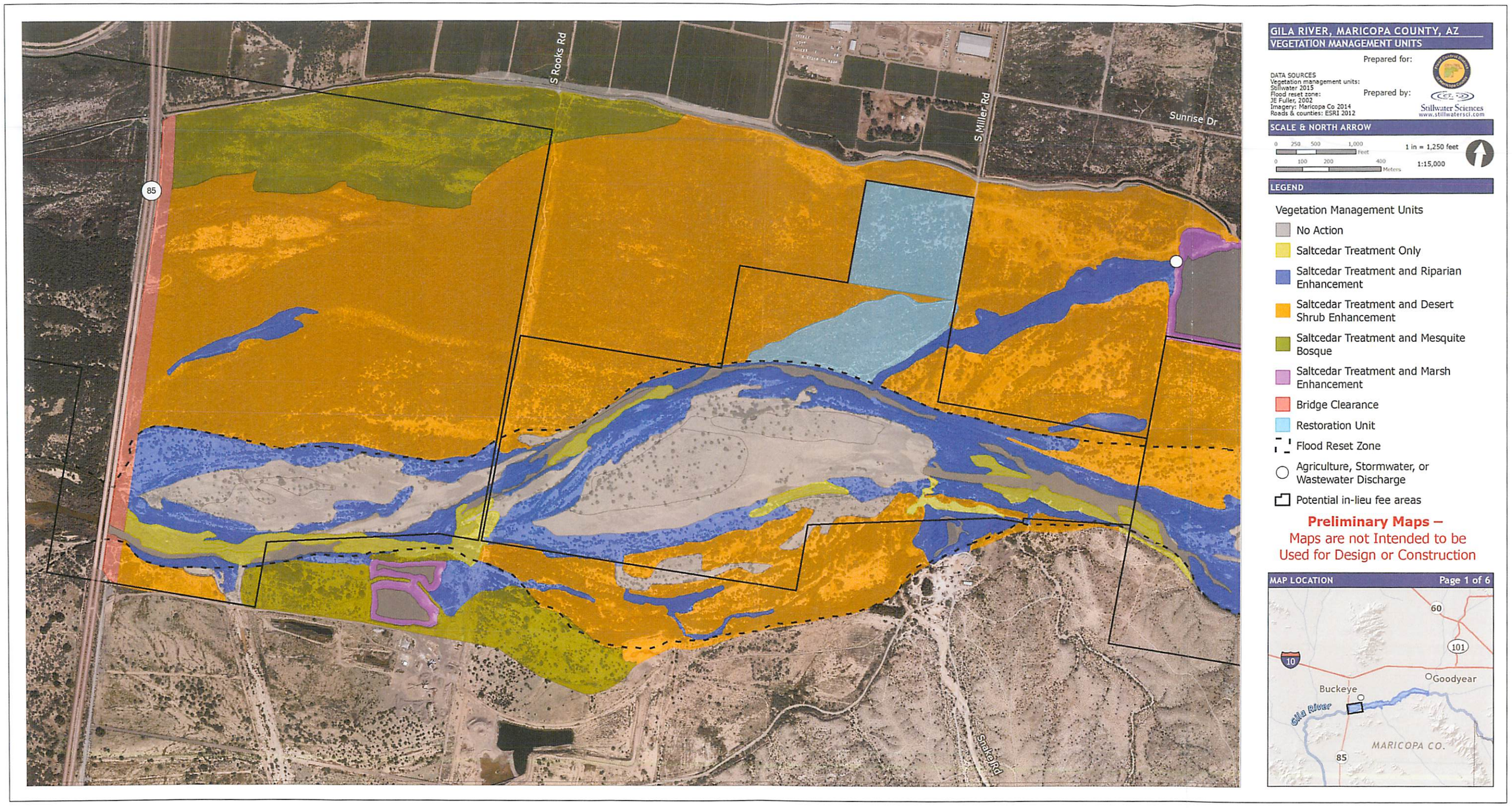


Figure A-1. Vegetation management units map (tile 1 of 6) of the planning area.

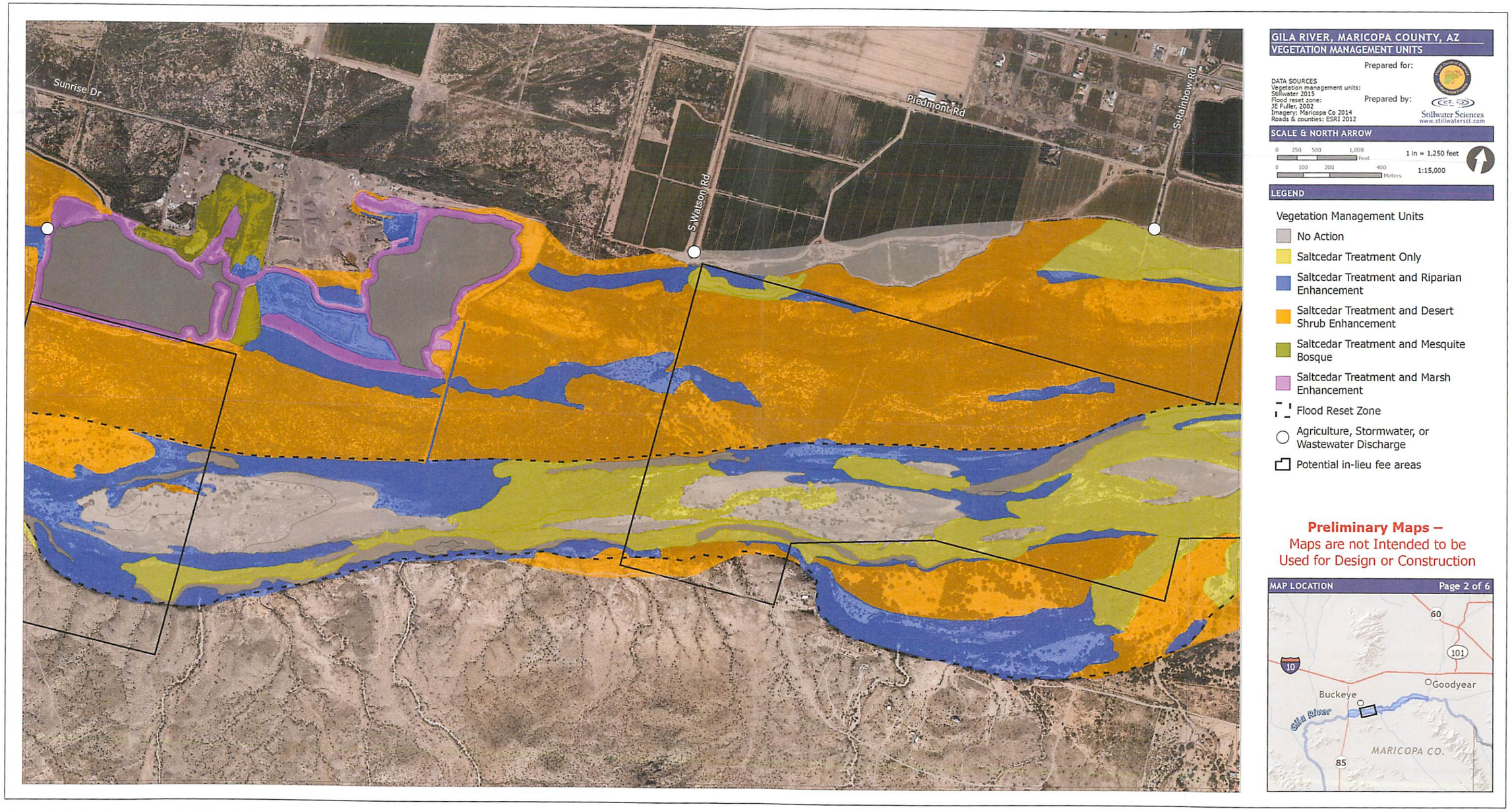


Figure A-2. Vegetation management units map (tile 2 of 6) of the planning area.

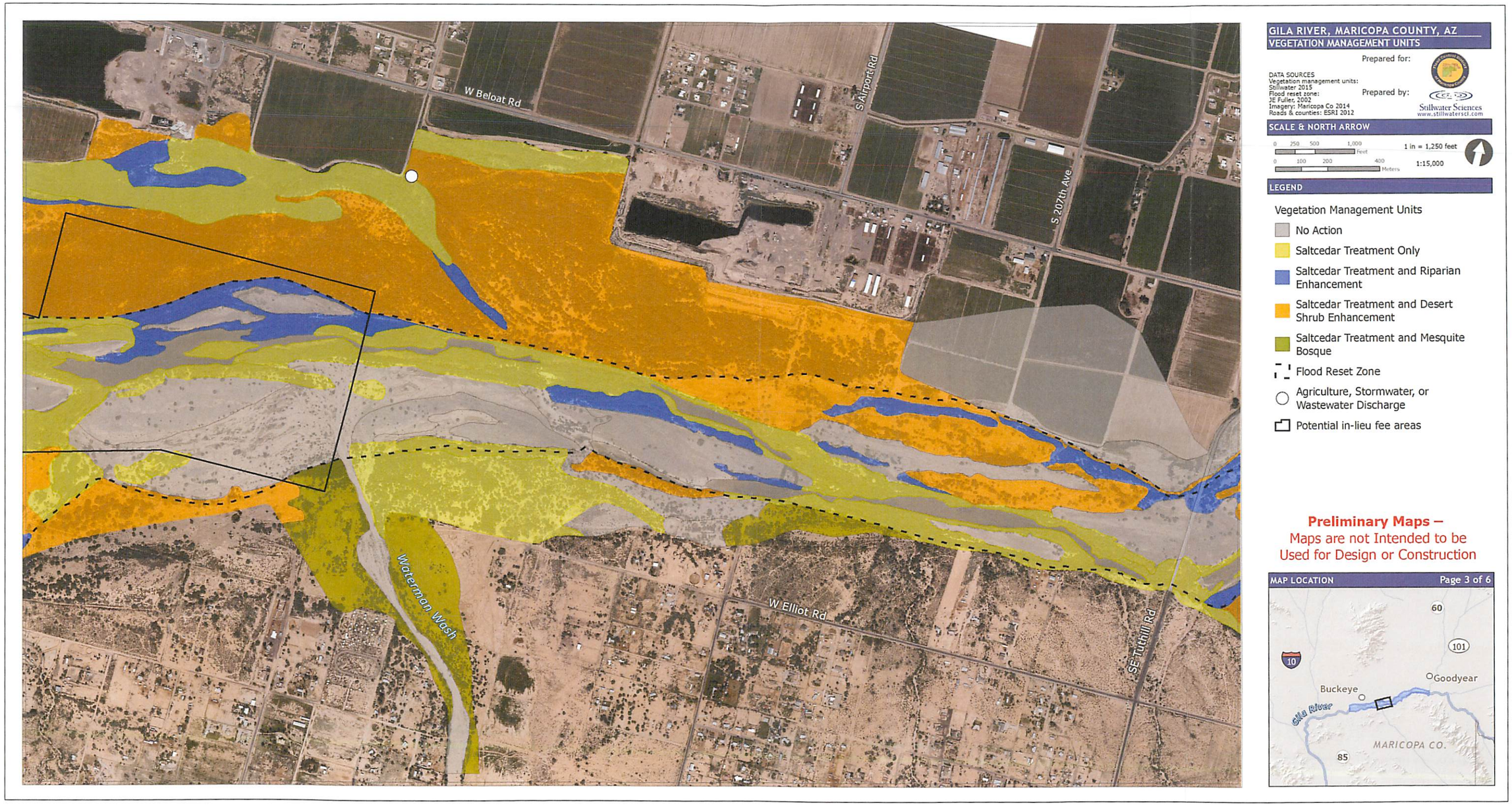
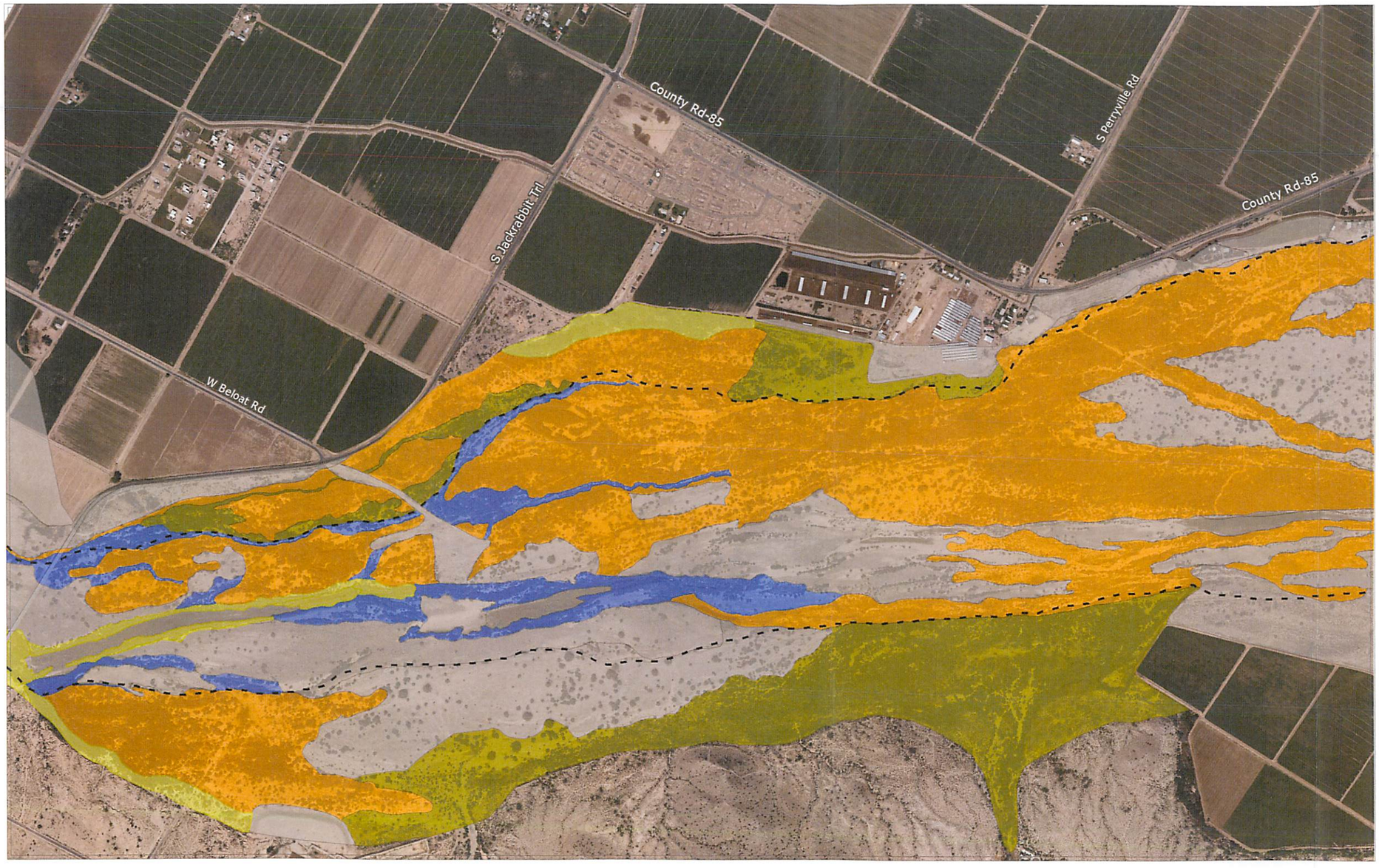


Figure A-3. Vegetation management units map (tile 3 of 6) of the planning area.



GILA RIVER, MARICOPA COUNTY, AZ
VEGETATION MANAGEMENT UNITS

Prepared for:

DATA SOURCES
Vegetation management units: Stillwater 2015
Flood reset zone: JE Fuller, 2002
Imagery: Maricopa Co 2014
Roads & counties: ESRI 2012

Prepared by:
Stillwater Sciences
www.stillwaterscl.com

SCALE & NORTH ARROW

0 250 500 1,000 Feet
0 100 200 400 Meters
1 in = 1,250 feet
1:15,000

LEGEND

Vegetation Management Units
- No Action
- Saltcedar Treatment Only
- Saltcedar Treatment and Riparian Enhancement
- Saltcedar Treatment and Desert Shrub Enhancement
- Saltcedar Treatment and Mesquite Bosque
- Flood Reset Zone

Preliminary Maps –
Maps are not Intended to be Used for Design or Construction

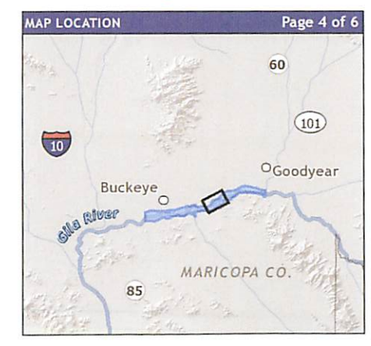


Figure A-4. Vegetation management units map (tile 4 of 6) of the planning area.

Figure A-5. Vegetation management units map (tile 5 of 6) of the planning area.

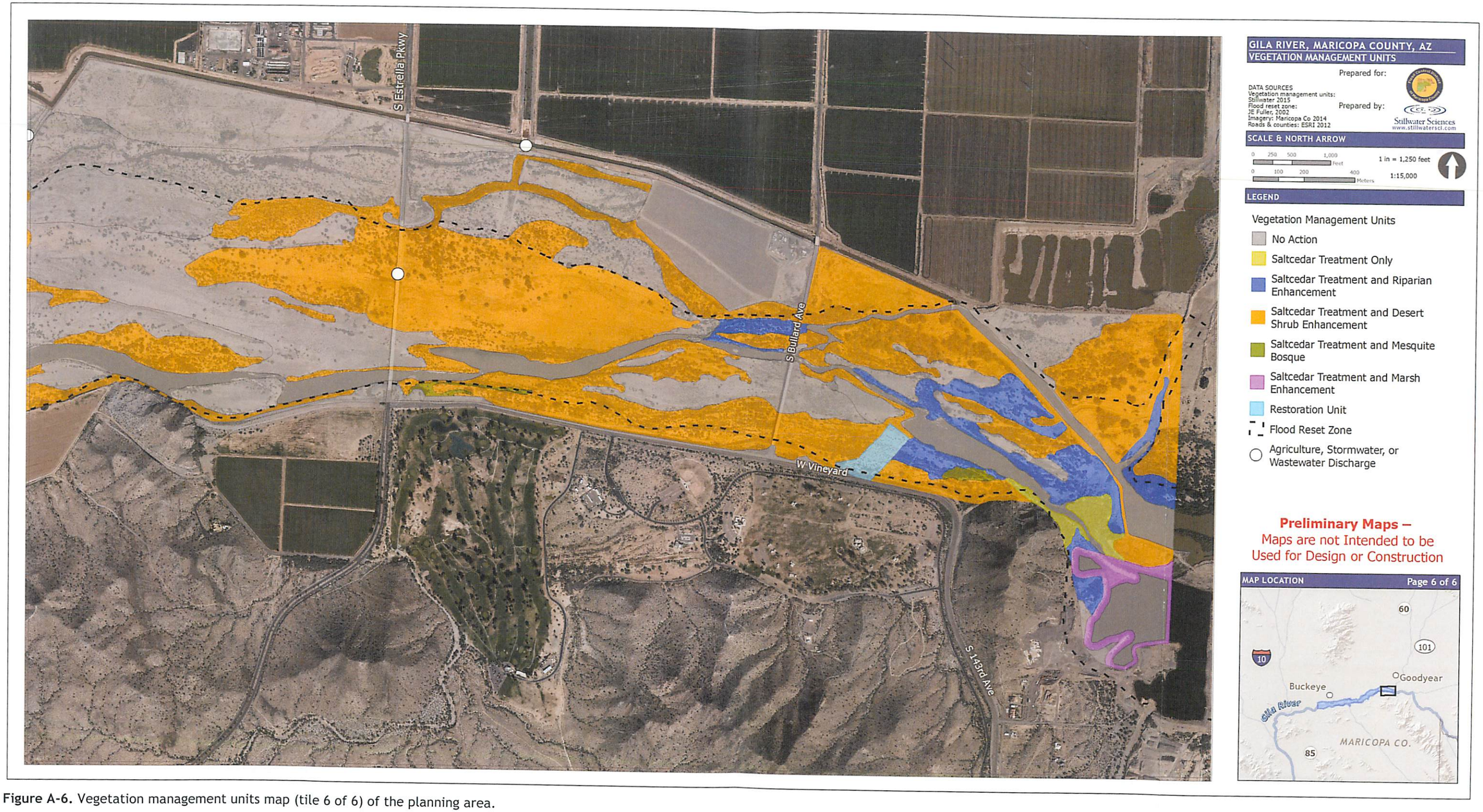


Figure A-6. Vegetation management units map (tile 6 of 6) of the planning area.

Appendix B

Vegetation Management Units under Altered Land Use Conditions Maps

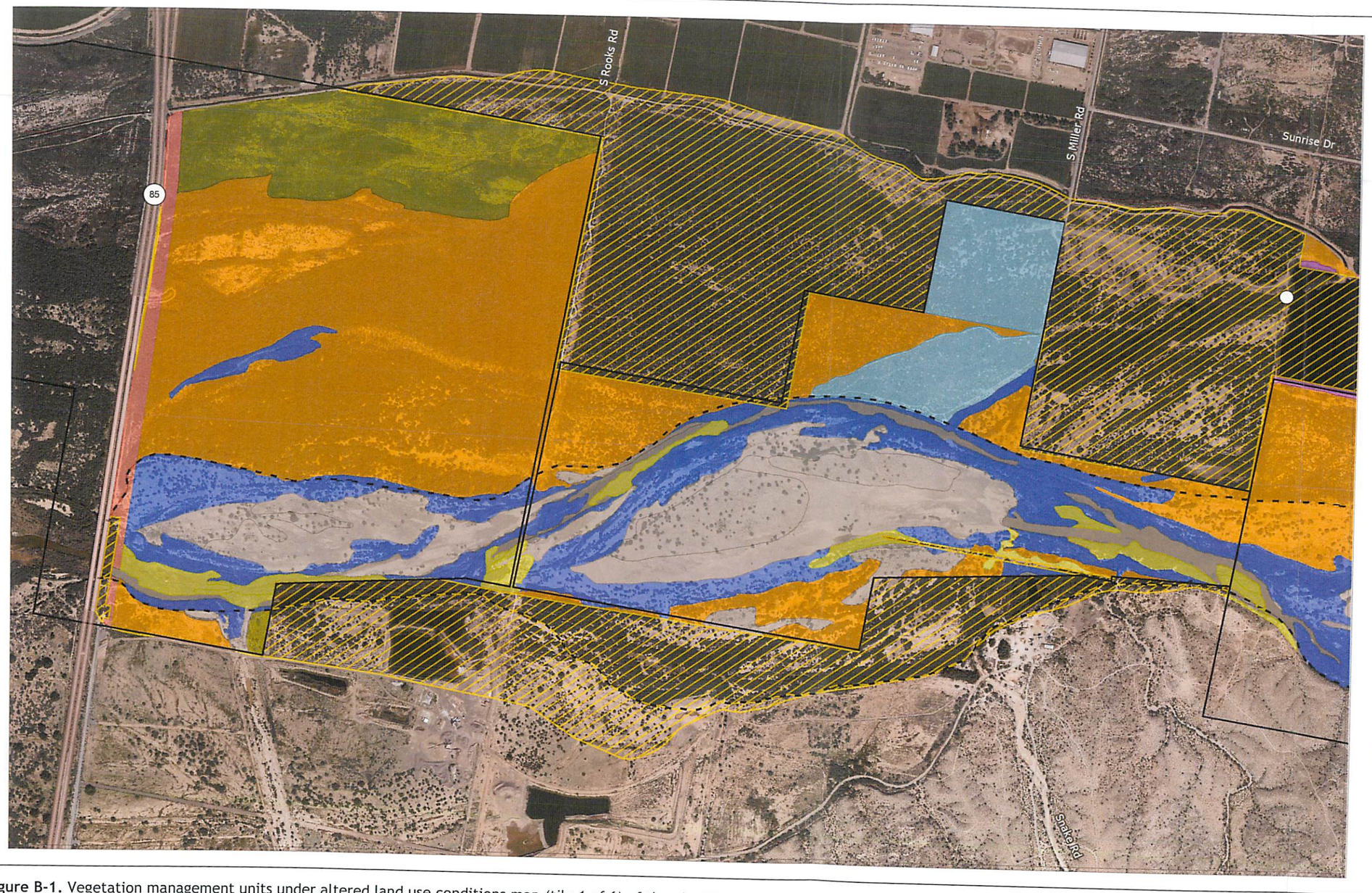


Figure B-1. Vegetation management units under altered land use conditions map (tile 1 of 6) of the planning area.

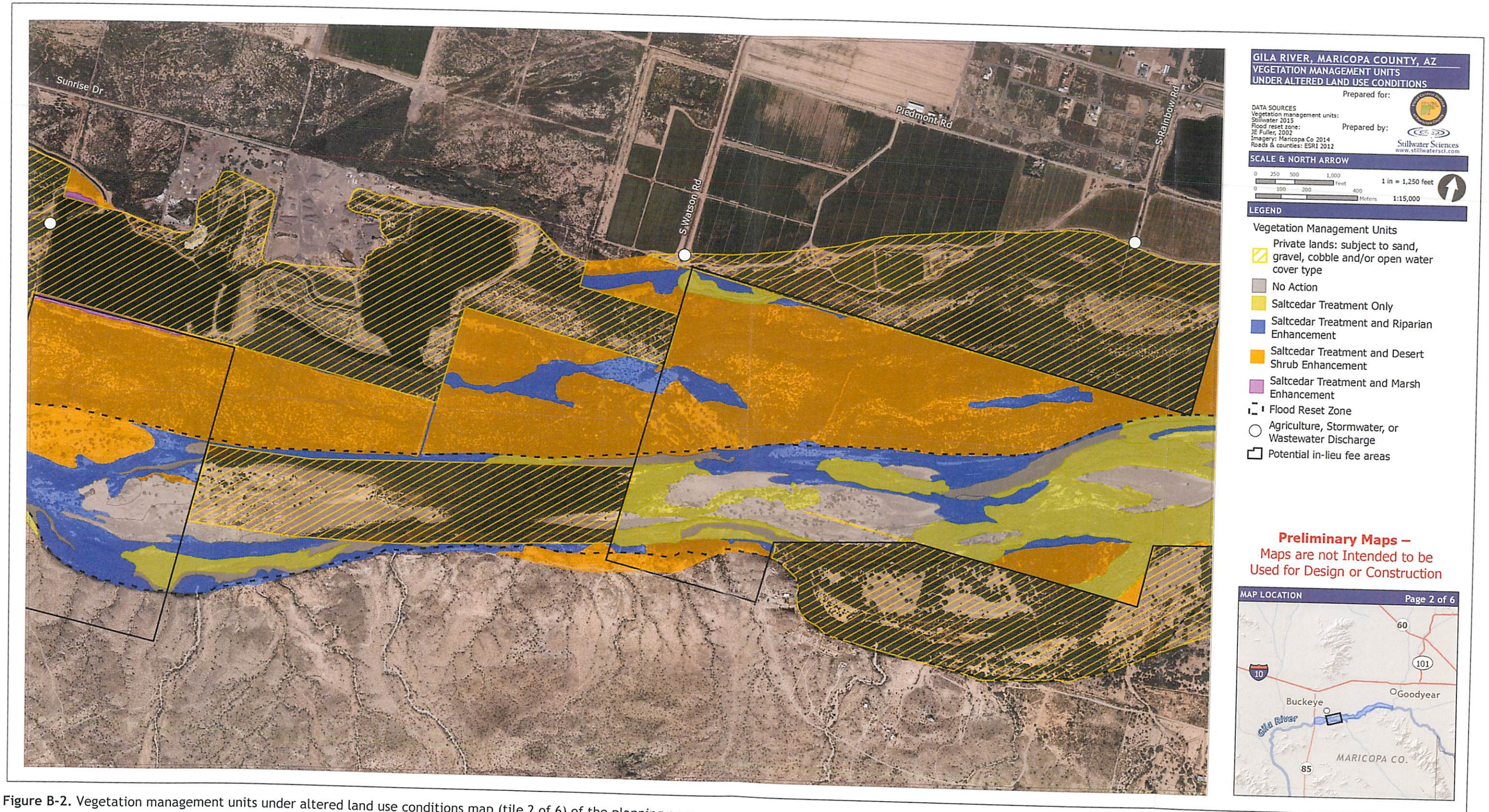


Figure B-2. Vegetation management units under altered land use conditions map (tile 2 of 6) of the planning area.

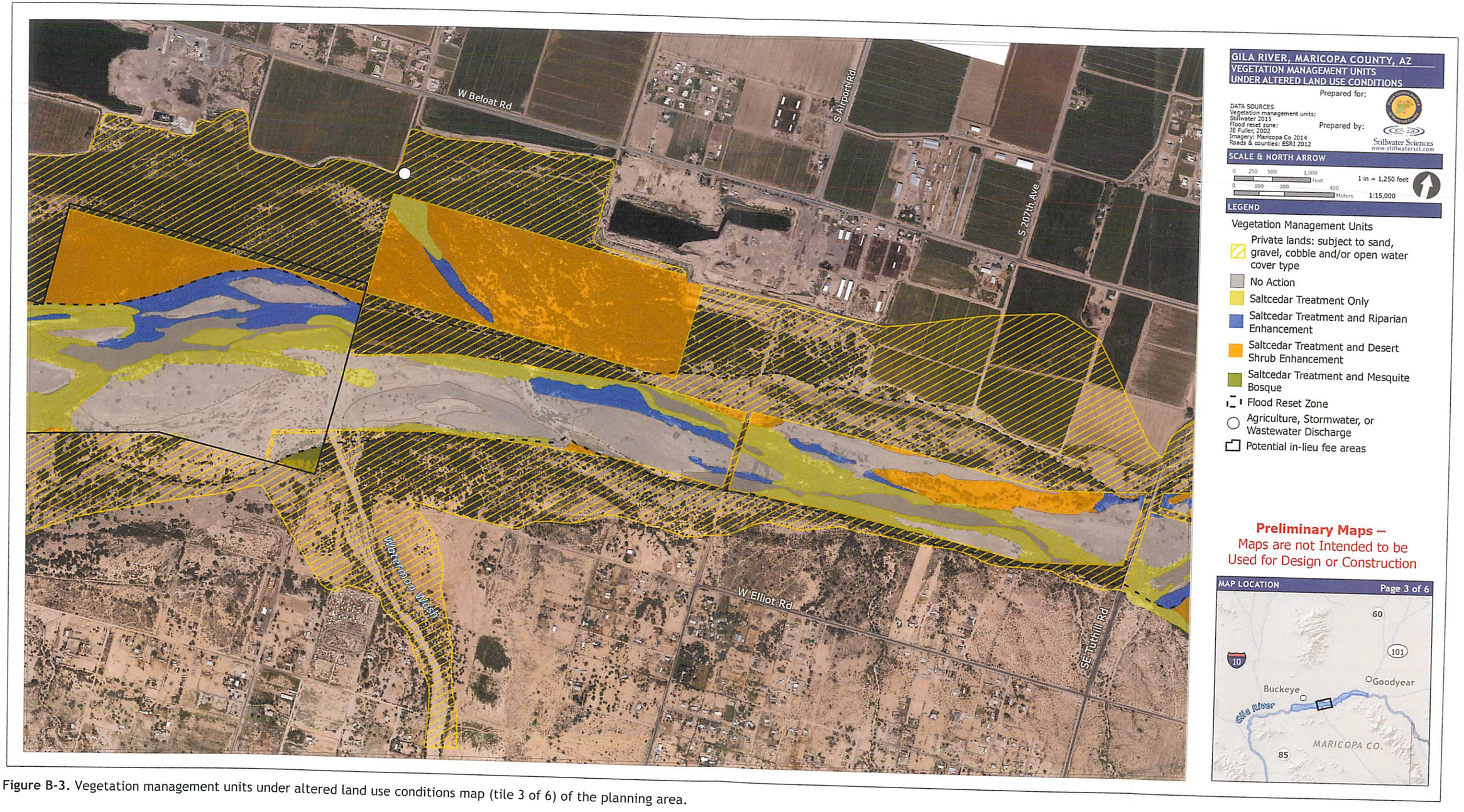


Figure B-3. Vegetation management units under altered land use conditions map (tile 3 of 6) of the planning area.

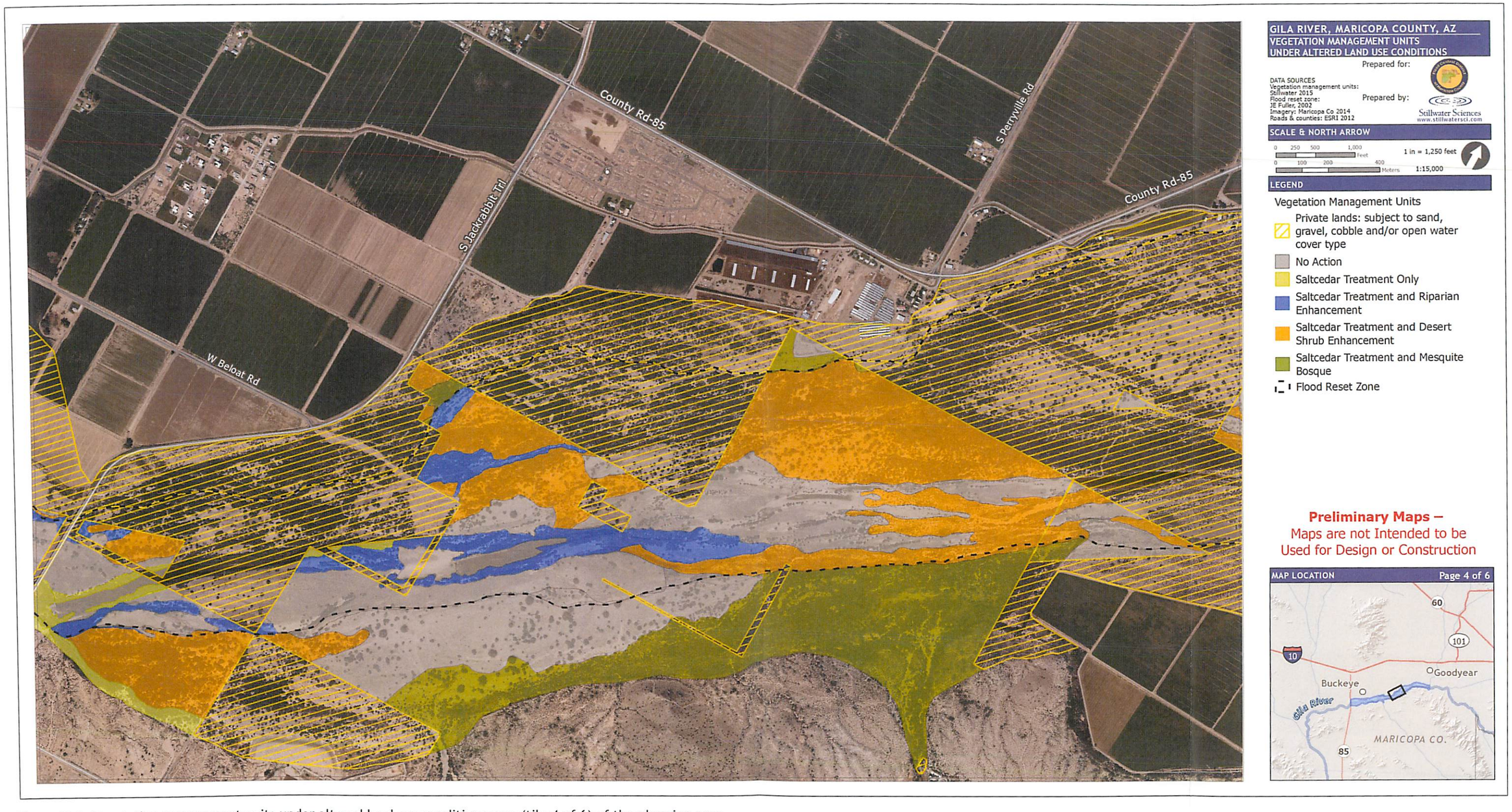
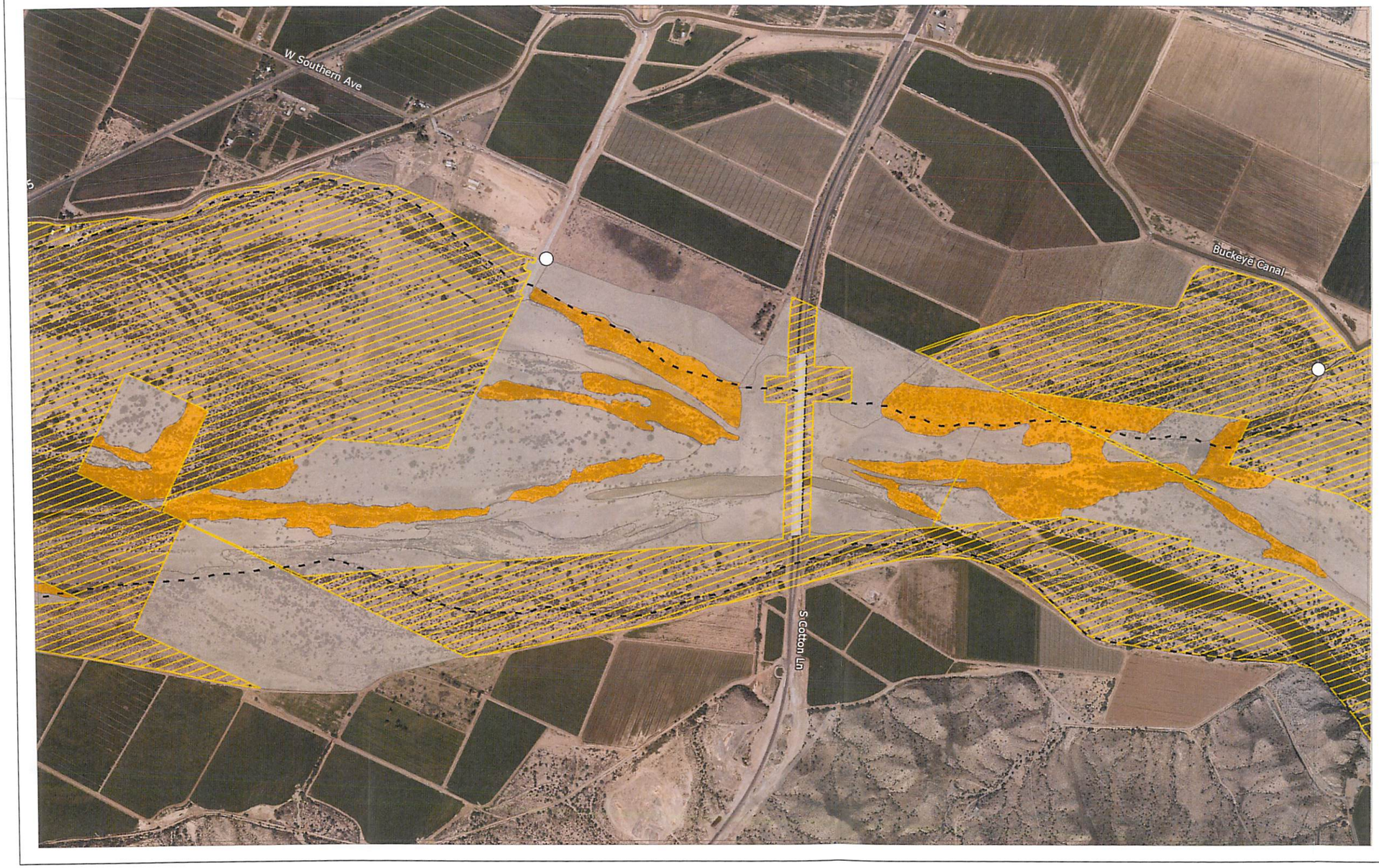


Figure B-4. Vegetation management units under altered land use conditions map (tile 4 of 6) of the planning area.



GILA RIVER, MARICOPA COUNTY, AZ
VEGETATION MANAGEMENT UNITS
UNDER ALTERED LAND USE CONDITIONS

Prepared for:

DATA SOURCES
Vegetation management units:
Stillwater 2015
Flood reset zone:
JE Fuller, 2002
Imagery: Maricopa Co 2014
Roads & counties: ESRI 2012

Prepared by:
Stillwater Sciences
www.stillwatersci.com

SCALE & NORTH ARROW

0 250 500 1,000 Feet
0 100 200 400 Meters
1 in = 1,250 feet
1:15,000

LEGEND

Vegetation Management Units
- Private lands: subject to sand, gravel, cobble and/or open water cover type
- No Action
- Saltcedar Treatment and Desert Shrub Enhancement
- Flood Reset Zone
- Agriculture, Stormwater, or Wastewater Discharge

Preliminary Maps –
Maps are not Intended to be Used for Design or Construction

MAP LOCATION Page 5 of 6

Figure B-5. Vegetation management units under altered land use conditions map (tile 5 of 6) of the planning area.

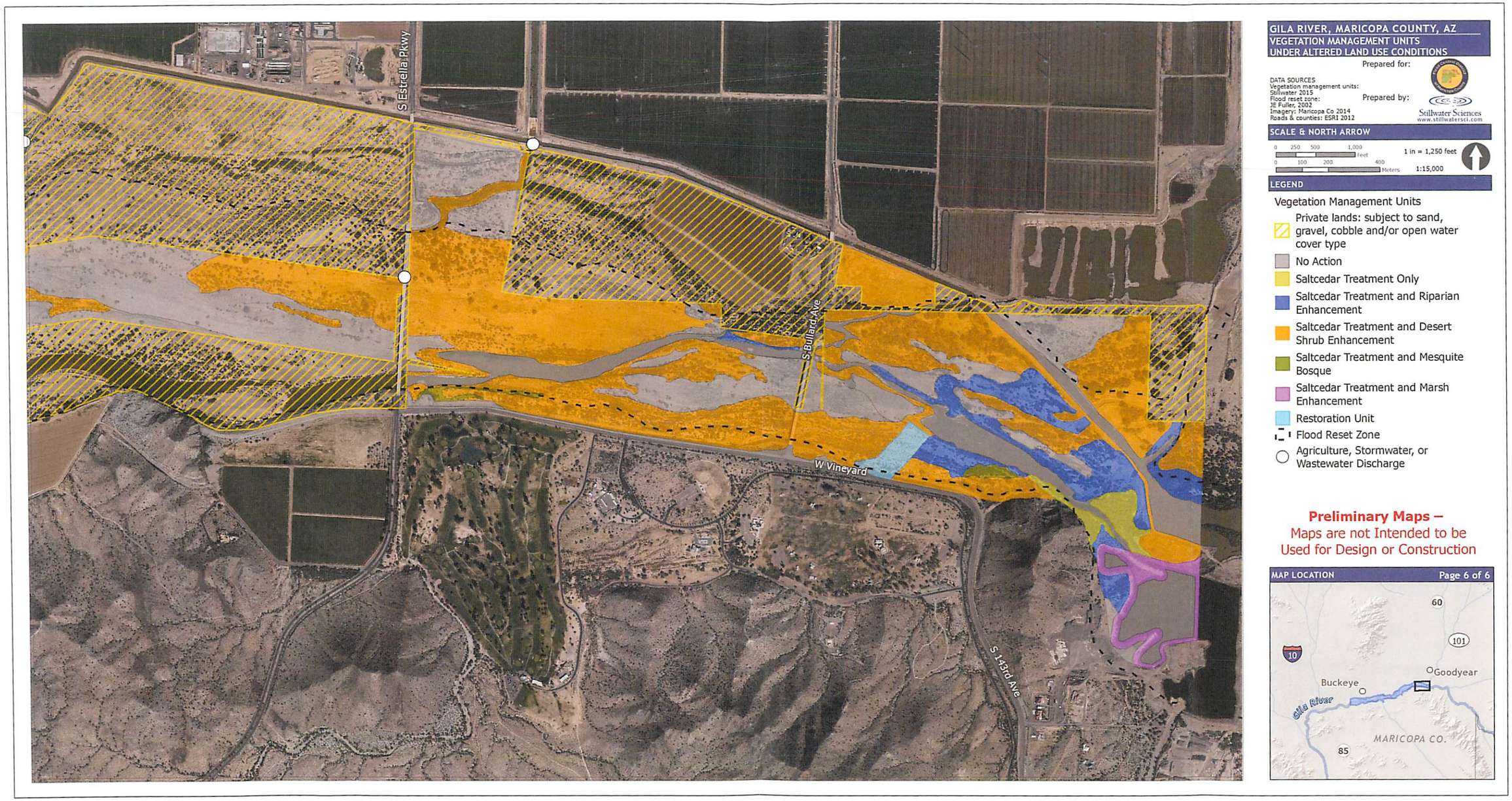


Figure B-6. Vegetation management units under altered land use conditions map (tile 6 of 6) of the planning area.

Appendix C

Permitting Requirements

1 INTRODUCTION

This appendix provides additional information about the potential permitting requirements of actions undertaken as a part of Plan implementation that are summarized in Section 3.6. As introduced in Section 3.6, the approach taken to comply with Section 404 of the Clean Water Act (CWA) will influence many aspects of the permitting process, including timing and level-of-effort. As such, options for Section 404 compliance are presented first.

It is important to note that informal and formal communications with the permitting and resource agencies—U.S. Army Corps of Engineers (USACE), U. S. Fish and Wildlife Service (USFWS), Arizona State Historic Preservation Office (SHPO), and Arizona Department of Environmental Quality (ADEQ)—and affected landowners will be critical to completing the permitting process in a timely manner. A pre-application meeting, in particular, held at either a potential project site or the lead agency's office, is an efficient way of making the agencies aware of the project, describing it to them, and soliciting and receiving agency input on the project before the project description is finalized and permit applications have been submitted. This is also the time when the permitting agencies specify the information that will be required and offer suggestions for measures that can be taken by the project proponent to avoid or minimize impacts and streamline the permitting process. The discussion points and outcomes of any such communications and meetings should be recorded and included as part of the permitting and project administrative record.

2 CLEAN WATER ACT SECTION 404

The objective of the CWA is to restore and maintain the integrity of the nation's waters, including wetlands. Section 404 of the CWA requires that project proponents receive a permit from the USACE to discharge dredged or fill materials into jurisdictional waters of the U.S., including wetlands. Permits can also be required for the operation of heavy machinery in jurisdictional waters and wetlands.

The lower Gila River is a jurisdictional water of the U.S., and removal of saltcedar using heavy machinery and any grading are activities subject to USACE jurisdiction. Based on the scope and objectives of the Plan, there are three primary options for Section 404 permitting. One option is that USACE establishes a Regional General Permit (RGP) that would cover removal of saltcedar and other nonnative, invasive plants across a geographic range that includes the planning area, such as Maricopa County, so long as permit terms and conditions are complied with. An RGP for saltcedar removal in the planning area does not currently exist, so it is not currently a viable permitting option, but the District is working to have one established. Current viable options for Section 404 permitting are that project proponents apply for an Individual or General Permit or apply for coverage under a Nationwide Permit (NWP; the most applicable is NWP #27, for habitat restoration).

Given the benefits and disadvantages of Section 404 permitting options (which are discussed below), it is likely that a combination of these options will be needed: (1) the RGP process can be initiated as soon as possible to streamline permitting of Plan activities in the future, but (2) Individual Permits or NWP coverage can be used to permit projects that are ready for implementation prior to RGP authorization. If a project undertaken as a part of Plan implementation is ultimately determined to be outside of USACE's jurisdiction (e.g., all actions

would occur outside of waters of the U.S., including wetlands) then a Section 404 permit would not be required.

2.1 Individual Permit

Individual Permits generally require the following steps and processes:

- An individual project proponent submits an application for a USACE permit (USACE ENG Form 4345), detailed project description (see Section 2.4 below for more detail), delineation of USACE jurisdiction (see Section 2.5), a project-specific Biological Assessment for USFWS consultation (see Section 3), and a project-specific cultural resources report for SHPO consultation (see Section 5).
- Any comments received on the application materials are addressed by the project proponent.
- Once the application materials are considered complete, USACE issues a 15-day public notice and, optionally, holds a public hearing. Comments received during this period are addressed by the project proponent.
- USACE consults with USFWS and SHPO, and Section 401 water quality certification is obtained from ADEQ. (These regulations and requirements are discussed in greater detail in the sections below.)
- A National Environmental Policy Action (NEPA) compliance document (see Section 4) and a more detailed analysis of alternatives referred to as 404(b)(1) guidelines are prepared (to facilitate timely processing of the permit application, project proponents often prepare these materials on behalf of USACE). A mitigation and monitoring plan may also be required if there may be permanent impacts to waters and wetlands. The NEPA document and consequent findings also require public review periods.

The primary drawback of using Individual Permits for Plan activities is the amount of time necessary to prepare all the required materials and conduct public reviews. The primary benefit is that Individual Permits can cover longer time periods than other Section 404 permitting options. Figure B-1 provides an estimated schedule for acquiring an Individual Permit, although this could be much shorter if there are no listed species or cultural resources issues.

Costs to prepare Individual Permit applications (there is no permit fee) can range widely, depending on the size and potential impacts of a project. For projects implemented under the Plan, the cost to prepare and process an Individual Permit application (not including other required permitting) is roughly estimated to range from $5,000–$20,000.

Figure B-1. Potential timeline for preparing and acquiring an Individual Permit

	MONTH	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Project Description*		D				F																			
Pre-Application Meeting(s)																									
CWA Section 404	Permit application					D						F													
	USACE review																								
	Public review (30 days)																								
	Permit granted																							X	
ESA Section 7*	Surveys																								
	Biological Assessment			D								F													
	USACE review																								
	USFWS consultation																								
	Biological Opinion																					X			
NEPA	Environmental Assessment			AD							D			F											
	USACE review																								
	Public review (30 days)																								
	Record of Decision (30 days from F)															X									
NHPA Section 106	Cultural resource survey and report			AD					D							F									
	USACE review																								
	SHPO consultation																	X							
CWA Section 401	401 Certification application																								
	ADEQ review															X									
	Public review (30 days)																								
Const. General Permit	NOI												D		F										
	SWPPP												D		F										
	ADEQ review (30 days)															X									
Fldpln Use Permit	Application and checklist												D		F										
	District review															X									

Legend:

*	Critical path item	AD	Administrative draft document preparation
	Project proponent activity	D	Draft document preparation
	Permitting agency activity	F	Final document preparation and submittal
	Public review period	X	Agency decision/permit granted

2.2 Regional General Permit

RGPs are issued on a regional basis and can cover a suite of activities or project types under a relatively large geographic area. For example, USACE has an RGP for nonnative invasive vegetation removal in their southern California region. RGPs may only be issued following the publishing of a public notice, and preparation of a decision document to ensure that the activities authorized under the RGP cause only minimal individual and cumulative environmental impacts. RGPs typically contain conditions to further ensure that environmental impacts are minimal during the implementation of activities that are covered by the RGP, including conditions for the submittal of a permit application prior to activities occurring within waters of the U.S.

Permitting under an RGP would require that the USACE Los Angeles District, Phoenix office first authorize an RGP that covers Plan activities and the planning area (at a minimum). This process would likely include the following steps and processes:

- Developing a detailed description of the activities and geographic area to be covered under the RGP.
- Consultations with USFWS, SHPO, and ADEQ under the Endangered Species Act (ESA), Migratory Bird Treaty Act (MBTA), National Historic Preservation Act (NHPA), and Section 401 of the CWA to determine appropriate terms and conditions for the RGP to ensure that projects implemented under the RGP will be in compliance with these laws.
- A public interest review that includes preparation of an appropriate NEPA document and circulation of the document for public review (see Section 4 below).
- Once the final NEPA document is adopted and a Record of Decision issued, USACE would authorize the RGP.

All told, it may take two years for an RGP to be authorized. Like all other Section 404 permits, RGPs are typically valid for five years, so USACE would need to reauthorize the RGP every five years. Reauthorization of RGPs is typically much more streamlined than the initial application process.

Once the RGP is in place, the District or another project proponent (e.g., the City of Buckeye) planning to implement a project under the Plan and that is covered by the RGP, would submit a concise letter to USACE describing the basic elements of the project and ways in which the project is authorized by and complies with the terms and conditions of the RGP, as well as a delineation of USACE jurisdiction (see Section 2.5 below), a project-specific Biological Assessment for USFWS consultation (see Section 3 below), a project-specific cultural resources report for SHPO consultation (see Section 5 below), and Section 401 certification from ADEQ (see Section 6 below). The District is currently working to produce planning-area wide resources to assist individual project proponents with these aspects of permitting, including suitable habitat modeling for endangered species to determine where surveys may or may not be necessary.

The primary drawback of an RGP is the initial time—upwards of two years (not unlike the schedule for an Individual Permit in Figure B-1)—that is necessary for it to be authorized. The primary benefit, however, is that the initial effort should greatly streamline permitting of

individual actions/projects that are covered by the RGP, no matter who the project proponent is. The timeline for permitting a project under the RGP is likely to be similar to that under a NWP (see Section 2.3 below). The cost to permit an individual project under an RGP (not including other required permitting) is roughly estimated to range from $3,000–$8,000.

2.3 Nationwide Permit

NWPs are a more streamlined option for Section 404 compliance, without the need for a NEPA compliance document, 404(b)(1) analysis, or a public review period. Activities under the Plan that include habitat enhancement are likely to qualify for a NWP #27 for Aquatic Habitat Enhancement. Permitting of individual projects under the Plan and under a NWP would include the following steps and processes:

- An individual project proponent would submit a Pre-Construction Notification (PCN) application (USACE ENG Form 4345), detailed project description (see Section 2.4 below for more detail), delineation of USACE jurisdiction (see Section 2.5 below), a project-specific Biological Assessment for USFWS consultation (see Section 3 below), a project-specific cultural resources report for SHPO consultation (see Section 5 below), and Section 401 certification from ADEQ (see Section 6 below).
- Any comments received on the application materials would need to be addressed by the project proponent.
- USACE would consult with USFWS and SHPO, and Section 401 water quality certification would be required from ADEQ. (These regulations and requirements are discussed in greater detail in the sections below.)
- Once confirmation of compliance with all other relevant laws is received by USACE, they would verify coverage under the NWP and on-the-ground work could begin, subject to the permit terms and conditions. NWPs can be authorized for up to five years. If the project is not completed before the NWP expires, then reauthorization under the NWP would be necessary.

The primary drawback of using NWPs for Plan activities is that only particular project types are covered. While projects that include habitat enhancement as a goal can be covered under NWP #27, there are not currently NWPs available that would cover activities without a habitat enhancement component, such as removal of saltcedar without subsequent revegetation. The primary benefit, however, is that authorization under NWPs typically requires less than one year (see Figure B-2), and may only take a few months if there are no listed species or cultural resources issues. During implementation, individual projects would need to comply with the terms and conditions of the NWP and any other project permits. The cost to permit an individual project under an NWP (not including other required permitting) is roughly estimated to range from $3,000–$8,000.

Figure B-2. Potential timeline for preparing and acquiring a NWP or coverage under an RGP

	MONTH	1	2	3	4	5	6	7	8	9	10
Project Description*		D	F								
Pre-Application Meeting(s)											
CWA Section 404	Water and wetland delineation	D	F								
	Prelim. Jurisdictional Determination		X								
	NWP application			D		F					
	USACE review (15 days)										
	Permit granted										X
ESA Section 7*	Surveys										
	Biological Assessment	D			F						
	USACE review			R							
	USFWS consultation (90 days)										
	Biological Opinion (45 days)									X	
NHPA Section 106	Cultural resource survey and report	AD			D		F				
	USACE review										
	SHPO consultation (30 days)						X				
CWA Section 401	401 Certification application										
	ADEQ review						X				
Const. General Permit	NOI			D			F				
	SWPPP			D			F				
Fldpln Use Permi	Application and checklist			D			F				
	District review							X			

Legend:

*	Critical path item	AD	Administrative draft document preparation
	Project proponent activity	D	Draft document preparation
	Permitting agency activity	F	Final document preparation and submittal
X	Agency decision/permit granted		

2.4 Project description

A written description of the project to be implemented, accompanied by maps and drawings, is required for Section 404 permitting and key to nearly every other regulatory process. The project description must be well-articulated in sufficient detail before an assessment of potential project-related effects and completion of permit applications can be produced. The schedules in Figures B-1 and B-2 assume that 10–30%-level engineering designs, or equivalent project details if engineering designs are not needed, are available at Month 0. These would be translated to a draft project description with associated graphics in Months 1 and 2. Site-specific assessments and consequent project designs will be needed to develop the necessary level of detail for the project description. The project description would then be revised or refined in response to input from the permitting agencies. The schedules in Figures B-1 and B-2 assume that the project description would not change materially during the course of the permitting phase or after permits have been acquired. Such changes generally result in significant schedule delays if they require re-analysis of potential impacts and re-submittal of materials to the permitting agencies, or re-starting permit review phases.

The following information must be provided in the project description that accompanies a 404 permit application. As a general rule, project descriptions submitted to various permitting agencies should be consistent with one another, if not exactly the same.

- Complete written description of activity
- Location
- Scheduling of the activity
- Type and quantity of structural materials used or removed
- Purpose of proposed activity
- Need for the proposed activity
- Maps and drawings (there are USACE standards for those that accompany the 404 permit and ADEQ standards for those that accompany the 401 Certification application)
- Photographs of the project site (aerials if available)
- Type of material to be dredged or used as fill
- Composition of material to be dredged or used as fill
- Quantity of material to be dredged or used as fill in cubic yards
- Method of dredging, if applicable
- Plans and location for disposal of the dredged material
- Dimensions of the fill area in square yards
- Location of the discharge site
- Source of the fill material
- Method of discharging material
- Method of transportation of dredged material
- Dimensions of the adjacent structures
- Proposed use of fill area, including specific structures to be erected on fill area or platform

The cost to develop a sufficiently detailed project description is roughly estimated to range from $2,000–$8,000.

2.5 Water and wetland delineation

A water and wetland delineation must be prepared to determine the extent of USACE jurisdiction in a project area, potential impacts to jurisdictional waters and wetlands, and any necessary mitigation. Under any Section 404 permitting option, it is assumed that water and wetland delineations submitted to USACE would be project-site-specific. In other words, the delineation would only cover the property or portion of a property where project access, staging, saltcedar removal, and habitat enhancement would occur. Alternatively, a delineation of the entire planning area could be submitted as a part of an RGP, which could further streamline individual project authorization since project-specific delineations would not theoretically be required. This approach, however, has the potential to conflict with project-specific delineations that may be submitted for other projects in the planning area, such as for gravel mining operations.

The following information must be provided to receive a preliminary jurisdictional determination (PJD) from USACE, complete 404 permitting, and accompany the 401 certification application:

- Delineation of waters of the U.S., including wetlands, in accordance with USACE protocols, guidance, and minimum standards. The delineation should include the full extent of any project activities, including temporary access routes and staging areas, plus a reasonable buffer around those activities (e.g., 100 feet); together these are referred to as the "review area." Delineation of the ordinary high water mark (OHWM) of the Gila River, as well as wetland boundaries, would need to be included.
- Delineation and description of any special aquatic sites within the review area. Special aquatic sites relevant to the El Rio planning area include refuges, wetlands, and stream riffle and pool complexes.
- Functional/condition assessment of wetlands within the review area. Such an assessment is not always required, but it is likely to be if wetlands would be impacted, since the assessment informs the kind of mitigation and mitigation ratios that would be required.

The cost to delineate waters of the U.S. at the site scale and acquire a PJD from USACE is roughly estimated to range from $3,000–$8,000.

3 ENDANGERED SPECIES ACT

The objective of the ESA is to protect critically imperiled species from extinction. If a project, regardless of who is undertaking it, has the potential to directly or indirectly affect a species listed under the ESA or its designated critical habitat, then the project must comply with the ESA. Required compliance activities are dependent on many factors and may range from avoiding habitat for an ESA-listed species, working outside of certain time periods, consulting informally with USFWS, to acquiring an incidental take permit. The involvement, or not, of a federal agency in a project triggers different sections of the ESA, which have very different ESA compliance requirements. If a federal agency is funding or authorizing a project, by allowing a project to occur on federal property or issuing a federal permit for a project, compliance with the ESA occurs via Section 7. Section 7 of the ESA requires federal agencies to consult with USFWS if any project that they are authorizing, funding, or carrying out occurs in the habitat of a species listed under the ESA, and provides a relatively streamlined process for ESA compliance. It is anticipated that nearly every project implemented under the Plan would have some sort of federal nexus, either as a result of receiving federal funds, requiring a federal permit, or occurring on federal property. As a result, the discussion below focuses on Section 7 requirements and processes.

If individual projects under the Plan do not have a federal nexus and could affect listed species or their habitat, compliance with the ESA would need to occur via Section 10. Section 10 requires the preparation and implementation of a Habitat Conservation Plan that describes how the project will be implemented to limit and/or mitigate impacts to species listed under the ESA, and can take far longer and much more effort, depending on the size and complexity of the project, than the Section 7 process. Vegetation management in areas that would require ESA compliance via Section 10 should not be undertaken, in order to protect the ESA-listed species that could be affected and avoid the lengthy and complex Section 10 process.

Independent of both Section 7 and Section 10, project proponents and federal lead agencies can consult informally with USFWS to discuss the project, develop protection measures that will

avoid impacts to listed species and their habitat, and/or determine whether ESA compliance activities are necessary and, if so, the most efficient process for completing them.

3.1 Biological Assessment

Due to the documented occurrences of federally listed species in and around the planning area, consultation with USFWS may be necessary for projects implemented under the Plan, and a Biological Assessment (BA) would be prepared to inform the USACE's (who would be issuing a Section 404 permit) Section 7 consultation process.

The following information is typically required in a BA:

- Summary of species and critical habitat that have potential to occur in the project area and be affected by project activities
- Description of any consultation with USFWS to-date
- Description of the project, including location, timing, construction activities, and conservation measures (see Section 2.4 above)
- Description of the status of the listed species and/or critical habitat in the project area, including the results of any focused surveys for the species
- Description of baseline conditions in the project area
- Analysis of the potential effects of the project on listed species and/or critical habitat, including potential cumulative effects of the project, given the overarching Plan

Under the Section 404 permitting options, the BA would be prepared for the project area by the project proponent, submitted to the USACE for review with the other permit application materials, and then USACE would distribute the BA to USFWS to initiate formal Section 7 consultation for the project. If the BA determines and USFWS concurs that "take" of listed species or their habitat may result from the project, then USFWS would issue a Biological Opinion (BO) that authorizes some level of incidental take of listed species or their critical habitat (incidental to an otherwise lawful activity). The definition of "take" can vary somewhat, but typically refers to the pursuit, injury, killing, or harassment of a wild animal, and can include modification and destruction of the species' habitat. BOs for individual projects will likely include numerous conditions to limit the take of listed species, such as pre-construction surveys, construction monitoring, and mitigation for permanent impacts to listed species habitat, if necessary. These can increase implementation costs significantly. Generally USFWS has 90 days to perform their consultation and 45 days to prepare the BO, but this timeframe would be much longer for a BO that covers the entire Plan, since review and analysis would be more complex. If the BA determines and USFWS concurs that take will not occur, then a BO authorizing take is not necessary and the USFWS will generally provide a letter of concurrence instead.

The cost to prepare a BA and acquire a BO from USFWS for an individual project is roughly estimated to range from $15,000–$30,000.

4 NATIONAL ENVIRONMENTAL POLICY ACT

NEPA establishes policy and goals for the protection, maintenance, and enhancement of the environment. Under NEPA, federal agencies, such as USACE and USFWS, are required to analyze the potential effects of their actions, including permitting and funding, on the environment. This analysis is done via an Environmental Assessment (EA), if significant effects are not anticipated, or an Environmental Impact Statement (EIS). It is anticipated than an EA would be the appropriate document for NEPA compliance for most projects implemented under the Plan. If an EIS was determined to be appropriate, then most aspects of NEPA compliance would be more complex and take more time than the EA process described below. The terms and conditions of RGPs and NWPs are such that no significant impacts on the environment should occur. As a result, NEPA compliance is typically embedded in a RGP or NWP and no NEPA document needs to be prepared.

4.1 Environmental Assessment

The EA would likely be prepared by the project proponent on behalf of the federal lead agency for NEPA, which for projects under the Plan would likely be USACE (since they would be issuing a Section 404 permit)[1]. The following information is typically required to prepare and process an EA for which USACE is the lead agency (33 CFR 325, 40 CFR 1502):

- Prepare the Draft EA, to include:
  - Purpose and need of the project
  - Alternatives analysis that is thorough enough to be used for both the USACE public interest review and 404(b)(1) guidelines
  - Affected environment: a succinct description of the environment of the area(s) to be affected or created by the alternatives under consideration
  - Environmental consequences: an analysis of potential environmental impacts of the alternatives, including the proposed action, any adverse environmental effects which cannot be avoided, the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity, and any irreversible or irretrievable commitments of resources
- Publish Notice of Intent to adopt the EA
- Circulate (generally for 15 to 30 days) and receive comments on the Draft EA
- File Draft EA with the U.S. Environmental Protection Agency
- Prepare, circulate, and file Final EA
- Adopt Final EA and prepare Record of Decision

The Migratory Bird Treaty Act (MBTA) makes it unlawful to take or kill individuals of over 1,000 species of migratory bird found in the United States (50 CFR 10.13). The MBTA sets

[1] Other potential lead agencies could be U.S. Bureau of Land Management or USFWS, if Plan activities are being conducted on their lands or with their funding.

seasons and bag limits for hunted species and protects migratory birds, their occupied nests, and their eggs (16 USC 703, 50 CFR 21, 50 CFR 10). In accordance with the MBTA, potential impacts of projects to migratory birds should be assessed as part of a project EA. If no EA is required, then potential impacts under the MBTA can be assessed as part of a project BA. In Arizona, most bird species are protected under the MBTA.

Although bald eagles were removed from the federal list of threatened and endangered species on August 9, 2007, and are no longer protected under the ESA, they remain protected under the Bald and Golden Eagle Protection Act (16 USC 668) enacted in 1940. The Bald and Golden Eagle Protection Act prohibits anyone without a permit issued by the Secretary of the Interior from taking, possessing, or transporting eagles, including their parts, nests, or eggs. An assessment to determine whether a project has the potential to non-purposefully take eagles is generally conducted as part of a project EA, but can be included in a project BA if no EA is required. Based on the assessment, the need for a take permit for eagles is evaluated.

The cost to prepare and process an EA for an individual project is roughly estimated to range from $30,000–$50,000.

5 NATIONAL HISTORIC PRESERVATION ACT

Similar to Section 7 of the ESA, Section 106 of the NHPA requires federal agencies to consult with SHPO if any project that they are authorizing, funding, or carrying out may affect historic, cultural, and/or archaeological resources. Consultation with SHPO, which is initiated by USACE as a part of the Section 404 permitting process, typically requires:

- A search of the Arizona State Museum online database (AZSITE) for previously recorded archaeological sites with the project review area
- A cultural resource survey of the project review area to identify any historic, cultural, and archaeological sites that may be present and evaluate the potential for adverse effects of the project on any previously recorded or surveyed sites.
- Submittal of the resulting cultural resources report, meeting SHPO (2012) standards, to SHPO for a 30-day review period.

As with ESA consultation, SHPO consultation can result in numerous conditions to limit risks to cultural resources. Due to the density of saltcedar in much of the planning area, pedestrian surveys of many project areas may not be possible and, as a result, an on-site cultural monitor may be required during ground disturbing activities. This can increase implementation costs significantly. The cost to conduct the cultural resource surveys and prepare a report for an individual project is roughly estimated to range from $5,000–$8,000.

6 CLEAN WATER ACT SECTION 401

When a Section 404 permit is required and there is potential for Plan activities, such as removal of saltcedar using heavy equipment, to affect surface water quality, 401 Certification for CWA Section 401 compliance would be necessary. Section 401 of the CWA requires project proponents

to "certify" that any discharge subject to Section 404 will comply with Arizona water quality standards. Certifications can also require mitigation and sediment testing and/or monitoring during and after construction. The following information is required for the 401 certification application:

- Application form
- Project description
- A topographic or contour map of the project area
- Plans or drawings to illustrate the project
- A map delineating the OHWM of jurisdictional waters to be affected by the project (see Section 2.4)
- A copy of the 404 Permit application
- Description of the measures that will be taken to demonstrate compliance with state surface water quality standards

These materials are typically prepared and submitted to ADEQ during the 404 permit public review period and, as a part of their 401 certification review, ADEQ may issue a public notice that provides the public with the opportunity to comment on the ADEQ certification. ADEQ certification can come with conditions that specify limitations and/or best management practices that must be undertaken by the project to ensure state water quality standards are not violated.

The cost to prepare a 401 certification application (assuming the necessary supporting materials, such as the project description and delineation of the waters of the U.S., have been completed) is roughly estimated to range from $2,000–$8,000.

7 STORMWATER CONSTRUCTION GENERAL PERMIT

Stormwater and other discharges from construction sites are overseen by ADEQ under the Arizona Pollutant Discharge Elimination System (AZPDES) permitting program. If a project will disturb greater than one acre, or is a smaller part of a larger development that will disturb at least one acre, then the project needs to obtain an AZPDES General Permit for Stormwater Discharges Associated with Construction (referred to as a Stormwater Construction General Permit). This permit is not required if a project is entirely within USACE's Section 404 jurisdiction. Project proponents submit a Notice of Intent (NOI) to the ADEQ. The NOI is a three-page document that requires:

- Construction site location
- Estimated start date and duration of construction
- Name and location of receiving water for runoff
- A confirmation that a stormwater pollution prevention plan (SWPPP) has been completed
- Payment of a fee (for projects over 50 acres the fee is $500)

Because the Gila River within the planning area is listed as an impaired Arizona Water, the SWPPP must be submitted to ADEQ with the NOI. The purpose of the SWPPP is to identify controls and procedures to minimize the negative impacts from stormwater discharges to the environment. Controls minimize runoff from the project site and procedures identify and describe the implementation of stormwater management Best Management Practices (BMPs).

The SWPPP must include:

- Project contact information
- Site and activity description, and site maps
- Identification of potential pollutant sources and description of pollutant controls
- Maintenance and inspection procedures
- Records of inspections and follow-up maintenance of BMPs
- SWPPP amendments and SWPPP certification

The fee for ADEQ to review the SWPPP is $1,000 (this is in addition to the fee associated with the NOI described previously). Following submittal of the NOI and SWPPP, the ADEQ has 30 days to notify the applicant if the SWPPP needs revisions or if permit coverage is granted or denied. Although the permitting schedules in Figures B-1 and B-2 show the Stormwater Construction General Permit being obtained far in advance of the Section 404 permit, in actuality it can be obtained just before construction starts; no other permit is dependent on it.

The cost to prepare a SWPPP for an individual project is roughly estimated to range from $5,000–$10,000.

8 FLOODPLAIN USE PERMIT

Any construction within the floodplain requires a Floodplain Use Permit from the District, or relevant local municipality, including projects undertaken by the District. The use permit ensures that the project complies with the Floodplain Regulations for Maricopa County, which regulate the construction of buildings and other improvements within designated floodplains to alleviate the upstream or downstream impacts of such improvements on flood risks.

To obtain a floodplain use permit, project proponents would need to submit an application and a checklist, which insures completeness of the application. The application needs to include:

- Project description
- Site plan, plot plan, and grading and drainage plan (these are detailed plans showing all project elements and flood elevations)

Since Plan activities are being undertaken to reduce flood risk, it is anticipated that engineering analyses and submittal of materials to Federal Emergency Management Agency would be unnecessary.

The fees associated with a Floodplain Use Permit are waived for projects undertaken by the District. Although the permitting schedules in Figures B-1 and B-2 show the Floodplain Use Permit being obtained far in advance of the Section 404 permit, in actuality it can be obtained just before construction starts; no other permit is dependent on it.

9 LONG-TERM MITIGATION-BENEFIT STRATEGY

Section 404 permitting and ESA Section 7 compliance can require mitigation to compensate for impacts to USACE-jurisdictional waters and wetlands and endangered species habitat, respectively. If compensatory mitigation is necessary to offset unavoidable impacts to water, wetland, or biological resources subject to USACE and USFWS jurisdiction, the amount of required compensatory mitigation must be sufficient to replace lost resource functions (USACE 2008). A minimum one-to-one acreage or linear foot compensation ratio (i.e., a 1:1 mitigation ratio; one acre of mitigation for every one acre of impact) may be used to determine the amount of mitigation necessary. Commonly, however, USACE requires mitigation at a ratio greater than 1:1; temporal loss, the difficulty of restoring the aquatic resource type, the distance from the impact site, and other factors affect how much compensatory mitigation may be required (USACE 2015[2]).

Implementation of the Plan, or individual projects under the Plan, may have short-term, construction related impacts to waters or wetlands that are subject to USACE jurisdiction, as a result of ground disturbance, as well as suitable habitat for species listed under the ESA, as a result of noise and habitat loss. Although the primary objective of the Plan is to reduce flood risk, implementation of the Plan should also benefit biological resources in the long-term, by replacing nonnative saltcedar with native species, particularly where native vegetation sufficiently replaces the habitat structure and cover that was provided by the removed saltcedar. Table B-1 provides a coarse estimate of the amount of habitat that is anticipated to be created or enhanced by implementation of the Plan. The benefits listed in Table B-1 should make Plan activities "self-mitigating" since they will offset, or compensate, the short-term, construction related impacts. As such, a detailed Mitigation and Monitoring Plan is not anticipated to be required for Section 404 or ESA permitting of the Plan (additional detail is provided in Section 10 below in case it is).

Mitigating for potential loss of habitat structure as a result of saltcedar removal would be most efficiently accomplished by enhancing habitat on the in-lieu fee (ILF) lands in the planning area. Under an in-lieu fee mitigation program, permittees provide funds to an in-lieu fee program sponsor for habitat creation and enhancement, instead of implementing permittee-responsible mitigation or purchasing credits from a mitigation bank. The ILF lands in the planning area are primarily federally owned, but are administered by AGFD, the ILF program sponsor. As the sponsor, AGFD will be able to receive funds (fees) from permittees to cover the costs of saltcedar removal, habitat creation and enhancement, and long-term maintenance and monitoring (which can be funded by using the fees to create an endowment). The ILF program is currently used for

[2] USACE. 2015. Final 2015 Regional Compensatory Mitigation and Monitoring Guidelines for South Pacific Division USACE. Accessed March 30, 2016 at: http://www.spd.usace.army.mil/Portals/13/docs/regulatory/mitigation/MitMon.pdf

Section 404-related mitigation only (i.e., to replace the loss of wetland habitat), but can be used for ESA-related mitigation as well[3] (i.e., to replace the loss of specific habitat types).

Table B-1. Summary of the mechanism for and amount of habitat creation or enhancement anticipated by implementation of the Plan.

Type and Mechanism	Habitat Type	Acres
Habitat Creation: saltcedar treatment and habitat enhancement in areas currently mapped as "disturbed" or "water"	Desert scrub	180
	Marsh	50
	Mesquite bosque	30
	Riparian (cottonwood/willow)	40
	Habitat Creation Subtotal	*300*
Habitat Enhancement: saltcedar treatment and/or habitat enhancement in vegetated areas currently mapped as either saltcedar or a mixture of saltcedar and native species	Desert scrub	2,770
	Marsh	60
	Mesquite bosque	660
	Riparian (cottonwood/willow)	1,440
	Habitat Enhancement Subtotal	*4,930*
Habitat Creation and Enhancement Total		**5,230**

Any habitat creation or enhancement that is conducted on ILF lands is protected in perpetuity, thus meeting one of the more cumbersome requirements of areas that can serve as mitigation by USACE and USFWS. Under this scenario, habitat creation or enhancement funded or conducted on ILF lands could serve as mitigation for short-term construction-related impacts from Plan implementation. Additionally, lands outside of the ILF on which habitat enhancement is undertaken could be added to the ILF program. This could be accomplished by transferring ownership of the land to AGFD or placing the land under a conservation easement that is held by AGFD, and providing a maintenance and monitoring endowment for the land. Exceptions are tribal, other federal, or Arizona State Trust lands; these cannot be incorporated into the ILF program (T. Wade, pers. comm., 2015). Land transfers and conservation easements could be written to allow District to address flood risks or other safety issues that arise in the future, but would otherwise restrict activities on the covered property.

An alternative to the ILF program would be for the District to establish their own mitigation/ conservation bank. A bank is a privately or publically owned large parcel or contiguous parcels of land managed for natural resource values. A mitigation bank mitigates for losses of waters of the United States (CWA Section 404) by protecting, restoring, establishing, and enhancing wetland

[3] While the ILF program can serve as mitigation for multiple regulatory processes, acres of ILF lands used for mitigation under one regulatory process may not be counted or used under any other regulatory process. For example, if a permittee pays for 12 acres of mitigation for impacts under Section 404 of the CWA, there are 12 less acres that may be used to mitigate impacts under the ESA.

and stream habitats. A conservation bank mitigates for impacts to listed species (ESA Section 7) by protecting habitat for threatened, endangered, or special status resources. Credits may be sold by the bank sponsor to project proponents who need to satisfy legal mitigation requirement for environmental impact projects. A detailed planning document (prospectus) and a bank enabling instrument must be prepared. This process includes an agreement between a bank sponsor, bank property owner, and the signatory agencies. Additional requirements may include conservation easements, a property assessment and warranty, and development of a long-term management plan. In light of the ILF program, the effort and cost of satisfying the requirements to establish a bank is not warranted.

An additional alternative would be for the District to use implementation of Plan activities as permittee-responsible mitigation for other District activities. This approach, however, would require that any lands used as mitigation be protected and maintained in perpetuity. As such, this approach would have many of the same requirements as the ILF program, but would make the District responsible for the liability and maintenance requirements of the lands, rather than the AGFD as is provided under the ILF.

10 MITIGATION AND MONITORING PLAN

If, for some reason, the Plan or projects under the Plan are not determined to be self-mitigating, then a mitigation and monitoring plan would need to be developed to demonstrate that additional mitigation will be provided to offset impacts. This plan would then need to be funded, implemented, and monitored by the project proponent. For Section 404 permitting, this requires that a "mitigation statement" be prepared and submitted along with the 404 permit application. The mitigation statement must discuss the amount, type, and location of any proposed compensatory mitigation, including any out-of-kind compensation (e.g., compensation of impacts to emergent wetlands with riparian wetlands), or indicate an intention to use an approved wetland mitigation bank or in-lieu fee program (USACE 2015). If project proponents decide to undertake permittee-responsible compensatory mitigation, rather than invest in the ILF program[4], then the 404 permit application should include, at a minimum, a conceptual mitigation plan. Alternatively, the development of the mitigation plan can wait until USACE has determined the project's compensatory mitigation requirements, but this could result in schedule delays as a USACE-approved final mitigation plan is required prior to commencing work subject to the 404 permit. Although the information in this section stems primarily from guidance provided by USACE, USFWS is likely to have similar requirements, and mitigation related to both Section 404 and ESA Section 7 compliance can be planned, documented, and implemented together.

Based on the conditions in the lower Gila River and activities under the Plan, permittee-responsible mitigation is likely to involve the planting and maintenance of native riparian and wetland vegetation and other restoration actions in currently degraded areas in or nearby to the El Rio planning area (i.e., mitigation via re-establishment, establish, rehabilitation, and enhancement), but could also include preservation. Monitoring plan requirements for these forms of mitigation are lengthy and detailed (see Chapter 4 of USACE [2015]) and include:

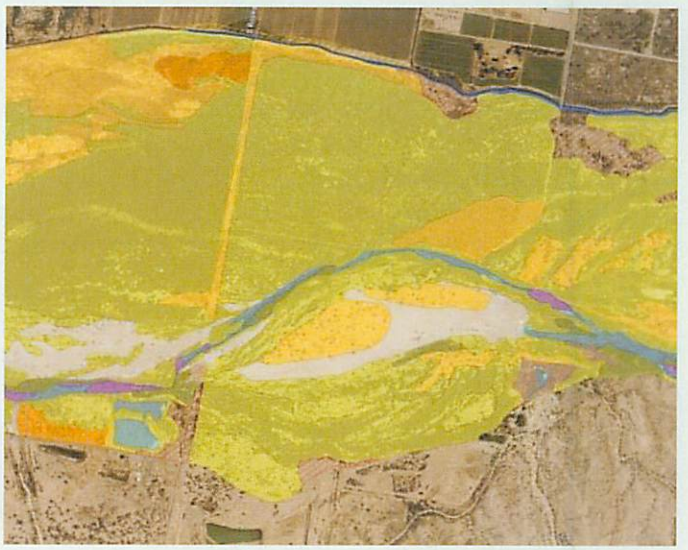
[4] The documentation necessary for wetland mitigation bank and in-lieu fee credit purchase is described in the compensatory mitigation and monitoring guidelines that have been recently developed for the USACE South Pacific Division (USACE 2015).

- Objectives and methods of compensation
- Mitigation site selection criteria
- Baseline information about the impact and mitigation sites
- Work plan to implement proposed mitigation (e.g., schedule of planting, species lists)
- Site protection instrument (e.g., conservation easement)
- Maintenance plan
- Ecological performance standards
- Monitoring requirements
- Long-term management plan
- Adaptive management plan
- Final assurances

Permittee-responsible mitigation is ideally implemented prior to the impacts that are being mitigated for and typically required to be monitored for a minimum of five years, with annual monitoring reports to USACE and USFWS.

FINAL TECHNICAL REPORT ◦ SEPTEMBER 2016

El Rio Vegetation Management Plan
Lower Gila River, Maricopa County, AZ
Volume 2: Data Collection and Analysis



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Cover graphics:

Upper left: View of saltcedar-dominated riparian vegetation along the Gila River near the City of Buckeye (photo by Stillwater Sciences).

Top right: Oblique view of riparian corridor dominated by mature saltcedar vegetation, located downstream of Waterman Wash (photo by Stillwater Sciences).

Bottom left: View of egrets and cormorants roosting in dense saltcedar, located at a gravel-pit lake near Buckeye (photo by Stillwater Sciences).

Bottom right: Subset of the vegetation type map produced for the planning area (created by Stillwater Sciences).

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LIST OF ACRONYMS AND ABBREVIATIONS

Acronym or abbreviation	Definition
%	percent
°F	degrees Fahrenheit
ADOT	Arizona Department of Transportation
AGFD	Arizona Game and Fish Department
APHIS	U.S. Department of Agriculture's Animal and Health Inspection Service
ASTM	American Society for Testing and Materials
Ave	Avenue
AZ	Arizona
BLM	Bureau of Land Management
CH	critical habitat
cfs	cubic foot/feet per second
cms	cubic meter(s) per second
District	Flood Control District of Maricopa County
EC	electrical conductivity
e.g.	"for example"
ENSO	El Niño–Southern Oscillation
ESA	Endangered Species Act
FC	federal candidate (for listing)
FE	federally endangered
FEMA	Federal Emergency Management Agency
ft	foot/feet
FT	federally threatened
GIS	geographic information system
GPS	global positioning system
GPSi	GEOspatial Professional Solutions, Inc.
i.e.	"that is"
in	inch(es)
Inc.	incorporated
LiDAR	Light Detection and Ranging
LLC	Limited Liability Corporation
MBTA	Migratory Bird Treaty Act
mmhos	millimhos
°N	degrees north
NAIP	U.S. Department of Agriculture's National Agriculture Imagery Program
NRCS	Natural Resources Conservation Service

Acronym or abbreviation	Definition
NM	New Mexico
NOAA	National Oceanic and Atmospheric Administration
NVC	U.S. National Vegetation Classification
pers. comm.	personal communication
pH	"acidity or basicity (alkalinity) of a substance"
Plan	Vegetation Management Plan
S	south
SGCN	species of greatest conservation need
spp.	species (plural)
SRP	Salt River Project
TAC	Technical Advisory Committee
U.S.	United States
USACE	U.S. Army Corps of Engineers
USDA	U.S. Department of Agriculture
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
WMP	El Rio Watercourse Master Plan

UNIT CONVERSION FACTORS

Most values presented in this report are reported in the U.S. Customary Unit System. This table presents conversion factors of the commonly used U.S. Customary system units to metric units.

U.S. Customary Units	Conversion	Metric Units
in (inches)	*x* 2.54	cm (centimeters)
	x 25.4	mm (millimeters)
	x 25,400	um (micrometers)
ft (feet)	*x* 0.3048	m (meters)
ft^2 (square feet)	*x* 0.0929	m^2 (square meters)
mi (miles)	*x* 1.609	km (kilometers)
ac (acres)	*x 0.4047*	ha (hectares)
mi^2 (square miles)	*x* 2.59	km^2 (square kilometers)
ft^3 (cubic feet)	*x* 0.028	m^3 (cubic meters)
oz (ounces)	*x* 28.35	g (grams)
°F (degrees Fahrenheit)	$\frac{°F - 32°}{1.8}$	°C (degrees Celsius)

1 INTRODUCTION

This technical report—Volume 2: Data Collection and Analysis—has been prepared to inform and facilitate the development of a science-based Vegetation Management Plan (Plan) for the El Rio reach of the lower Gila River in Maricopa County. This report, and the Plan as presented in detail in Volume 3, have been prepared by Stillwater Sciences for the Flood Control District of Maricopa County (District), with input from District staff and a technical advisory committee.

1.1 Planning Area

The El Rio reach of the lower Gila River, and the area addressed by the Plan, extends from the confluence of the Agua Fria River with the Gila River, downstream to Maricopa County Highway 85 bridge (Figure 1). This reach is approximately 17 miles long and 1 mile wide, and is referred to as the "planning area" throughout the Plan. The width of the planning area is defined by the extent of the 100-year floodway (Figure 1), which currently includes the non-developed corridor of the Gila River. The 100-year floodway typically defines the maximum amount of development encroachment allowed by the Federal Emergency Management Agency (FEMA) into the 100-year floodplain: development can occur within the 100-year floodplain so long as it and any associated mitigation does not result in changes to the floodway. The 100-year floodplain (also shown in Figure 1) is the area predicted to be inundated by a flow event that statistically has a one percent chance of occurring in any given year.

1.2 Background and Need for Vegetation Management

Between 2002 and 2006, comprehensive biological and hydrological studies of the El Rio reach were conducted as part of the El Rio Watercourse Master Plan (WMP; Stantec 2006). The WMP, which included the same area as the Plan, provided the basis for evaluating, and ultimately recommending, flood risk management alternatives that will maintain and enhance natural functions of the river while reducing flood risks to impending development in the river valley. The WMP recommended the construction of a levee along the entire north bank and portions of the south bank to reclaim land from the floodplain. The levee would be constructed by property owners as the land becomes developed. The WMP also included a recommendation and a conceptual plan for replacing non-native, invasive saltcedar (or tamarisk, which, in the planning area, primarily includes *Tamarix ramosissima, T. chinensis,* and hybrids of these two species) with native species. In addition to these recommendations, the WMP resulted in the implementation of the El Rio Research Project located upstream of the Bullard Avenue (Ave) bridge in the planning reach, which included saltcedar removal, revegetation of native species, walking trails, and interpretative signs.

In 2014, the District completed a preliminary updated delineation for the Gila River floodplain between Bullard Ave and Painted Rock Reservoir (Stantec 2015). The delineation showed that the floodplain had expanded by 7.3 square miles since the effective delineation was completed in 1999. Increased hydraulic roughness from the growth of saltcedar was the primary cause of the expanded floodplain. The updated delineation spurred the District and neighboring cities to further refine the WMP recommendations, which include vegetation management within the floodway and levee construction in strategic locations along the 100-year floodway alignment. This report, and related Plan (see Volume 3), will serve as the guiding document for how vegetation will be managed within the floodway.

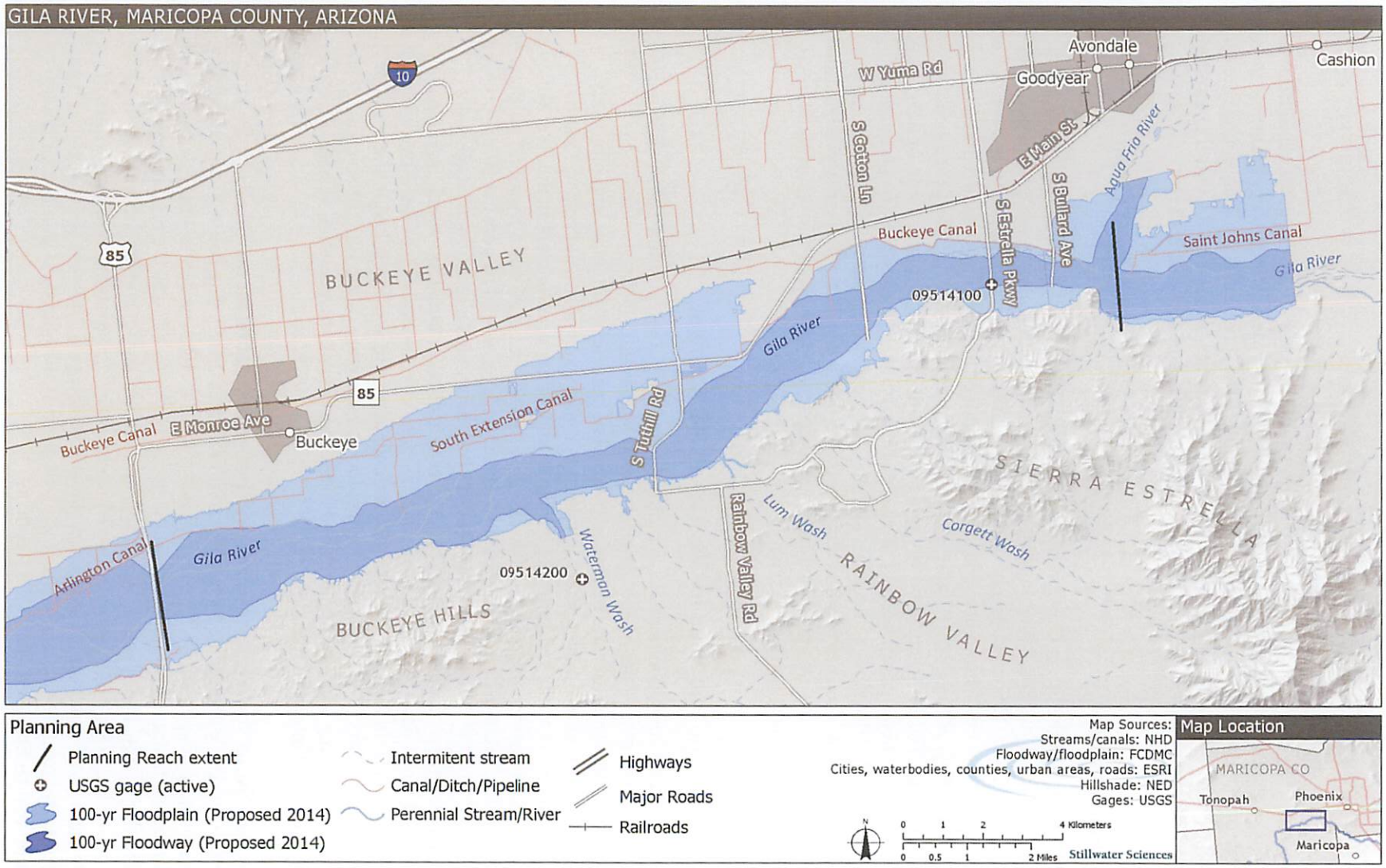
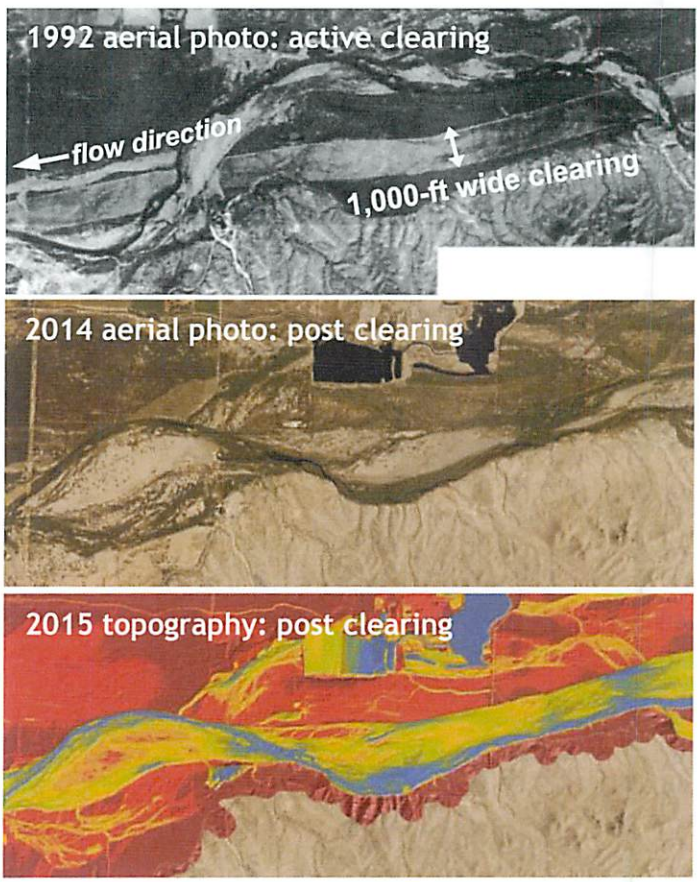


Figure 1. Location map of the planning area (source data from the District).

The overarching challenge facing flood management in the El Rio reach is the establishment of dense stands of saltcedar, which has become the dominant woody plant species in the floodway. Saltcedar can grow at greater densities than native species in the planning area due, in part, to its tolerance of saline soils and more xeric (*i.e.*, dry) conditions, which are exacerbated by the disturbed hydrologic regime of the El Rio reach, as a result of upstream dams, groundwater pumping, stormwater and wastewater discharges, increased impervious surfaces and altered runoff patterns, and floodplain development. These dense stands increase hydraulic roughness on higher surfaces in the floodway above what would normally occur. Thus, a science-based, holistic approach to active replacement of existing stands of saltcedar with appropriate native riparian and upland vegetation is needed to provide floodplain-management and associated benefits throughout the planning area.

1.2.1 Flood risks from saltcedar

Between 1980 and 1993, the District cleared vegetation from a 1,000-foot-wide corridor through the El Rio reach to enhance conveyance of flood waters, thereby reducing flooding hazards to developments in the Buckeye Valley. The clearing ran approximately 33 miles from the confluence of the Gila and Salt rivers downstream to Gillespie Dam near Gila Bend (see photos at right). This clearing was discontinued after the 1993 flood.



Historical aerial view from 1992 of District's 1,000-foot wide clearing of vegetation in the El Rio reach *(top)*, contemporary aerial view *(middle)* and topographic view *(bottom)* of same reach with evidence of past clearing activities and flood-scour path (Sources: District, NAIP, GPSi, and Stillwater Sciences)

Since the development of the WMP in the early 2000s and the hydraulic modeling of flood scenarios contained therein, saltcedar coverage expanded in the planning area. Saltcedar species, as well as athel (*T. aphylla*), a much less invasive species of *Tamarix* that has more of a tree-like form rather than a multi-stem shrub form of other *Tamarix* species, are native to eastern Asia, northern Africa, the Middle East, India, and southern Europe. Saltcedar and athel were introduced in the United States for use as landscape ornamentals, wind-breaks, and erosion control beginning in the 1800s, but subsequently became widely naturalized. Saltcedar is listed as a noxious weed in all states west of the continental divide except for Arizona (CISM 2015).

Along much of the Gila River in Maricopa County, including the El Rio reach, colonization by saltcedar is particularly intense as it has become the dominant woody plant species in the riparian corridor over the past century. Saltcedar has various traits that have facilitated its rapid expansion and replacement of native vegetation in the planning area and in river systems throughout much of the western United States. These include its ability to colonize areas with deeper water tables, high seed production and viability, extended seed dispersal periods relative to native cottonwoods and willows, ability to resprout quickly after flood and fire, tolerance of high salinities, and ability to excrete the salt from its leaves and then deposit the salt on the soil surface with the leaf litter (Merritt and Bateman 2012, Auerbach *et al.* 2013, Drus 2013, Hultine and Dudley 2013, Nagler and Glenn 2013, Ohrtman and Lair 2013).

Dense thickets of saltcedar, such as occur in the planning area (see photo at right), increase flooding by narrowing river channel widths and increasing sinuosity of the low-flow channel(s), taking up space within the floodway where water could be flowing, and increasing hydraulic roughness (Graf 1988). As a result, the continued expansion of saltcedar in the planning area since the development of the WMP has decreased the flood conveyance capacity of the river to the extent that more recent hydraulic modeling predicts that areas slated for development are now within the 100-year floodplain of the river. The expansion of the predicted 100-year floodplain puts impending development along the river at higher risk of flooding and underscores the need for vegetation management, and specifically the removal of saltcedar, as a critical component of flood risk management.

Saltcedar along the El Rio reach (Photo by Stillwater Sciences)

1.2.2 Tamarisk beetle arrival

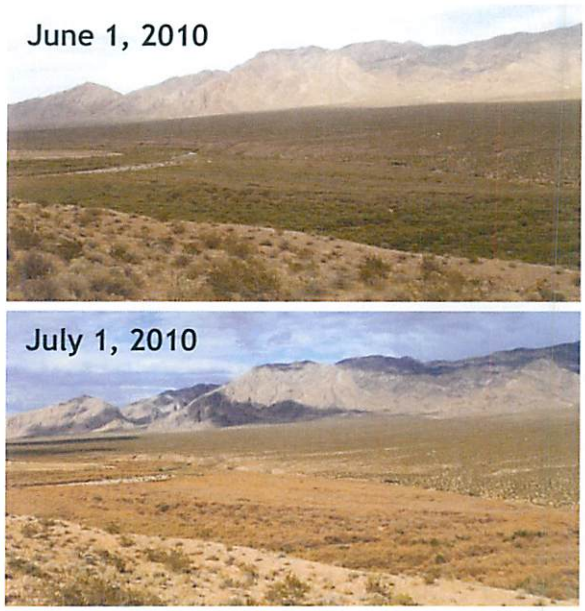
In response to the colonization and threat of saltcedar to western river systems, four of five distinct species of tamarisk beetle (*Diorhabda elongata* complex) were introduced into portions of Colorado, Nevada, Texas, Utah, and Wyoming during 2001–2009 by the U.S. Department of Agriculture (USDA) for biological control of saltcedar (Tracy and Robbins 2009, Tamarisk Coalition 2009, Bloodworth *et al.* 2016) (see photo at right). As intended, the beetle expanded its range and has led to widespread defoliation of saltcedar-dominated habitats in many other southwestern watersheds. Individual plant mortality typically occurs after 3+ years of repeat defoliation (Bean *et al.* 2013). Somewhat surprising is that the northern tamarisk beetle (*D. carinulata*) has evolved its physiological ability to establish farther south than the originally introduced insects would have tolerated (*i.e.*, south of 38 degrees north [°N] latitude), so it is likely that that species is, or will soon be, capable of establishment in the lower Gila River (*i.e.*, near 33°N latitude). Currently, the northern tamarisk beetle is present in northern and southern (upper Rio Grande River), north (San Juan and

Subtropical tamarisk beetle (Photo courtesy of Salvador Vitanza, USDA)

Little Colorado Rivers), and west (Virgin River/Lake Mead), and beetle establishment in 2012 below Hoover Dam marks their arrival into the lower Colorado River basin.

According to projections of ecological niche models by Tracy *et al.* (2015), most of the Sonoran Desert is not climatically suitable habitat for the northern tamarisk beetle, but this desert is highly suitable for the subtropical tamarisk beetle (*D. sublineata*) released in Texas on the Rio Grande River, which is now moving northward through New Mexico. The subtropical tamarisk beetle was originally projected to arrive at the Elephant Butte Reservoir (north of Truth or Consequences, New Mexico [NM]) by 2014 (Tracy 2014). However, dispersal north through the El Paso and Mesilla (Las Cruces, NM) valleys along the Rio Grande River was slower than expected, possibly due to agricultural pesticides, and the beetles only recently reached the lower end of Elephant Butte Reservoir in August of 2015. Extending this one year delay in projected dispersal westwards, the subtropical tamarisk beetle may reach the Phoenix area by 2018/2019 rather than the originally projected year of 2017/2018. Dispersal westwards in Arizona could be further slowed in areas of potentially heavy pesticide use along the Gila River in the Safford and Phoenix valleys (J. Tracy, pers. comm., 2015). Thus, one or more species of the tamarisk beetle is likely to arrive in the Gila River[1] in the foreseeable future (potentially within 4–5 years) and have impacts to saltcedar similar to those seen elsewhere.

Based on observations and data from other southwest rivers (see photos at right), colonization by tamarisk beetles is expected to result in the defoliation and dieback of much, although not all, of the saltcedar in the El Rio reach over a few years. Such widespread mortality and defoliation will reduce saltcedar biomass, allowing for easier treatment of affected saltcedar and replanting of native species in a more cost-effective manner, and may further reduce interspecific competition with native riparian flora following passive and active restoration. While mortality of saltcedar by tamarisk beetles will help increase flood conveyance capacity, and possibly provide other benefits associated with saltcedar suppression (*e.g.*, water conservation, riparian habitat recovery, fire risk reduction), it introduces uncertainty into long-term vegetation management. For example, even after the beetle arrives, biocontrol will still take several years to decades to achieve desired levels of reduction in saltcedar density, and will not remove the remaining woody biomass of dead saltcedar. It, therefore, has the potential to increase local



Repeat views of dense saltcedar stands along the Virgin River near Littlefield, AZ, showing effects of tamarisk beetle defoliation in 2010 (Photos courtesy of Tom Dudley, U.C. Santa Barbara)

[1] See also "Yearly Distribution (2007–2015) of Tamarisk Beetle (*Diorhabda* spp.)" maps published annually by the Tamarisk Coalition of Grand Junction, CO; weblink: http://www.tamariskcoalition.org/programs/tamarisk-beetle-maps

micro-climate temperatures and reduce relative humidity, exacerbate wildfire risk, and disturb existing riparian habitat conditions (see photos above) (Drus *et al.* 2012, Bateman *et al.* 2013).

Potential short-term adverse impacts to sensitive wildlife are particularly likely for the endangered southwestern willow flycatcher (*Empidonax traillii extimus*), because about one third of its native nesting habitat of willows and cottonwoods has been largely replaced by saltcedar (Durst *et al.* 2007). If defoliation by tamarisk beetles occurs simultaneously with flycatcher nesting, the loss of cover could result in juvenile mortality, as has recently been observed along the lower Virgin River (Dobbs *et al.* 2012, McLeod and Pellegrini 2013, Bateman and Johnson 2015). Other special-status wildlife species, such as the threatened western population of yellow-billed cuckoo (*Coccyzus americanus*), are also associated with many riparian systems in which saltcedar is the predominant vegetation but does not provide breeding habitat (Johnson *et al.* 2012, Halterman *et al.* 2015). It is thus important to plan now for the arrival of the tamarisk beetle in the El Rio reach by restoring native plant communities and habitat, both to take advantage of the biocontrol benefits once the beetle is present and to mitigate for its indirect impacts to southwestern willow flycatcher and other sensitive wildlife.

It is important to note that, per the USDA's Animal and Health Inspection Service (APHIS), any unauthorized human-assisted movement of the tamarisk beetle, particularly into designated critical habitat of southwestern willow flycatcher and western yellow-billed cuckoo (the latter of which includes the El Rio reach), may constitute a violation of the Endangered Species Act (ESA), which could result in criminal punishment and/or fines, as well as the Plant Protection Act, which could result in criminal penalties and/or fines of up to $250,000 (APHIS 2010).

1.2.3 Water savings

River management practices and the concurrent colonization of saltcedar throughout the United States have had dramatic effects on floodplain hydrology and water supply. All species of saltcedar are phreatophytes[2] with a long tap root and, as a result, consume and transpire water from or near the groundwater table (Figure 2). The notion that dense stands of saltcedar consume greater quantities of shallow groundwater than their native woody vegetation counterparts emerged within decades of the introduction and spread of the species. However, recent technological and methodological advances have revealed mixed results as water consumption by any phreatophyte species is potentially great where an adequate water supply is available, and ultimately variable over space and time as a function of numerous factors. Graf (1988, table 6.6) compiled comprehensive accounts of published evapotranspiration rates for saltcedar and other woody vegetation found in the southwest region, which clearly demonstrated the variability in intrinsic water usage by species. Literature reviews conducted by Shafroth *et al.* (2005) and more recently Doody *et al.* (2011) indicate that saltcedar generally produce stand-level evapotranspiration rates ranging from 0.7 to 4.9 feet per year with a mean of 2.3 feet/year across regions. Native cottonwoods (*Populus* spp.) and willow (*Salix* spp.) generally have evapotranspiration rates ranging from 1.5 to 4.6 feet/year; mesquites (*Prosopis* spp.) generally range from 1.3 to 2 feet/year (see Doody *et al.* 2011 for a more comprehensive review of these studies).

[2] Phreatophytes are plants with a deep root system that draw their water supply from the groundwater table or the soil just above it. Cottonwoods and willows are considered obligate phreatophytes, while saltcedar species are considered to be facultative phreatophytes.

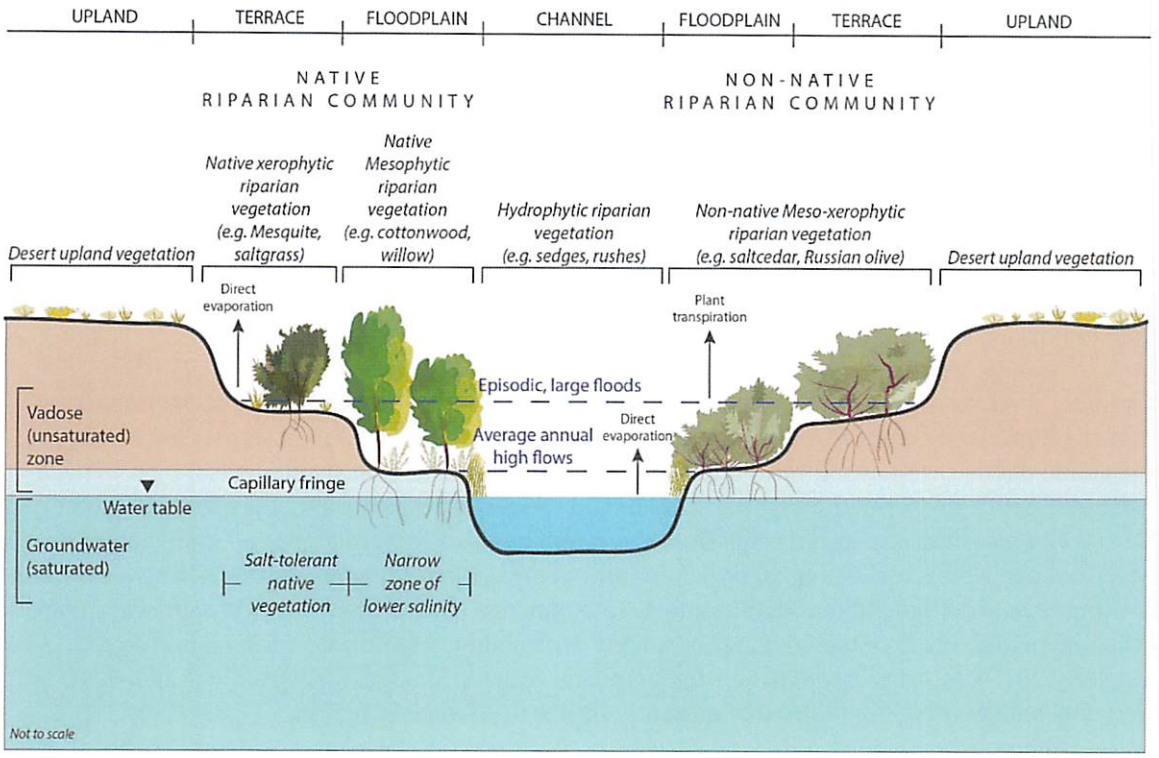


Figure 2. Conceptual view of a vegetated river bottom showing geomorphic, groundwater, and vegetation characteristics typical of arid and semi-arid systems, like the El Rio reach (adapted from figures 2 and 3 [p. 37-38] in Shafroth *et al.* [2010], and figure 7.1 in Auerbach *et al.* [2013]).

Although current research indicates water use of saltcedar is comparable with water use by other stream-side phreatophytes, saltcedar exhibits several traits which may favor its persistence and dominance over native phreatophytes and transitional-zone species (see Figure 2). Saltcedar has a substantially higher leaf area index than native species which allows them to transpire considerably more water (DiTomaso 1998). As facultative phreatophytes, saltcedar can withstand periods of little to no water availability, unlike obligate phreatophytes such as native willow and cottonwoods that require a dependable water supply. The widespread establishment of saltcedar is a response to the hydrologic regime of the Gila River. Unless there are changes to the way humans manage the river, this species will persist. Saltcedar possesses a longer tap root which allows it to reach deeper water tables than native species, and grow on higher elevation fluvial surfaces and at farther distances from the main channel than species dependent on shallow groundwater (Nagler *et al.* 2009, Merritt and Bateman 2012). These factors have contributed to the expansion of saltcedar across river floodplains into areas where native phreatophytes could not persist, and have further increased the total areal extent of transpiring vegetation that contributes to water loss in a river system. Thus, if evapotranspiration losses can be minimized or eliminated by the removal of saltcedar, water supply for beneficial use potentially could be improved (Nagler *et al.* 2009).

Water saving through saltcedar removal, referred to as water "salvage," has been met with mixed results. One of the principal challenges of citing water-salvage amounts with sufficient confidence is the rarity of long-term studies and/or those having sufficient measurement precision

(Cleverly 2013). In a U.S. Geological Suvery (USGS) study on the upper Gila River in Graham County, over 5,100 acres of saltcedar-dominated vegetation were cleared, followed by limited planting of grass cover (Culler *et al.* 1982). Evapotranspiration was not directly measured but was instead calculated as the change in the local water budget. Estimated water salvage ranged between 1.2 to 2.2 feet/year following saltcedar removal. One of the longer-term salvage studies conducted to date occurred on the Pecos River in Texas. This six-year study by Hatler and Hart (2009) found seasonal water salvage ranged from 0 to 0.3 feet/year four years after saltcedar control to 2.2 to 2.3 feet /year two years after control. These studies suggest that water salvage may be possible if the replacement species have lower evapotranspiration rates, but additional research is needed.

Ongoing work by researchers from Utah State University (2013) on behalf of the Metropolitan Water District of Southern California has been able to show water savings, expressed through measured decreases in evapotranspiration rates and increases in water table levels, by replacing saltcedar with a mix of native riparian and upland species at test sites along the lower Colorado River. The researchers cite a savings from the evapotranspiration reduction to be on the order of 1 acre-foot per 1.85 acres managed, or 0.5 acre-foot/acre. This finding is consistent with a common recommendation found in the literature that water savings can be achieved with saltcedar control when its removal is maintained and it is quickly replaced by appropriate xeric plants (*e.g.*, Cleverly 2013). However, replacing riparian plants with xeric plants will greatly diminish the diversity and density of wildlife that currently utilize this valuable habitat.

In September 2014, Senator John McCain sent a letter to the USDA and U.S. Department of the Interior that requested the government use tamarisk leaf beetle biocontrol measures and replant with native xeric shrub vegetation as one strategy to salvage water in the drought-stricken southwest. The letter also included a request for information on: (1) the restrictions imposed by the USDA on the continued introduction of the beetle, (2) projects working to manage saltcedar, and (3) a cost estimate for large-scale revegetation plan across the lower basin that assumes the continued migration of the beetle.

1.2.4 Wildfire threat

Wildfire is an increasingly common disturbance in southwestern rivers owing, in part, to the colonization of saltcedar. The El Rio reach has experienced several instances of wildfire, including the 800-acre Buck Fire in 2006, located upstream of the Highway 85 bridge and along the northern side of the river channel. In 2014 the Robbins Butte Fire burned over 100 acres of saltcedar forest downstream of the Highway 85 bridge (see photo at right), prompting Bureau of Land Management (BLM) to establish firebreaks of cleared vegetation on their property. Riparian areas are generally considered to be barriers to wildfire spread, but the replacement of fire-resistant native vegetation with higher moisture content (*e.g.*, willows and cottonwoods) by more flammable saltcedar has reversed this relationship, with saltcedar-dominated areas burning approximately 10 times more frequently

Robbins Butte wildfire along the lower Gila River near Buckeye on July 26, 2014 (Photo courtesy of Anne Lippert, Scripps Media)

than native-dominated counterparts (Busch and Smith 1995). Defoliation by tamarisk beetles can temporarily exacerbate fire susceptibility, but as saltcedar dies back from repeated defoliation, fire susceptibility should decrease (Drus *et al.* 2012). The spread of fire from land-clearing on adjacent agricultural areas has become a serious concern for land managers, particularly where weedy forbs next to fields carry fire into the arid, saltcedar-dominated riparian edges, and then into the mixed native/saltcedar vegetation along the river. This establishes a feedback loop in which fire promotes saltcedar, which recovers readily from burning to become even more abundant, eventually displacing native elements in the stand. Biocontrol by the tamarisk beetle eventually reduces saltcedar volume, and after 3+ years of repeat defoliation can lead to mortality (Bean *et al.* 2013), thereby gradually reducing fire risk over the long term, although active restoration efforts are needed to speed up the process of reducing riparian fire risk in critical areas (*e.g.*, Mosher and Bateman 2015). That said, remaining biomass of dead saltcedar may continue to present a fire hazard.

1.3 Project Goal and Objectives

The primary goal of the Vegetation Management Plan is to provide science-based, comprehensive guidance for the removal of saltcedar and revegetation with appropriate native riparian and upland plant species that will ultimately provide floodplain-management throughout the El Rio reach.

More specific objectives of the Vegetation Management Plan are to:

- Provide a framework for reducing the size of the modeled 100-year floodplain through saltcedar management, while maintaining and enhancing riparian habitat assets.
- Identify appropriate, ecologically sustainable, and spatially-explicit management actions, such as saltcedar treatment, revegetation with native plant species, or no action, based on biological and hydrological factors, as well as the reasonableness of costs, local community expectations, and flood risk reduction benefits.
- Develop monitoring methods to evaluate progress toward Plan objectives and, to apply adaptive management to enhance the likelihood of achieving those objectives, and increase understanding of flood and ecosystem interactions.
- Prepare for anticipated changes to the system, such as climate change, land-use changes, and colonization by tamarisk beetle (*Diorhabda elongata* complex).
- Prepare for implementation of rapid, active ecological restoration and other management strategies for threatened, endangered, and other native wildlife species potentially displaced by saltcedar treatment activities, and to enhance pollinator habitat.
- Provide consideration for proper implementation techniques, implementation costs, permitting requirements, short- and long-term maintenance needs, water use/savings, and wildfire control.
- Identify a pilot vegetation management site, with a conceptual-level action plan, that could be implemented in 2016, as well as other high-priority areas for treatment.

1.4 Report Goals and Objectives

The goal of this technical report—Volume 2: Data Collection and Analysis—is to summarize the physical, biological, and land use conditions that together provide the foundation for the development of the Vegetation Management Plan.

More specific objectives of this technical report have included the following:

- Define problem statement(s) and a set of management objectives derived from the District's overarching project goal (Sections 1.2 and 1.3).
- Characterize the dynamic nature of the ecologically sensitive floodway corridor to provide the holistic baseline information necessary to identify appropriate vegetation-management actions, including vegetation coverage, groundwater, and soils (Chapter 2).
- Summarize the initial findings of the assessment of ecohydrological conditions (as described in Chapter 2), and provide a preliminary discussion of their implications for vegetation management options in the planning area (Chapter 3).

The next technical report—Volume 3: Vegetation Management Units and Implementation Elements—identifies vegetation management actions meant to satisfy the planning goals of the District within the planning area. Together, the two technical reports compose the Vegetation Management Plan that describes appropriate types of actions and their locations, and considers permitting requirements, mitigation strategies, maintenance needs, monitoring and adaptive management needs, funding opportunities, and implementation costs.

1.5 Technical Advisory Committee

This report, along with Volume 3, was reviewed by, and improved in light of comments from, a technical advisory committee (TAC) composed of individuals with expertise in southwest riparian systems, including the El Rio planning reach. The TAC members included the following individuals:

- **Dr. Heather Bateman**—Conservation Biologist and Professor, Arizona State University
- **Matt Johnson**—Avian Ecologist and Director, Colorado Plateau Research Station, Northern Arizona University
- **Kris Randall**—Biologist and State Coordinator, Partners for Fish and Wildlife Program, U.S. Fish and Wildlife Service
- **Lisa Thornley**—Botanist and State Weeds Coordinator, Bureau of Land Management
- **James Tracy**—Entomologist and Doctorate Candidate, Texas A&M University
- **Tim Wade**—Biologist and Wildlife Contracts Branch Chief, Arizona Game and Fish Department
- **Kelly Wolff-Krauter**—Biologist and Regional Habitat Program Manager, Arizona Game and Fish Department

2 ASSESSMENT OF ECOHYDROLOGICAL CONDITIONS

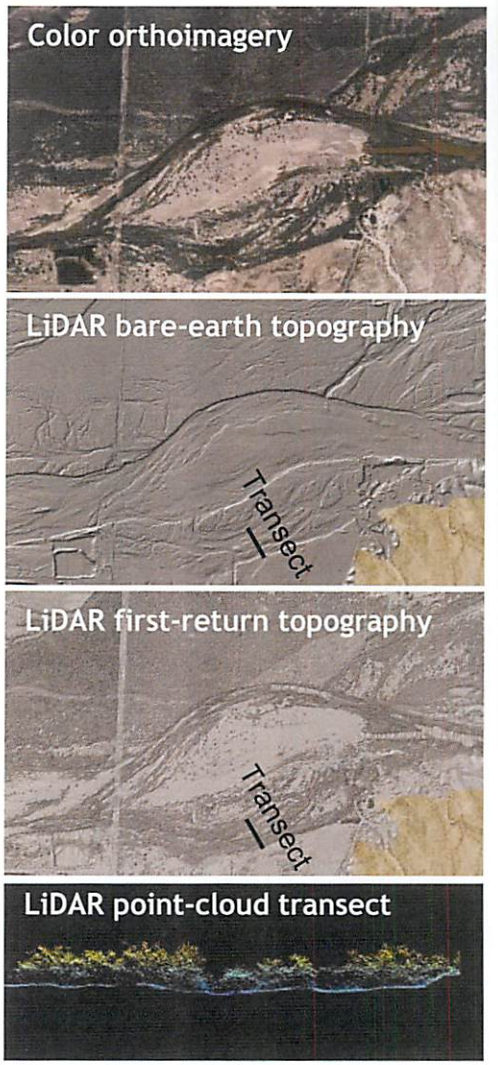
The purpose of this assessment is to characterize the dynamic nature of the ecologically sensitive floodway corridor to provide the holistic baseline information necessary to identify appropriate vegetation-management actions. The comprehensive biological and hydrological studies previously conducted in support of the El Rio Watercourse Master Plan (WMP; Stantec 2006) provide a very strong foundation for this assessment. Where deemed necessary, we have supplemented or updated these data with new information, including recently acquired field data. This chapter describes methods and results of the assessment.

2.1 Remote-Sensing Data Collection

A key component of the assessment has been the use of high-resolution remote-sensing data products to characterize existing conditions throughout the entire planning area. Aerial photography used in the assessment was derived from multiple sources, the most recent of which were from the USDA's National Agriculture Imagery Program (USDA-NAIP), with imagery of the county collected in summer 2013, and from the District, with imagery of the El Rio reach collected in fall 2014. Both of these products consist of high-resolution, orthorectified imagery of the entire planning area (see District product example at top right).

High resolution topographic data used in the assessment were collected via Light Detection and Ranging (LiDAR) methods by GEOspatial Professional Solutions, Inc. (GPSi) on behalf of the District in early April 2015. The LiDAR dataset consisted of classified point-cloud data and two terrain surfaces: a bare-earth surface depicting the ground surface absent of vegetation and structures, and a "first-return" surface depicting the highest point of any detected vegetation or structure (see product examples at right).

These remote-sensing data products were subsequently used to assist with analysis of hydro-geomorphic and riparian habitat conditions in the planning area (see below).



Example remote-sensing products: color orthoimagery *(first)*, LiDAR bare-earth topography *(second)*, LiDAR first-return topography *(third)*, and LiDAR-derived cross-section of riparian vegetation and bare-earth surface *(fourth)*

2.2 Physical Setting

The Gila River is the downstream-most major tributary to the Colorado River and courses 650 miles from its headwaters in western New Mexico nearly due west across the southern part of Arizona. As part of the Mexican Highland section of the Basin and Range physiographic province, the watershed drains a vast area of rugged mountain ranges and broad desert lowlands totaling about 58,000 square miles. About half of the landmass in Arizona drains to the Gila River, thereby highlighting the importance of the river and its many perennial and ephemeral tributaries. As part of the lower watershed, the 17-mile long El Rio reach receives runoff from approximately 46,345 square miles, most of which is regulated by several large water-storage dams and numerous diversion structures.

The Buckeye Valley, within which the planning area is located, is a broad, alluvial basin trending east-to-west and bounded on the south by the Estrella Mountains and Buckeye Hills, and the north by the White Tank Mountains (see Figure 1). The valley ends as the river course veers southward against the Gila Bend Mountains, forcing the river through a narrow gap at Gillespie Diversion Dam between the Gila Bend Mountains and the Buckeye Hills. Within the planning area, the river and its floodway course along the southern side of the valley at the base of the Buckeye Hills. The valley is composed of thick sequences of geologically young alluvium overlying deep basin-fill (lacustrine and conglomerate) deposits, which in turn overlie much older basement rock (Reynolds and Skotnicki 1993, 2002a,b; HydroLogic 2006).

2.3 Land Uses

Land ownership in the planning area is roughly split evenly between public and private entities. The primary land owners and managers, and the proportion of their lands in the planning area, are listed in Table 1. The locations of these lands are shown in Figure 3 and in more detailed maps presented in Appendix A. The District currently owns about 1,300 acres, or 15%, of the planning area. These parcels and other public lands, which include the BLM's Fred J. Weiler Greenbelt and a number of designated State wildlife areas, provide opportunities for vegetation management since future uses of the land are unlikely to conflict with vegetation management objectives and the habitat benefits provided by saltcedar treatment and habitat enhancement would be protected in perpetuity. In fact, much of the publicly-owned land in the downstream half of the planning reach is managed by the Arizona Game and Fish Department (AGFD) as in-lieu fee areas, where habitat enhancement can be used to mitigate the effects of other projects on endangered species.

Table 1. Land management in the El Rio Planning Area (source data from the District).

Land Manager		Area within the Planning Area [A]	
		(acres)	(%)
Bureau of Land Management		2,055	23%
Arizona Game and Fish Department		611	7%
Arizona Department of Transportation		29	0.3%
Arizona State Land Department (State Trust lands)		358	4%
Municipal	Maricopa County lands and parks	197	2%
	Flood Control District	1,324	15%
	City of Buckeye	101	1%
Private		4,112	47%
Total Planning Area		**8,787**	**100%**

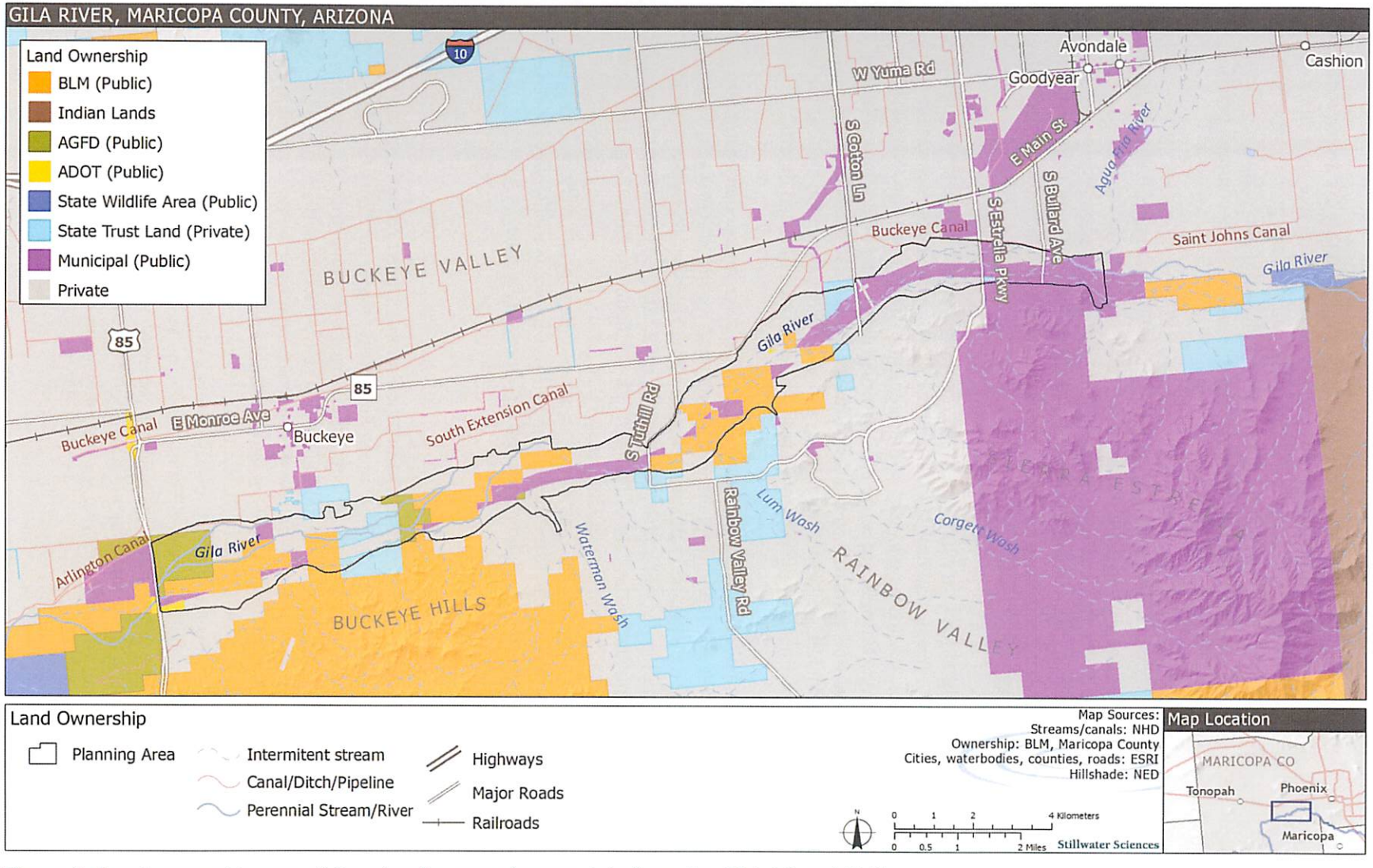


Figure 3. Land ownership map of the planning area (source data from the District and BLM).

The floodway within the planning area is undeveloped and is used primarily for recreational uses such as hunting, fishing, and off-road vehicle use. There are also several active and retired sand and gravel mining operations in and adjacent to the floodway. Many of the private parcels in the floodway potentially could be developed in the future for new sand and gravel mining. Illegal dumping of garbage and construction and landscaping debris is also a fairly common practice in the floodway.

Agricultural lands border almost the entire northern perimeter of the planning area, as well as a portion of the southern perimeter, and include alfalfa and other crop production as well as livestock and dairy production. Portions of the Buckeye and Arlington canals receive diverted river water to the north of the river. There are several notable agricultural return-flow outfalls along the northern perimeter that help to sustain some of the largest and tallest stands of native vegetation in the planning area.

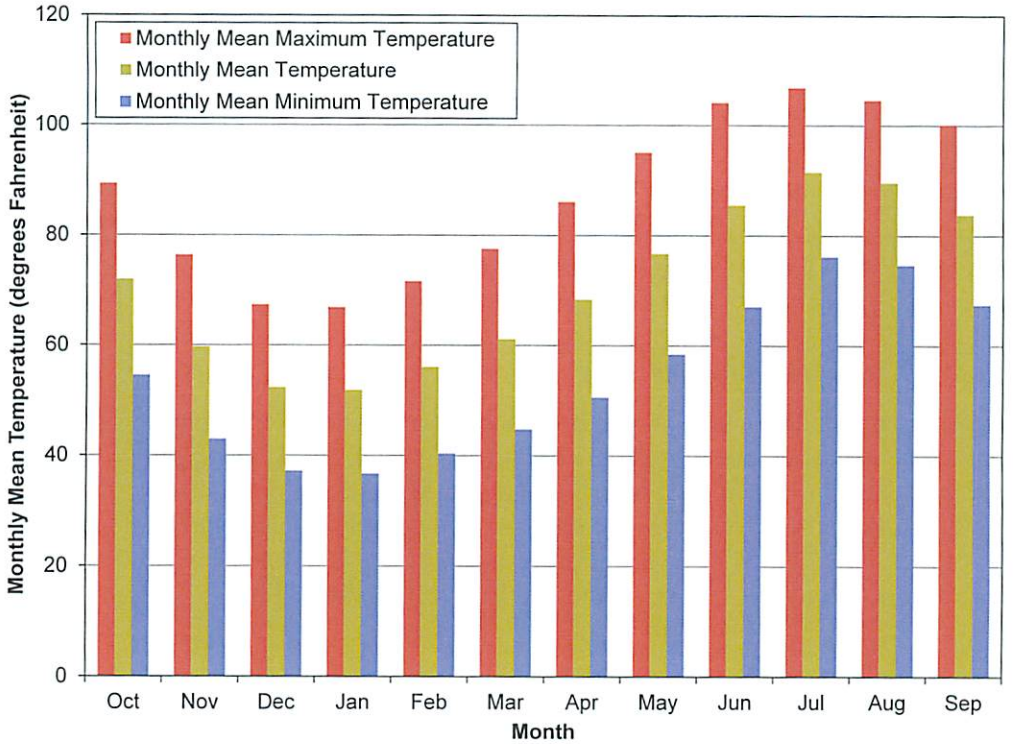
Since the 1980s, agricultural lands in Maricopa County have been steadily replaced by urban development, and most of the agricultural land around the planning area has been recently developed or is slated for development as part of the expansion of the towns of Avondale, Goodyear, and Buckeye. Residential areas occur and are also expanding along the southern perimeter of the planning area, primarily in the Rainbow Valley and Estrella Mountain areas. Other than relatively small areas of agricultural lands and urban developments, most of the land outside of the southern perimeter of the planning area is undeveloped Sonoran desert.

A number of relatively small-scale saltcedar treatment, revegetation, and/or demonstration wetland projects have already been implemented or are planned for the El Rio reach. These include, but are not limited to, planned saltcedar removal along Highway 85 by the Arizona Department of Transportation (ADOT); planned saltcedar removal, revegetation, and recreational and educational improvements by the City of Buckeye; planned construction of experimental wetlands to treat wastewater by the City of Goodyear, BLM, and City of Phoenix; post-burn revegetation outside of Buckeye by the District (*i.e.*, Buck Fire Revegetation Project); and the District's El Rio Educational Research and Development Project, which included revegetation of native cottonwood and mesquite vegetation types, off of Vineyard Avenue.

2.4 Climate

The region experiences a warm desert climate within the Sonoran Desert climatic region with air temperatures varying seasonally. The monthly mean maximum temperature occurs in July (107 degrees Fahrenheit [°F]) and mean minimum temperature occurs in January (37°F) (Figure 4a), as recorded at the Litchfield Park meteorological monitoring station between 1919 and 2014 (NOAA NCDC 2015). Evaporation rates follow the same seasonal trend with July having the highest monthly average rate of about 13 inches and December with the lowest of about 3 inches, as monitored in Mesa during 1896–2005 (WRCC 2015). Precipitation patterns are bi-seasonal, with cold, winter frontal storms arriving between December and March and tropical monsoons arriving in July through October. The wettest month has been August (1.2 inches) while the driest month is June (0.1 in), based on rainfall measurements recorded at Litchfield Park during 1919–2014 (NOAA NCDC 2015). River hydrology closely follows the rainfall patterns, exhibiting flashy runoff events during winter storms and summer monsoons (see Section 2.5.1 Surface Water Hydrology below).

a)



b)

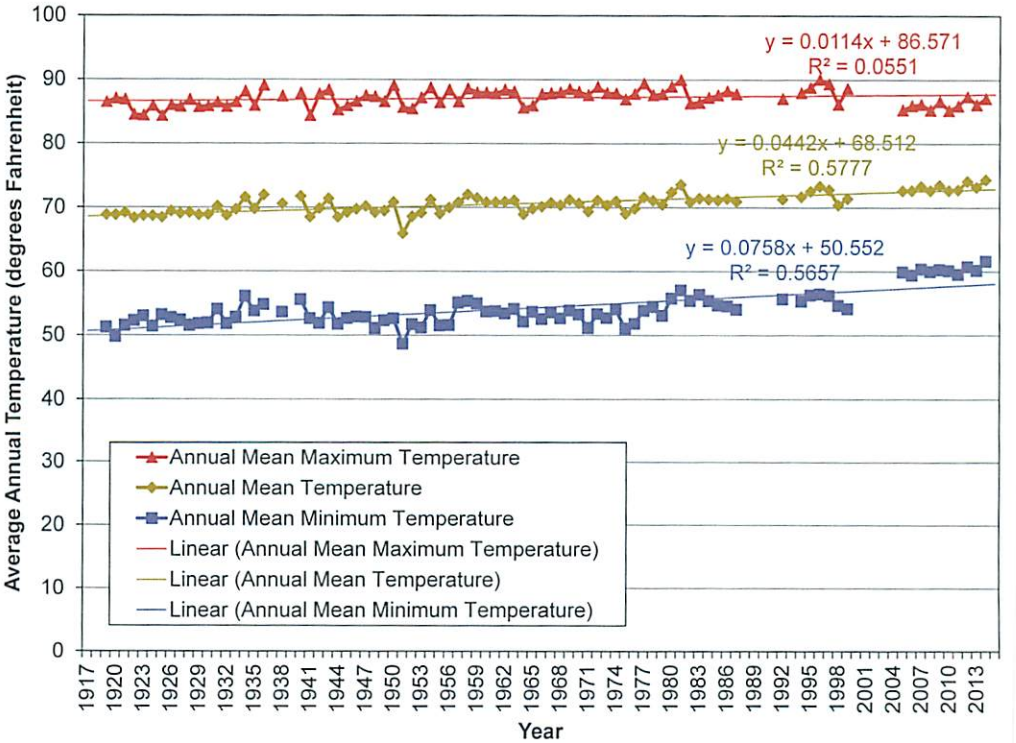


Figure 4. Monthly mean air temperatures (a) and average annual air temperatures (b) recorded at the Litchfield Park meteorological monitoring station during 1919-2014 (source data from NOAA NCDC 2015). Only years with mean monthly values reported for all 12 months were included in the plot (b).

Examination of the long-term air temperature record at Litchfield Park reveals a steady increase in annual mean values (Figure 4b), equating to about +1°F over the past 25 years. This finding is consistent with regional observations that have reported average annual increases of about 1.5°F over the last century, and temperatures are predicted to rise an additional 2.5 to 8°F by the end of this century (*e.g.*, USGCRP 2009). Meanwhile, precipitation is projected to decrease at least 5–20% (Seager *et al.*, 2007, Solomon *et al.* 2007, Diffenbaugh *et al.* 2008). The implications of this temperature increase, along with attendant changes in precipitation patterns, on the local riparian habitat will require the Plan to incorporate flexibility in any recommended management actions.

2.5 Hydro-geomorphology

A brief evaluation of the surface-water hydrology and channel morphology was performed to better understand the essential hydro-geomorphic character of the river corridor. We focused on examining contemporary flood and baseflow hydrology, and the potential for flood-scour to occur within the El Rio reach. This evaluation builds directly upon much more comprehensive hydrology, hydraulics, and geomorphic assessments performed in the early 2000s by Stantec and JE Fuller on behalf of the District for the El Rio WMP (Stantec 2002, JE Fuller 2005).

2.5.1 Surface water hydrology

The arid climate in central Arizona is interrupted by periods of intense winter and late-summer storms that often cause high-water flow in the Gila River and the ephemeral tributaries draining to the El Rio reach. Information presented in the WMP documents that the contemporary river hydrology is dominated by floods. Between flood periods, flows through the El Rio reach are intermittent with some sub-reaches going dry in the summer months, while other sub-reaches support perennial flow. Baseflow is enhanced in part by a combination of effluent discharge and seasonal agricultural runoff. Effluent discharge is received from five wastewater treatment plants serving Phoenix, Avondale, and Goodyear.

Supplemental to the information presented in the WMP reports, we reviewed streamflow data from 10 long-term gaging stations positioned along the mainstem Gila River and its major tributaries in the vicinity of the planning area. These data were obtained from the USGS National Water Information System website: http://waterdata.usgs.gov/nwis. The spatially distributed stations provide a reliable and contemporary characterization of the river's average daily flows, as well as its episodic hydrologic regime. Basic information for the gages is summarized in Table 2. The Gila River at Estrella Parkway gage best represents streamflow conditions directly within the planning area, and the Gila River below Gillespie Dam gages provide a good representation of streamflow at the downstream end of the valley.

A bi-modal seasonal hydrologic pattern is apparent in examination of the river's monthly mean discharge for the mainstem Gila River upstream and, to a lesser extent, within the El Rio reach, as depicted graphically in Figure 5. A unimodal pattern, however, is apparent downstream of the reach as reported at the Hassayampa River and Gillespie Dam gages. Within the El Rio reach (blue bars in Figure 5), January and February have typically experienced the highest monthly mean flows over a given water year. Also apparent here is the substantial increase in monthly mean flow below the confluence of the Salt and Agua Fria rivers at Estrella Parkway, indicating the degree to which both natural runoff from the added watershed area *and* artificial input from treated wastewater influent and agricultural runoff affect the local hydrology.

Table 2. USGS discharge gaging stations used to characterize river flows in the planning area.

USGS gaging station [upstream to downstream]	Total period of record in water years [A]	Drainage area (mi^2) [B]	Maximum peak discharge [C] (cfs)	Daily mean discharge (cfs)
09512165 Salt River at Priest Drive near Phoenix, AZ	1994–present	13,223	81,400 (2/16/1995)	170
09479350 Gila River near Maricopa, AZ	1995–present	19,915	1,080 (7/31/2006)	0.3
09479500 Gila River near Laveen, AZ	1940–1995	20,615	41,900 (1/20/1993)	61
09489000 Santa Cruz River near Laveen, AZ	1940–present	8,581	33,000 (10/4/1983)	17
09514100 Gila River at Estrella Parkway, near Goodyear, AZ	1993–present	45,585	162,000 (1/9/1993)	540
09514200 Waterman Wash near Buckeye, AZ	1965–2013	420	9,400 (8/8/1997)	No daily streamflow records
09517000 Hassayampa River near Arlington, AZ	1960–present	1,471	39,000 (9/5/1970)	54
09518500 Gila Bend Canal at Gillespie Dam, AZ	1976–present	49,650	No peak streamflow records	78
09519500/1 Gila River below Gillespie Dam, AZ	1891–2013 Low-flow gage: 1993–present		178,000 (2/16/1980)	710

Table footnotes:

[A] Period of records utilized in the flood-frequency and daily-duration analyses slightly differ from the total period of record due to data gaps and/or unreliable historical data. Source data from USGS.

[B] Drainage area of square miles (mi^2) from USGS.

[C] Peak discharge and daily mean discharge considered through the end of water year 2014. Source data from USGS; analysis by Stillwater Sciences.

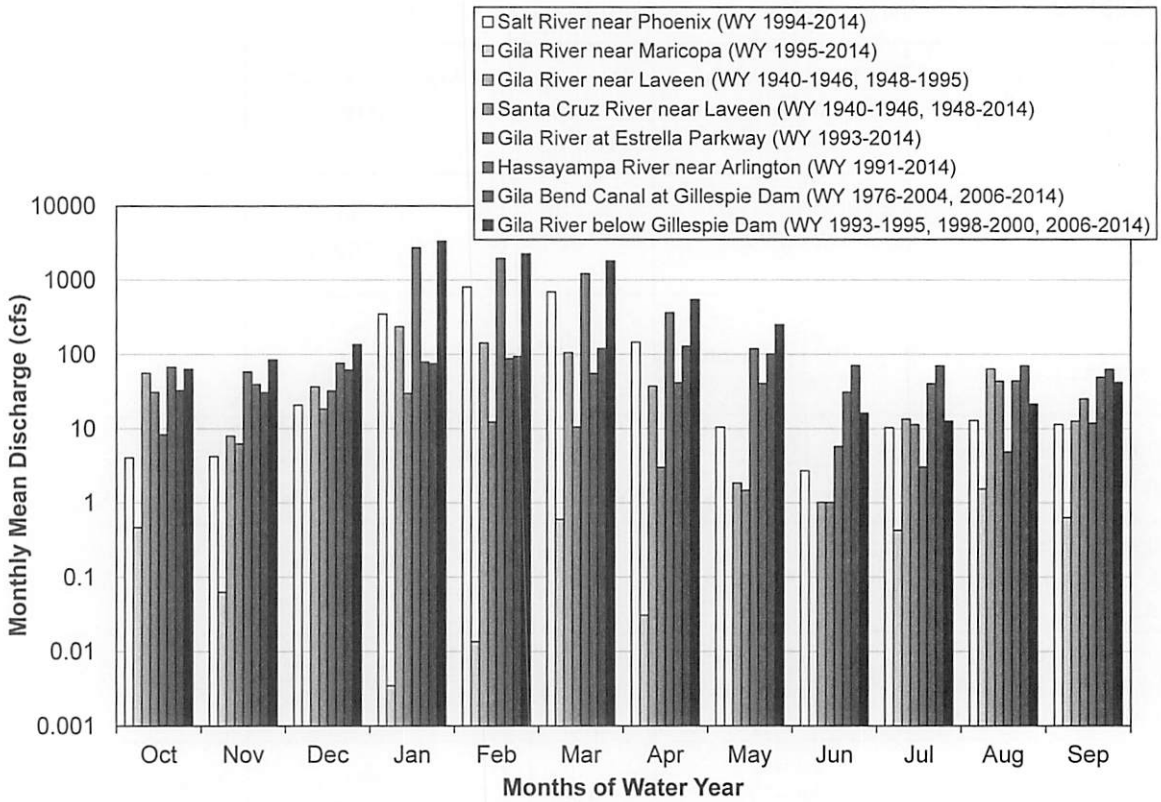
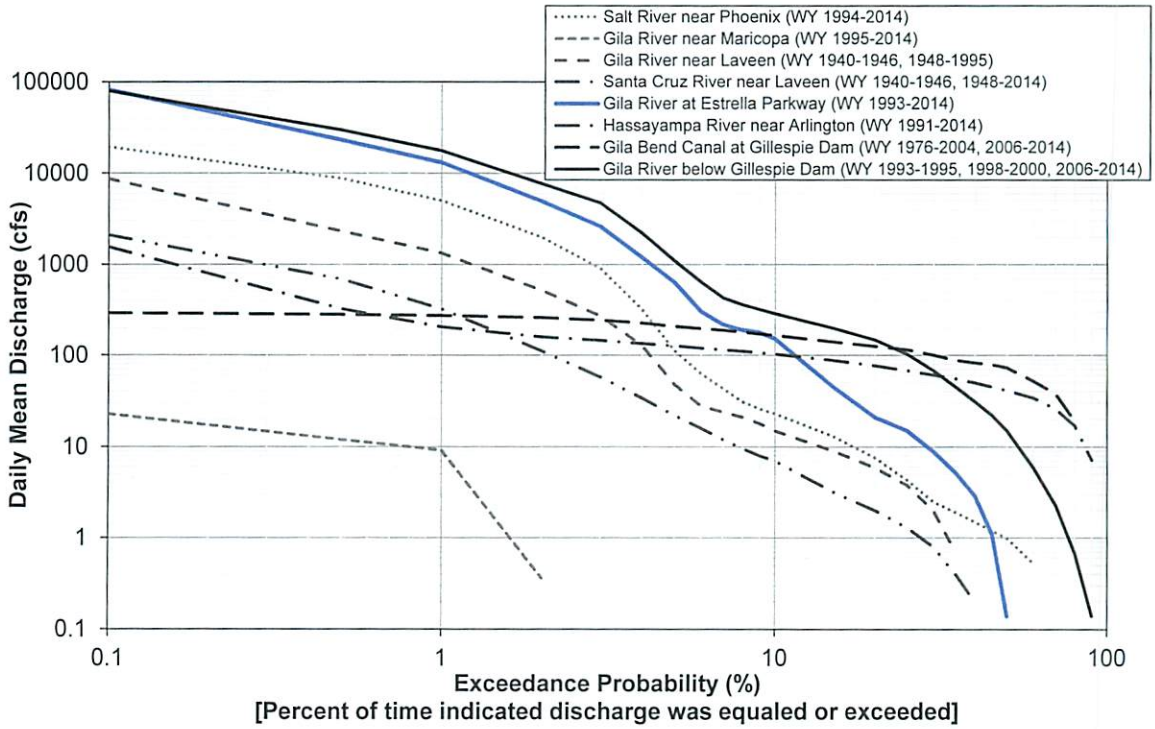


Figure 5. Monthly mean discharge computed at eight long-term streamflow gages near the planning area (source data from USGS; analysis by Stillwater Sciences).

Daily flows in a given water year average about 500 cubic feet per second (cfs) in the El Rio reach (from the Estrella Parkway gage), and appear to increase along its length as indicated by the average daily flows of about 700 cfs recorded at the Gila River below Gillespie Dam low-flow gage (Figure 6a,b). This accretion is driven by agricultural return flow and rising groundwater as the valley depth shallows towards the Gila Bend Mountains (HydroLogic 2006). Accordingly, the density of riparian vegetation also increases in the downstream direction of the reach (see Section 2.8 Vegetation below). Overall, mean daily flows in the reach are typically less than 200 cfs for 90 percent of the time (as recorded at the Estrella Parkway gage), and less than 1 cfs for 50 percent of the time (Figure 6a, b).

a)



b)

Parameter			Stream Gage Location							
			Salt River at Priest Dr. near Phoenix, AZ	Gila River near Maricopa, AZ	Gila River near Laveen, AZ	Santa Cruz River near Laveen, AZ	Gila River at Estrella Parkway, near Goodyear, AZ	Hassayampa River near Arlinghton, AZ	Gila Bend Canal at Gillespie Dam, AZ	Gila River below Gillespie Dam, AZ
Water Years			1994-2014	1995-2014	1940-1946, 1948-1995	1940-1946, 1948-2014	1993-2014	1991-2014	1976-2004, 2006-2014	1993-1995, 1998-2000, 2006-2014
Number of Samples			7,603	7,075	19,832	26,876	8,035	8,766	13,880	5,478
Flow (cfs)	Mean		170	0.3	61	17	536	54	78	708
	Std. Dev.		1388	7	683	217	4669	106	65	5028
	Minimum		0	0	0	0	0	0	0	0
	Exceedance Probability (%)	100%	0	0	0	0	0	0	0	0
		90%	0	0	0	0	0	7	0	0
		80%	0	0	0	0	0	17	19	1
		70%	0	0	0	0	0	26	38	2
		60%	1	0	0	0	0	34	52	6
		50%	1	0	0	0	0	41	73	15
		40%	2	0	0	0	3	50	83	31
		30%	3	0	2	1	9	61	101	68
		20%	8	0	6	2	21	77	126	148
		10%	23	0	15	7	153	103	166	290
		5%	113	0	48	22	641	127	209	1100
		1%	5018	9	1333	327	13200	206	275	17800
		0.10%	19540	23	8683	2102	82667	1559	293	80000
		0.01%	40600	469	36500	18000	132000	5400	304	130000
	Maximum		40600	469	36500	18000	132000	5400	304	130000

Figure 6. Mean daily flow duration curves (a) and statistics (b) for eight long-term streamflow gages near the planning area (source data from USGS; analysis by Stillwater Sciences).

The District and Stantec have performed extensive analyses of the flood hydrology in the planning reach as part of the WMP and subsequent floodplain delineation studies (*e.g.*, Stantec 2002). This information is valuable for managing riparian resources as the potential for impacts from flood-induced scour remains high despite the numerous dams and diversions located upstream. Annual peak flows in the El Rio reach can be characterized as "flashy": they are massive in comparison with the mean daily flows (*e.g.*, 540 cfs versus 162,000 cfs [see Table 1]), but usually span only a few hours to days. The two largest floods of record at the Gillespie Dam occurred in 1980 and 1993, which were estimated to have peaked at 178,000 and 130,000 cfs, respectively (Stantec 2002). The WMP studies reported the 5-, 10-, and 100-year flood return-periods for the El Rio reach near the confluence with Waterman Wash as 17,000, 160,000, and 210,000 cfs, respectively (Stantec 2002). These values were taken from the March 1996 U.S. Army Corps of Engineers (USACE) report for the modifications to Roosevelt Dam (USACE 1996, as cited in Stantec 2002). The two largest peak flows at the nearby Estrella Parkway gage since the WMP studies were completed in the early 2000s were 29,900 and 20,900 cfs (850 and 590 cubic meters per second [cms]), and occurred in February 2005 and January 2010, respectively (Figure 7). The Plan must therefore consider the potential for large channel-scouring floods to occur in any given water year.

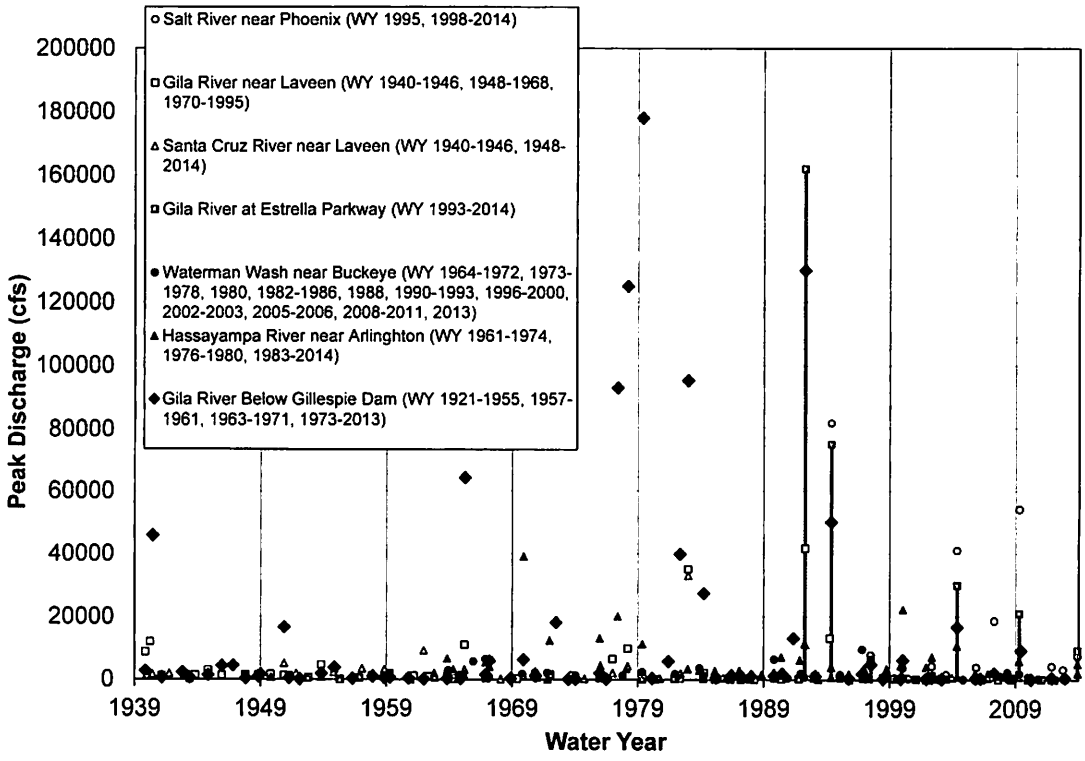
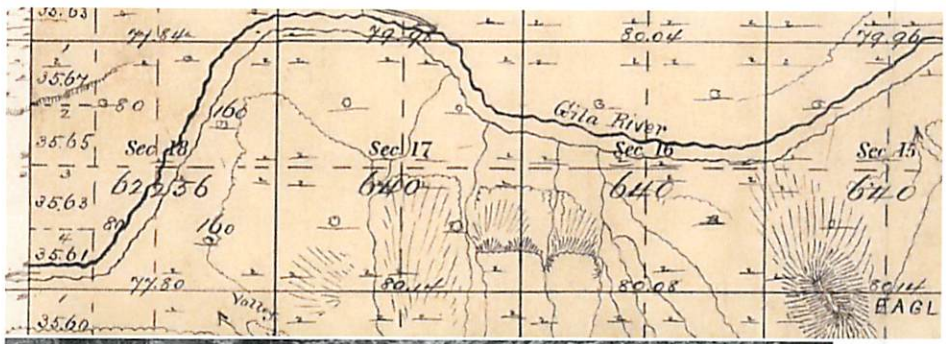


Figure 7. Historical peak streamflows through water year 2014 at six long-term streamflow gages near the planning area (source data from USGS; analysis by Stillwater Sciences).

2.5.2 Channel morphology and flood-scour potential

The geomorphic character of the El Rio reach was thoroughly assessed by JE Fuller as part of the WMP studies (JE Fuller 2005), which greatly benefits the information baseline to be considered by the Plan. The results revealed that the low-flow channel position can shift across the broad river bottom during single or successive flood events according to the magnitude of the event and other factors, such as sediment loading, floodplain encroachment, and previous vegetation clearing. Historical views of the downstream extent of the El Rio reach near the City of Buckeye are presented in Figure 8.

a) **1883 Original Land Claim Map** (source: BLM General Land Office)



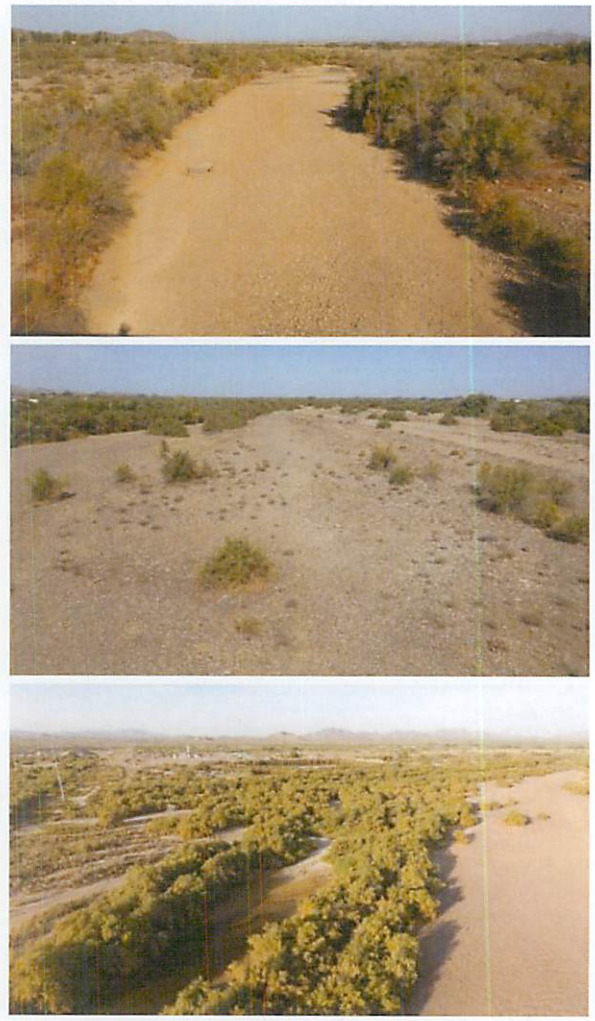
b) **Jul 1941 Aerial Photograph, following 45,800 cfs in Mar 1941** (source: USDA)

c) **Dec 1991 Aerial Photograph, before 162,000 cfs in Jan 1993** (source: USGS)

d) **Jun 2013 Aerial Photograph** (source: USDA)

Figure 8. Historical views of the El Rio reach showing adjustments in the river morphology.

The geomorphology of the El Rio reach is relatively homogenous along its length and width, consisting primarily of a broad, low gradient, compound channel composed of a mixed assemblage of sediment types and sizes (see photos at right). The floodway is bordered by a higher floodplain surface supporting crop cultivation and some urban developments. Sediments actively accrete and scour during flood events. The sediment character in the low-flow channel and floodway is varied throughout, consisting of sand- and gravel/cobble-dominated expanses (*i.e.*, cobble strand), with finer materials concentrated in densely vegetated patches and/or topographically higher surfaces (see Section 2.6 Soils below). As a compound channel with an episodic flow regime, the appearance of the river changes depending on stage, where a single, highly sinuous channel is evident during lower flows, a braided-channel appearance develops during moderately sized floods, and a large, single-thread river emerges during the largest floods.



Downstream views of the planning area during drier conditions: from S Bullard Ave bridge *(top)*; from S Tuthill Rd bridge *(middle)*; and near Highway 85 bridge *(bottom)* (Photos by Stillwater Sciences)

The contemporary appearance and function of the river is thought to be vastly different from the pre-settlement channel morphology due to invasive vegetation establishment (saltcedar), sand and gravel mining, floodplain encroachment, bridges, and dam construction upstream and downstream (Graf 1988) (see Figure 8). JE Fuller reported that early accounts of the river channel in the mid-1800s describe a wide, braided system with defined channels lined with cottonwoods and bushes (Ross 1923 and Huckleberry 1993, both as cited in JE Fuller 2005). Graf (1988, figure 6.12) describes the process by which the naturalization and eventual dominance of saltcedar came to dominate and forever re-shape the Gila River in the Buckeye Valley through induced sedimentation and changes in bank resistance, particularly where saltcedar density is greatest in the lower half of the valley as a consequence of the shallow water table and baseflow sustained by agricultural runoff and treated wastewater effluent, even during the otherwise dry seasons. Over-steepened streambanks and fine-sediment accumulation in the denser stands of saltcedar are ubiquitous features in the El Rio reach, particularly in its lower half between the South Tuthill Rd and Highway 85 bridges (see Section 2.8 Vegetation below).

The most recent active-channel area delineated in JE Fuller's analysis represented conditions through 2002 which, when compared to aerial imagery from 2014 and the LiDAR dataset from 2015, appears almost wholly unchanged (Figure 9). This outcome is somewhat expected

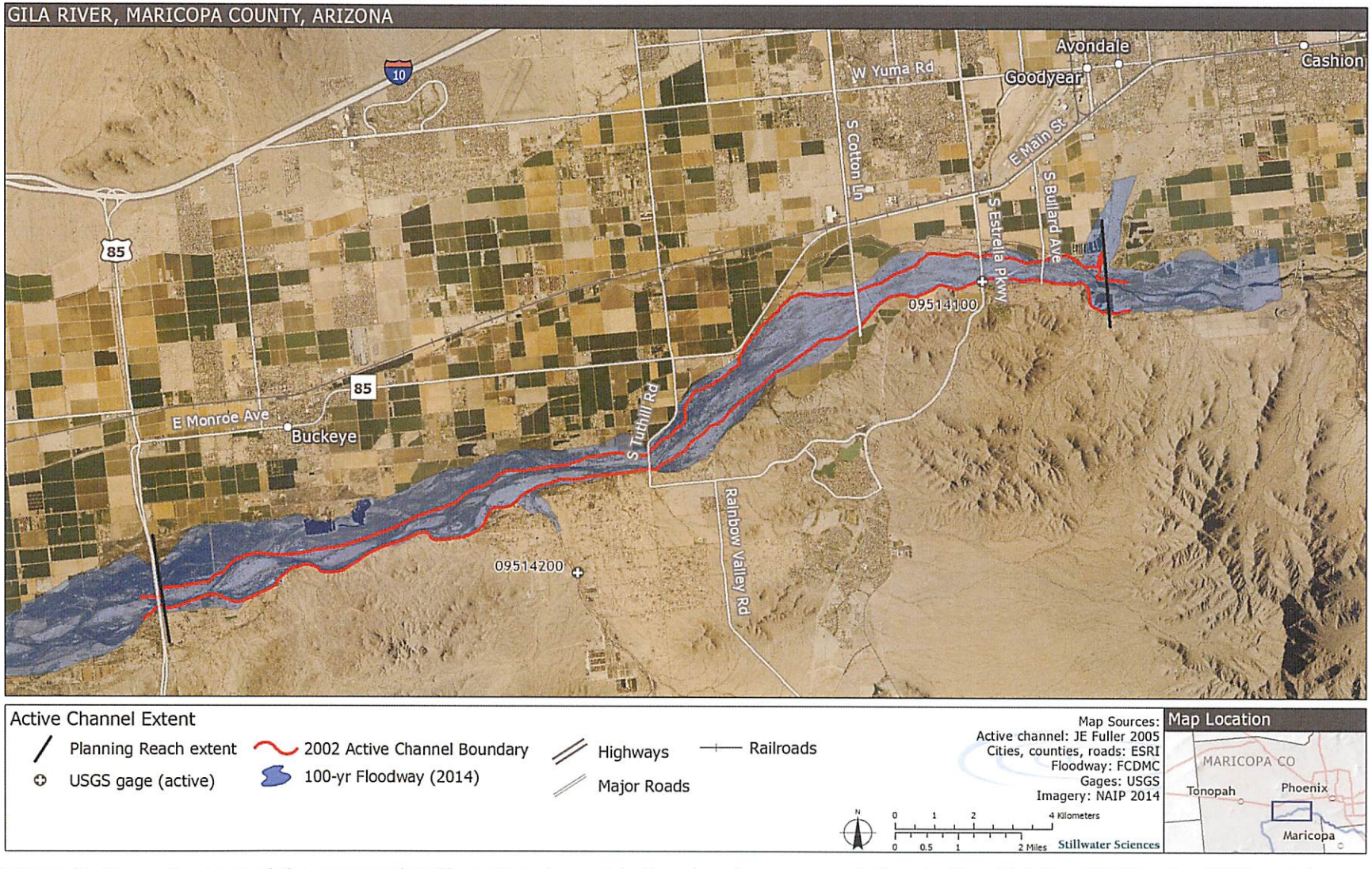


Figure 9. Mapped extent of the geomorphically active channel in the planning area, as delineated by JE Fuller (2005) using 2002 aerial photography.

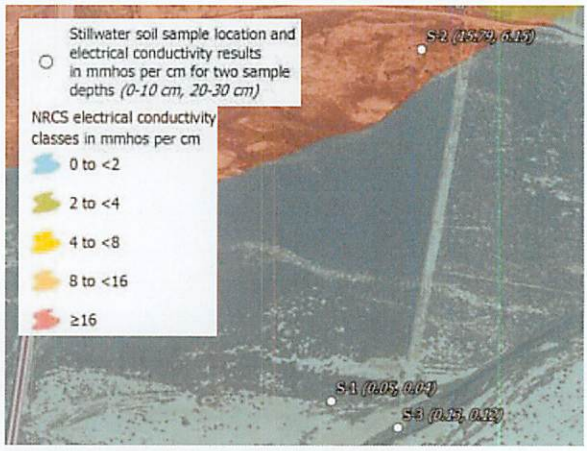
considering that the flood activity over the past 13 years has been minimal compared with the floods of the 1980s and 90s. Therefore, the active channel area of 2002, which aligns closely to the most barren portions of the floodway in 2015, may be re-purposed to represent the "flood reset zone," within which management actions will need to consider flood-disturbance risks.

2.6 Soils

Equally important to vegetation management are soil conditions, such as texture and salinity. Surficial soils in the planning area were therefore examined through review of published literature and maps, and field-sample collection to help further characterize planting suitability and inform Plan development. The Environmental Resources Report (Stantec 2003) published in support of the El Rio WMP acknowledged a need to generate specific soil data in the planning area to assist with vegetation management.

2.6.1 Review of existing information

Soils mapped by the Natural Resources Conservation Service (NRCS) in the planning area reflect the depositional and erosional patterns of surficial sediments and *in situ* formation of soil materials (NRCS 2007). The river corridor portion of the planning area expected to host vegetation management activities is primarily composed of Carrizo and Brios soils, described as very deep, excessively drained soils formed in arid climates and of mixed igneous alluvium (NRCS 2007). In general, these soil types are described as excessively well drained, gravelly sand alluvium with minor fractions of clay. Organic content and salinity levels are reported to be generally low. Soil reaction, or *pH*, is reported to be moderately alkaline. Additional details are presented in Table 2. A comprehensive, tabular summary of the two soil units mapped by NRCS in the planning area is presented in Appendix B. Map tiles depicting soil salinity estimated by the NRCS are also presented in Appendix B (see excerpt from soil salinity maps above). While spatially detailed, the NRCS mapping data is too coarse for assessing soil suitability for vegetation-related actions at the site scale.



Excerpt of soil salinity and sample location maps (see Appendix B for complete map tiles)

In 2009, Stantec performed a comprehensive, field-based sediment characterization effort in the planning area, which concluded that the reach is composed of a wide range of particle sizes, from clays and silts up through large cobbles (Stantec 2009). The river bed material is predominately coarse sand and gravel, with some cobbles (*i.e.*, bed-material load), while densely vegetated and topographically higher surfaces are composed of clays, silts, and fine sands (*i.e.*, wash load).

2.6.2 Soil sampling and analytical results

Shallow soil samples were collected throughout the planning area and analyzed for soil texture, electrical conductivity (*EC*), and soil reaction (*pH*) to assess suitability of active planting in the

planning area (see photos at right). Measurements of EC and *pH* help to characterize soil physical and chemical properties, namely salinity, which can be a limiting factor for successful propagation of many types of riparian vegetation, such as cottonwood and willows. The sampling methods, results, and implications for vegetation management are discussed below.

A total of twenty-one locations along nine transects were sampled between June 28 and July 2, 2015. At least two sample locations were situated along a given transect to help characterize lateral variability across the width of the river channel and floodway. Sampling locations focused on areas with soil development, which were typically well vegetated, and avoided gravel and cobble bars, which were typically devoid of vegetation. Soil samples were collected using a 6-inch long, 2.5-inch diameter, stainless steel, hand-auger sampler. Approximately 16 ounces of material were collected consistently from two soil horizons at each location: surface layer (0–10 centimeters [cm]) and subsurface layer (20–30 cm). Soil sample locations are shown on the map tiles in Appendix B.

View of silty sand soils *(top)* and sandy gravels (not sampled) *(bottom)* in the El Rio reach (Photos by Stillwater Sciences)

Laboratory analyses on the 42 soil samples were performed by Restoration Science, LLC operating at the University of California at Santa Barbara. A copy of the laboratory report is included in Appendix B.

The laboratory results indicate that the sampled soils were predominately composed of sand with considerably smaller proportions of finer-grained silts and clay (Table 3). Silt-dominated soils were present at sample locations S-2 and S-6, both of which were collected near the downstream end of the planning reach along the northern side of the floodway (see Figure B-1). The measured soil reaction, or *pH*, values ranged between 6.6 and 7.9, which indicates the soils are predominately neutral or slightly alkaline. There were some instances of moderately alkaline conditions detected in sample locations S-2, S-5, and S-16. The salinity, or *EC*, concentrations detected in all but one sample location ranged from 0.02 to 1.53 millimhos per centimeter (mmhos/cm), which is indicative of non-saline conditions (Table 3). Slightly to moderately saline conditions, with values of 6.15 to 15.79 mmhos/cm, were detected at sample locations S-2.

Further consideration of the laboratory results reveals that neither the measured values of *pH* or *EC* are significantly correlated with soil-horizon depth. Salinity does appear to be inversely correlated to proportion of sand content ($R^2 \approx 60\%$), meaning lower salinity levels are associated with sand-dominated soils (Figure 10). No such correlation occurs between *pH* and sand content ($R^2 \approx 10\%$). All sample locations exhibiting silt-dominated texture *(i.e.*, S-2 and S-6) or moderate alkalinity (*i.e.*, S-2, S-5, and S-16) lie outside of the active channel boundary delineated by JE Fuller (2005) based on geomorphic conditions in 2002 (see Figure 9).

Table 3. Texture and chemistry results of soils sampled in the planning area.

Sample ID [A]	Transect ID	Soil Texture [B]				Soil Chemistry [C]			
						Reaction		Salinity	
		% Sand	% Silt	% Clay	Dominant Texture Class	*pH*	NRCS Classification	*EC* (mmhos/cm)	NRCS Classification
S-1 @ 0-10 cm	1	83.5	2.5	14.0	Sand	7.04	Neutral	0.05	Nonsaline
S-1 @ 20-30 cm	1	86.0	0.0	14.0	Sand	6.97	Neutral	0.04	Nonsaline
S-2 @ 0-10 cm	1	28.5	50.0	21.5	Silt	7.42	Slightly Alkaline	15.79	Moderately Saline
S-2 @ 20-30 cm	1	28.5	52.5	19.0	Silt	7.92	Moderately Alkaline	6.15	Slightly Saline
S-3 @ 0-10 cm	1	76.0	7.5	16.5	Sand	6.74	Neutral	0.13	Nonsaline
S-3 @ 20-30 cm	1	81.0	5.0	14.0	Sand	6.83	Neutral	0.12	Nonsaline
S-4 @ 0-10 cm	2	83.5	2.5	14.0	Sand	7.41	Slightly Alkaline	0.06	Nonsaline
S-4 @ 20-30 cm	2	83.5	0.0	16.5	Sand	7.09	Neutral	0.03	Nonsaline
S-5 @ 0-10 cm	2	56.0	27.5	16.5	Sand	7.94	Moderately Alkaline	0.13	Nonsaline
S-5 @ 20-30 cm	2	61.0	22.5	16.5	Sand	6.64	Neutral	0.86	Nonsaline
S-6 @ 0-10 cm	2	41.0	42.5	16.5	Silt	7.06	Neutral	0.92	Nonsaline
S-6 @ 20-30 cm	2	33.5	50.0	16.5	Silt	7.44	Slightly Alkaline	0.61	Nonsaline
S-7 @ 0-10 cm	4	68.5	15.0	16.5	Sand	6.68	Neutral	0.44	Nonsaline
S-7 @ 20-30 cm	4	51.0	32.5	16.5	Sand	7.56	Slightly Alkaline	0.68	Nonsaline
S-8 @ 0-10 cm	4	71.0	12.5	16.5	Sand	6.89	Neutral	0.18	Nonsaline
S-8 @ 20-30 cm	4	81.0	5.0	14.0	Sand	6.82	Neutral	0.08	Nonsaline
S-9 @ 0-10 cm	5	66.0	20.0	14.0	Sand	7.43	Slightly Alkaline	1.53	Nonsaline
S-9 @ 20-30 cm	5	83.5	0.0	16.5	Sand	7.62	Slightly Alkaline	0.33	Nonsaline
S-10 @ 0-10 cm	5	78.5	7.5	14.0	Sand	6.88	Neutral	0.04	Nonsaline
S-10 @ 20-30 cm	5	81.0	5.0	14.0	Sand	7.42	Slightly Alkaline	0.04	Nonsaline
S-11 @ 0-10 cm	5	83.5	2.5	14.0	Sand	6.90	Neutral	0.02	Nonsaline
S-11 @ 20-30 cm	5	86.0	0.0	14.0	Sand	7.23	Neutral	0.02	Nonsaline
S-12 @ 0-10 cm	8	61.0	22.5	16.5	Sand	6.72	Neutral	0.34	Nonsaline
S-12 @ 20-30 cm	8	71.0	12.5	16.5	Sand	7.56	Slightly Alkaline	0.15	Nonsaline
S-13 @ 0-10 cm	8	76.0	10.0	14.0	Sand	7.57	Slightly Alkaline	0.95	Nonsaline
S-13 @ 20-30 cm	8	83.5	0.0	16.5	Sand	6.97	Neutral	0.15	Nonsaline
S-16 @ 0-10 cm	10	83.5	5.0	11.5	Sand	7.89	Moderately Alkaline	0.04	Nonsaline
S-16 @ 20-30 cm	10	81.0	2.5	16.5	Sand	6.92	Neutral	0.04	Nonsaline

Sample ID [A]	Transect ID	Soil Texture [B]				Soil Chemistry [C]			
						Reaction		Salinity	
		% Sand	% Silt	% Clay	Dominant Texture Class	*pH*	NRCS Classification	*EC* (mmhos/cm)	NRCS Classification
S-17 @ 0-10 cm	10	86.0	0.0	14.0	Sand	6.82	Neutral	0.03	Nonsaline
S-17 @ 20-30 cm	10	83.5	0.0	16.5	Sand	6.93	Neutral	0.04	Nonsaline
S-18 @ 0-10 cm	11	73.5	10.0	16.5	Sand	6.90	Neutral	0.42	Nonsaline
S-18 @ 20-30 cm	11	86.0	0.0	14.0	Sand	6.82	Neutral	0.17	Nonsaline
S-19 @ 0-10 cm	11	73.5	10.0	16.5	Sand	7.36	Slightly Alkaline	1.35	Nonsaline
S-19 @ 20-30 cm	11	73.5	10.0	16.5	Sand	6.81	Neutral	0.31	Nonsaline
S-20 @ 0-10 cm	12	86.0	0.0	14.0	Sand	7.26	Neutral	0.03	Nonsaline
S-20 @ 10-20 cm	12	86.0	0.0	14.0	Sand	6.94	Neutral	0.04	Nonsaline
S-21 @ 0-10 cm	12	81.0	5.0	14.0	Sand	6.92	Neutral	0.04	Nonsaline
S-21 @ 20-30 cm	12	66.0	17.5	16.5	Sand	6.92	Neutral	0.06	Nonsaline
S-22 @ 0-10 cm	14	78.5	7.5	14.0	Sand	6.73	Neutral	0.13	Nonsaline
S-22 @ 20-30 cm	14	63.5	20.0	16.5	Sand	7.04	Neutral	0.07	Nonsaline
S-23 @ 0-10 cm	14	73.5	12.5	14.0	Sand	7.00	Neutral	0.05	Nonsaline
S-23 @ 20-30 cm	14	78.5	5.0	16.5	Sand	7.33	Slightly Alkaline	0.06	Nonsaline

Table footnotes:

[A] Locations S-14 and S-15 were not sampled.

[B] Texture analysis performed by Restoration Science, LLC following American Society for Testing and Materials (ASTM) D422 (sieve & hydrometer [for silt/clay samples] or sieve with #200 wash [for sand samples]) protocol (see attached laboratory reports in Appendix B). Particle size ranges, as based on the Udden-Wentworth scale, are:

i. Gravel: 64–2 millimeters (mm [2.5–0.08 in])
ii. Sand: 2–0.0625 mm (0.08–0.0025 in)
iii. Silt: 0.0625–0.0039 mm (2.5×10^{-3}–1.5×10^{-4} in)
iv. Clay: <0.0039 mm (<1.5×10^{-4} in)

[C] Reaction, or *pH*, and salinity, or *EC*, analyses performed by Restoration Science, LLC following ASTM D4972 and Rayment and Higginson (1992), respectively (see laboratory reports in Appendix B. See classifications of soil *pH* and *EC* in footnotes of Table 2 above.

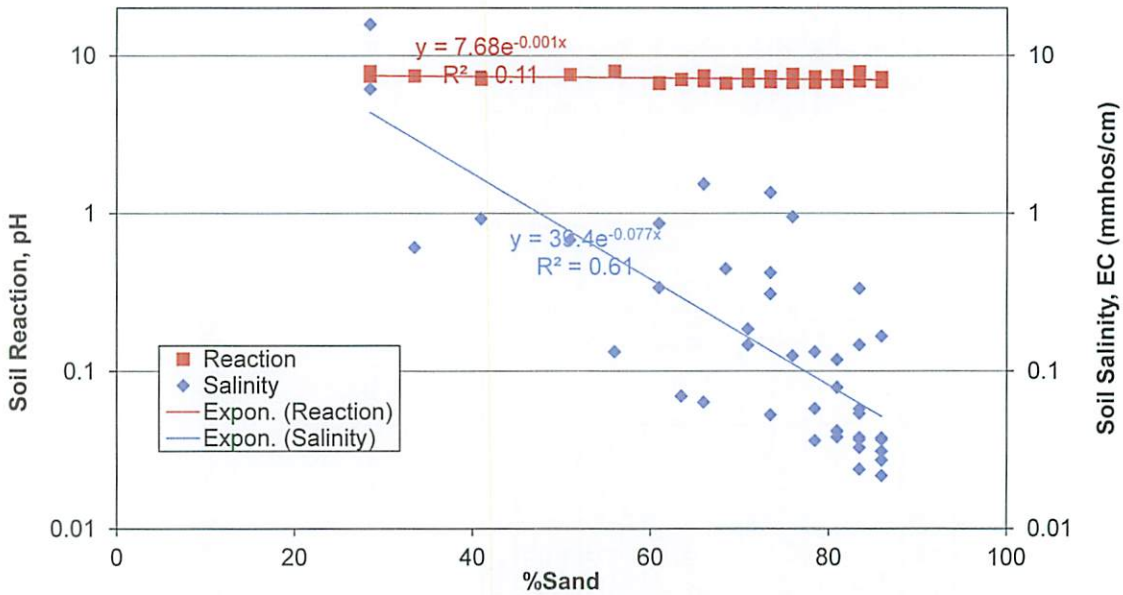


Figure 10. Relationships of soil reaction (*pH*) and salinity (*EC*) with proportion of sand measured in soils collected in the planning area (source data from Stillwater).

2.7 Groundwater

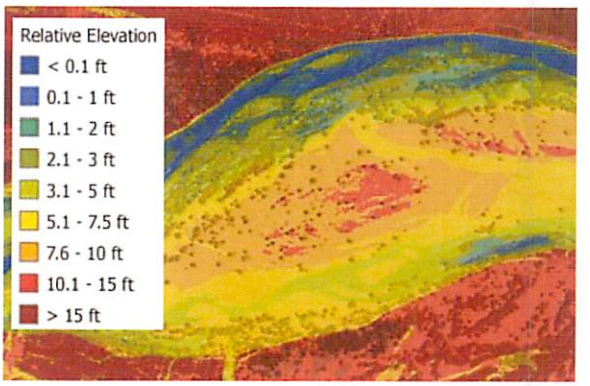
Examination of groundwater levels and processes within the planning area was undertaken to assist with identification of appropriate management actions. The survival of native riparian trees, whether naturally recruited or planted, depends on having root systems that remain in contact with groundwater or perennially moist soils. Plants on floodplains with rapidly declining groundwater tables, or in areas that experience high diurnal fluctuations in groundwater depth (*e.g.*, from groundwater extraction through pumping or evapotranspiration), often undergo severe water deficits. These conditions result in low plant productivity, canopy dieback and/or mortality, and ultimately reduce the prospects for successful native plant revegetation.

Although successful germination of native riparian seedlings depends on a variety of hydrologic and geomorphic variables, seedling survival of phreatophytes such as cottonwoods and willows following germination (or of planted cuttings or container stock under horticultural restoration) is above all contingent on constant contact with the water table and/or its capillary fringe throughout the growing season (McBride and Strahan 1984, Stromberg *et al.* 1991). Research indicates that when the water table decline is more rapid over a long period than the rate of root growth, seedlings of phreatophytic species become isolated from their water source and suffer high mortality (McBride *et al.* 1989, Stromberg *et al.* 1996). In addition to the importance of groundwater levels for seedling survival, research indicates that groundwater levels play an integral role in determining sapling survivorship and adult riparian community composition (Smith *et al.* 1991, Merritt and Bateman 2012). Furthermore, comparative studies indicate that some non-native plant species (such as saltcedar) are more drought-tolerant than natives, and thus are better able to establish and persist along reaches with extreme inter- and intra-annual water table fluctuations (Smith *et al.* 1991; Friedman *et al.* 1995; Shafroth *et al.* 1998, 2000).

The WMP included a comprehensive groundwater analysis of the system, including the local, shallow water table that supports the vegetation communities in the planning reach (HydroLogic 2006). Through compilation of numerous well data (mostly water production wells on the farmed

portions of the floodplain) and modeling of groundwater processes, the study evaluated current trends and dependability of water supply in the near future. Review of this past work, as well as JE Fuller's map of groundwater-depth contours (Figure 7 in JE Fuller 2005), reveals the depth to groundwater during average water-year conditions is as shallow as 10 feet (ft), principally along the low-flow channel trace(s) and lower half of the El Rio reach (*i.e.*, downstream of S Tuthill Rd bridge), and as deep as 30 ft. The water-surface levels in the sand and gravel mining ponds generally coincide with the local water table.

We additionally evaluated shallow groundwater levels by creating a relative-elevation surface map derived from the April 2015 LiDAR dataset. The surface consists of elevation-height contours above the water surface elevation of the low-flow channel (see excerpt from Appendix C maps at right). Based on our work on the upper Gila River in eastern Arizona (Orr *et al.* 2014), and elsewhere, this approach provides a reliable means to estimate depth to shallow groundwater below the floodway ground surface throughout the study reach. The relative-elevation contours are consistent with measured groundwater depths compiled for the WMP studies. We additionally compared the relative elevation values to measured water levels in older wells installed within the planning reach as published by the Arizona Department of Water Resources (ADWR: https://gisweb.azwater.gov/), which revealed a fair correlation ($R^2 \approx 55\%$) (Figure 11). Because of the coarse substrates present throughout the entire planning reach, field-based validation of shallow groundwater levels via exploratory wells was not possible with traditional, manually operated soil-coring or drive-point equipment.



Excerpt of relative-elevation surface maps (see Appendix C for complete map tiles)

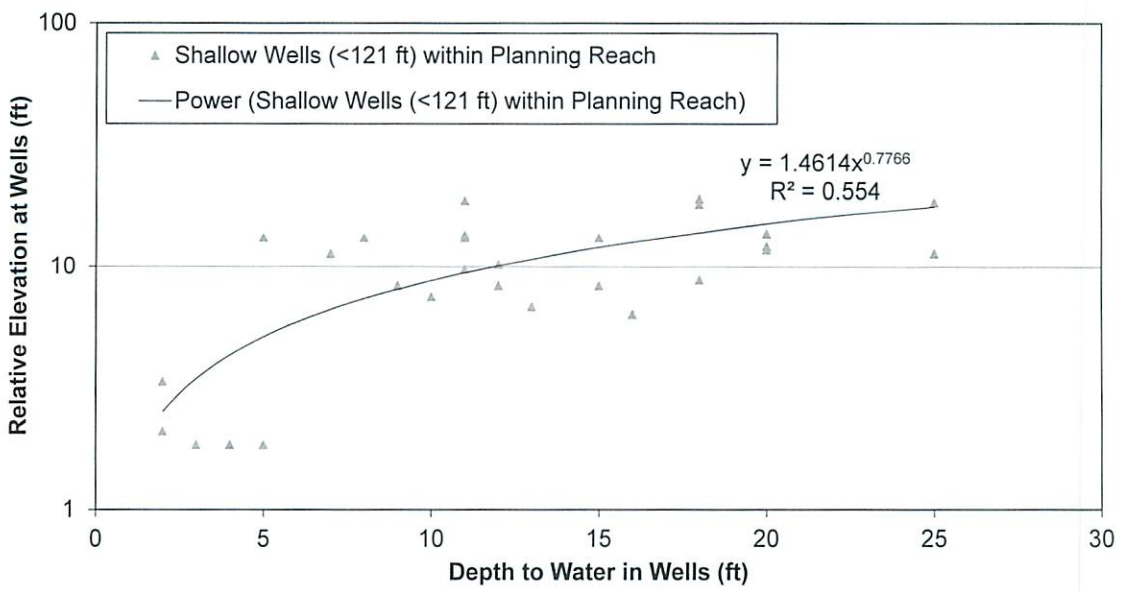


Figure 11. Plotted relationship of measured depth to water in wells shallower than 120 feet below ground surface and relative ground-surface elevations above the low-flow river channel's water surface elevation (source data from ADWR and Stillwater).

The relationship between relative elevation and depth to groundwater, however, apparently shifts in the upper half of the El Rio reach between approximately the crossings of the Tuthill Road and Bullard Avenue bridges, where the depth to groundwater is seemingly greater based on a general lack of vegetation and surface water ponding (which is prevalent in the downstream half of the reach even during the dry season). The Plan will need to incorporate this condition in development of appropriate management actions.

2.8 Vegetation

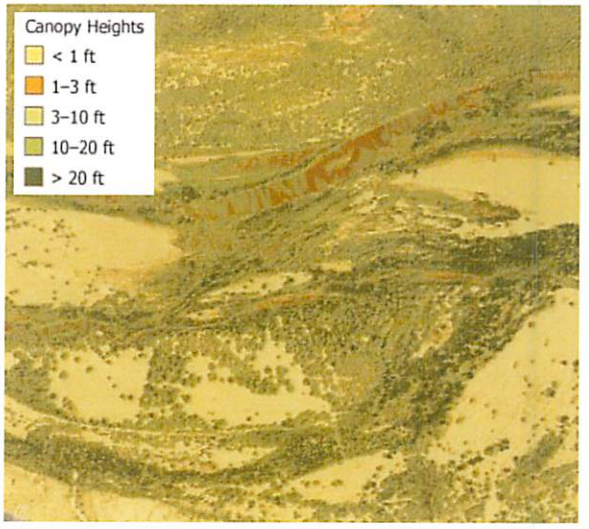
Vegetation in the planning area was mapped and plot data were collected to characterize contemporary riparian vegetation composition and distribution patterns in the planning area, and to better understand the relationships between vegetation and physical conditions in the riparian corridor. The goals of this characterization were to understand how riparian vegetation conditions have changed since a previous vegetation mapping effort in 2002/2003 (EcoPlan 2003), and how those changes may be influencing river hydraulics, and to inform the selection of suitable restoration areas based on the understanding of the physical conditions that do, or could, support the establishment and growth of native vegetation types.

2.8.1 Plot survey and vegetation mapping methods

To characterize riparian vegetation patterns, we collected vegetation composition and physical condition data at 68 plots spread across the planning area. We first reviewed aerial photography, previous vegetation mapping (Stantec 2003), relative elevation data (see Appendix C), and LiDAR-derived canopy-height data (see maps in Appendix D) to select accessible plot locations that represented the variety of vegetation and topographic conditions in the planning area. Each plot was visited between June 28 and July 3, 2015 by a plant ecologist with knowledge of the plant species of the Gila River valley and Sonoran Desert. Plots varied in size based on the stature of the vegetation and the area visible to the field crew, but were generally 400 square meters (20 x 20 meters). At each plot, a geotagged photograph was taken to both record the location of the plot and document plot conditions, and the following data were recorded:

- **Estimated time since last flooded:** <1, 1–2, 3–5, 6–10, or >10 years
- **Soil texture:** gravel, silt, loam, clay, sand
- **Topography:** convex, flat, concave, undulating
- **Percent ground cover of:** water, vegetation, organic debris, cobble/boulder, gravel, and fine sediments
- **Evidence of:** flooding, fire, and agricultural, wastewater, or stormwater return flows
- **Types and intensities of unnatural disturbances:** competition from nonnative invasive species, off-road vehicle use, and bulldozing/earth moving, for example
- **Vegetation-type dominance:** trees, shrubs, or forbs
- **Tree, shrub, and herb phenology:** early, peak, or late
- **Species:** name, age (*e.g.*, seedling, mature, decadent), and percent cover of all prevalent plants
- **Vegetation type:** name of primary type and any adjacent type; the vegetation types loosely correspond to those used by EcoPlan (2003), but have been revised in some instances to better characterize contemporary conditions and/or correspond to group or alliance levels of the U.S. National Vegetation Classification (NVC) system (http://usnvc.org/).

Back in the office, the relative elevation and canopy height (see excerpt from Appendix D maps at right) of each plot were queried in a geographic information system (GIS) and appended to the field-collected data in a Microsoft Excel spreadsheet. The canopy height GIS query included a 100-foot buffer around each survey plot centroid, in order to capture the variation in the surrounding canopy height and to account for possible error in the global positioning system (GPS) coordinates of the plot location. The frequency at which several native species occur in several different relative-elevation zones was plotted. All plot data, whether collected in the field or derived in GIS, are tabulated in Appendix D.

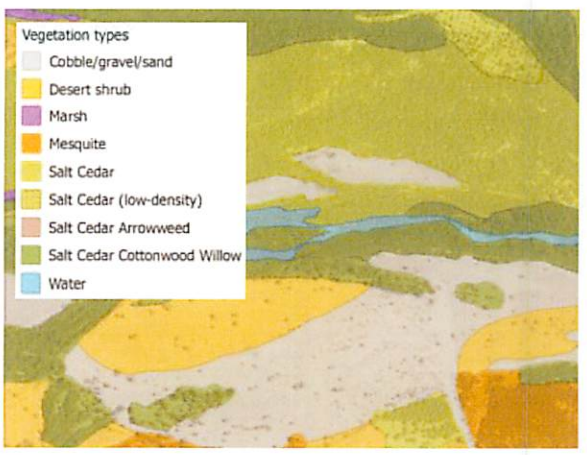


Excerpt of vegetation canopy height maps (see Appendix D for complete map tiles)

Aerial photography interpretation of 2013 imagery of the planning area, along with the plot data and other observations made in the field during the plot surveys, were then used to update in GIS the vegetation type names and polygon boundaries of the previous vegetation map (Stantec 2003) of the planning area.

2.8.2 Vegetation types and distribution patterns

Vegetation and other land cover types in the planning area are presented as map tiles in Appendix D, and summarized in Table 4 (see excerpt from Appendix D maps at right). Also listed in Table 4 are the average and maximum canopy heights that were derived from GIS for most of the vegetation types in the planning area, which can serve as a proxy for wildlife habitat availability and productivity. The primary vegetation types in the planning area, as documented during the plot survey, and the major patterns in their distribution in the planning area are described in the sections below.



Excerpt of vegetation type maps (see Appendix D for complete map tiles)

Table 4. Vegetation and other land cover types in the planning area.

Vegetation/Land Cover Type	Subtype	Area (acres)	Mean Canopy Height (feet)
Agriculture	no subtype	217	
Canal/ditch	no subtype	11	
Cobble/gravel/sand [A]	no subtype	740	
Desert shrub	no subtype	*561*	0.76
	Saltbush (*Atriplex* spp.)	*360*	1.56
	Burrobush (*Hymenoclea salsola*)	*19*	n/a
	Mojave seablite (*Suaeda moquinii*)	*48*	n/a
	Rabbitbrush (*Ericameria nauseosa*)	*38*	1.11
	Sandpaper plant (*Petalonyx thurberi*)	*30*	0.11
	Wirelettuce (*Stephanomeria pauciflora*)	*120*	0.87
	Total	1,176	
Developed/road	no subtype	66	
Disturbed [B]	no subtype	242	
Marsh	no subtype	*22*	2.71
	Giant reed *(Arundo donax)*	<1	4.53
	Saltcedar/marsh *(Tamarix* spp./*Typha* spp./ *Schoenoplectus* spp.)	*32*	6.29
	Total	54	
Mesquite	no subtype	*23*	
	Mesquite/Palo verde (*Prosopis* spp./*Parkinsonia* spp.)	*80*	3.17
	Saltcedar/Mesquite (*Tamarix* spp./*Prosopis* spp.)	*114*	4.60
	Total	217	
Saltcedar	Medium–High density	*3,577*	5.39
	Low density	*1,574*	0.75
	Total	5,151	
Saltcedar/cottonwood/ willow	no subtype	*271*	8.19
	Saltcedar/Arrowweed (*Tamarix* spp./*Pluchea sericea)*	*23*	4.21
	Saltcedar/Cottonwood (*Tamarix* spp./*Populus fremontii)*	*26*	7.95
	Saltcedar/Willow (*Tamarix* spp./*Salix* spp.)	*197*	9.56
	Total	517	
Water	no subtype	395	
Grand Total		**8,787**	

Table footnotes:

[A] Includes entirely or largely unvegetated areas of cobble, gravel, or sand. These are primarily alluvial, scoured features in the floodway.

[B] Includes unpaved areas that are subject to regular human land uses, such as high-use off-road vehicle and other recreational uses, garbage dumps, and unpaved staging and storage.

2.8.2.1 Saltcedar

The most common vegetation type in the planning area is saltcedar (or tamarisk, which, in the planning area, primarily includes *Tamarix ramosissima, T. chinensis,* and hybrids of these two species), as summarized in Table 4 and shown in map tiles in Appendix D.

The saltcedar vegetation type was mapped where saltcedar is the dominant species present (see photos at right). Although, it is important to note that saltcedar is also present in every other vegetation type in the planning area with very few exceptions. Areas where saltcedar may still be the dominant species, but Fremont cottonwood (*Populus fremontii*), Goodding's willow (*Salix gooddingii*), arrowweed (*Pluchea sericea*), mesquite (*Prosopis glandulosa* and/or *P. velutina*), and/or palo verde (*Parkinsonia microphylla, P. florida,* and/or *P. aculeata*) occur above 10% cover are mapped separately and described in the sections below to highlight the restoration potential associated with these areas.

Dense, monotypic stand of saltcedar in the river floodway outside Buckeye *(top)*. Low density cover of saltcedar, near Liberty *(bottom)* (Photos by Stillwater Sciences)

Vegetation density in areas mapped as saltcedar can range widely, from continuous and very dense stands to more open areas with only 10% or so of saltcedar cover. Some of these areas are mapped separately as "saltcedar (low density)" to indicate the notable difference in saltcedar density and to emphasize that saltcedar removal will be comparatively easy in these areas, but that physical conditions may not be suitable for the sustainable establishment of other vegetation types as well (*e.g.*, these areas may be too xeric) (see photo above). Saltcedar canopy heights are typically 5 feet, and on average no more than 30 feet. Athel, which is a very tall *Tamarix* species, likely accounts for this high average maximum height. The herbaceous layer in saltcedar stands is often missing or very low in floristic diversity, comprised mostly of a sparse cover of small annual grasses and/or herbs such as Asian mustard (*Brassica tournefortii*), disc mayweed (*Matricaria discoidea*), and Panamint cryptantha (*Cryptantha angustifolia*).

Stands of saltcedar are found under a wide range of conditions. They occur across a range of substrate types, from silt to gravel/cobble, and can tolerate relatively saline soils. Saltcedar can also tolerate a wide variety of flood and scour frequencies, and saltcedar stands are found from stream banks to more mesic upland areas, and at relative elevations ranging from 0 to 15 feet. In comparison to the 2002/2003 vegetation map (Stantec 2003), saltcedar extent has increased by approximately 670 acres in the planning area.

2.8.2.2 Saltcedar/cottonwood/willow

The saltcedar, cottonwood, saltcedar/cottonwood/willow, and saltcedar/willow vegetation types typically have Fremont cottonwood and/or Goodding's or red willow (*Salix laevigata*; probably introduced into the area; Argus 1995) trees present at 10–30% cover. These areas tend to have a dense, high canopy 8–50 feet tall (see photos at right). In the planning area, most cottonwood and willow trees are mature or decadent, and there appears to be very little to no recent natural recruitment of any of these species. Saltcedar is still the dominant species in these vegetation types, with typically 20–90% cover. The understory tends to be more diverse than in saltcedar stands, with mulefat (*Baccharis salicifolia*), arrowweed, and/or mesquite as frequently co-occurring species. Historical herbarium records from the Agua Fria River near the confluence with the Gila River suggest that shrubby, clonally-spreading coyote willow (*Salix exigua*) was likely a historically frequent component of the riparian understory (SEINet 2015a). Coyote willow has been demonstrated to be quickly replaced by saltcedar in other southwest rivers (Mount *et al.* 1996), despite its higher tolerance of salinity compared with other native riparian trees and shrubs that do occur in the planning area (Jackson *et al.* 1990, Warrence and Bauder 2001; Appendix E). More recent surveys of the Agua Fria River just upstream of the planning area revealed unexpectedly low populations of both coyote willow and mulefat in the riparian understory (RBF Consulting 2010). In general, the herbaceous layer is very sparse to absent and the ground layer has a moderate cover of downed wood and other organic litter.

Saltcedar cottonwood willow downstream of Buckeye *(top)*, and Saltcedar willow downstream of Goodyear *(bottom)* (Photos by Stillwater Sciences)

Saltcedar/cottonwood and/or willow vegetation is found across a variety of substrate types, from loam and silt to gravel and cobble. These vegetation types require nearly year-round access to water, and tend to occur along or in close proximity to the river channel, and along or at the outlets of agricultural return-flow channels. Cottonwood and willow trees were documented in 18 and 19 plots, respectively (see Appendix D), and were found to occur most frequently at relative elevations of 2 to 10 feet (Figure 12). Saltcedar/cottonwood and/or willow vegetation is most prevalent in the central portion of the planning area, between the Tuthill Rd Highway 85 bridges.

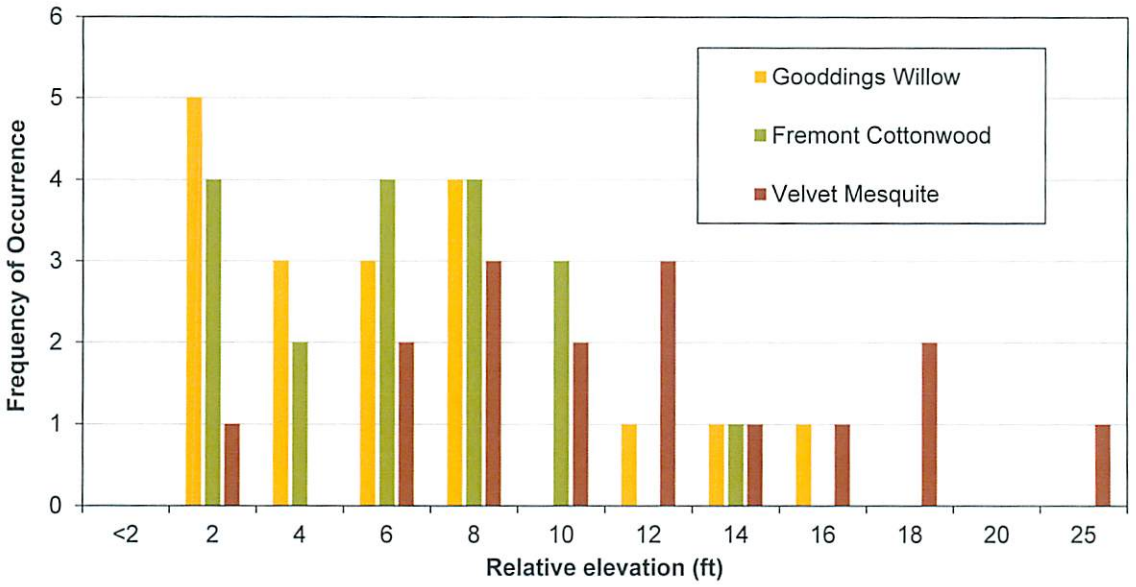


Figure 12. Histogram of Goodding's willow, Fremont cottonwood, and velvet mesquite occurrence by relative-elevation class above the river channel.

2.8.2.3 Desert shrub

Desert shrub (Atriplex) with low density saltcedar, downstream of Bullard Ave overpass (Photo by Stillwater Sciences)

Desert shrub vegetation in the planning area is characterized by a sparse cover, typically around 30%, of one or more native desert shrubs, such as creosote (*Larrea tridenta*), burrobrush (*Hymenoclea monogyra*), wirelettuce (*Stephanomeria pauciflora*), rabbitbrush (*Ericameria nauseosa*), fourwing saltbush (*Atriplex canescens*), big saltbush (*Atriplex lentiformis*), sweetbush (*Bebbia juncea*), and Thurber's sandpaper plant (*Petalonyx thurberi*). Saltcedar is nearly always present at low cover (no more than 30%), and a few trees, such as mesquite, palo verde, desert willow (*Chilopsis linearis*), cottonwood, and Goodding's willow, may also be present (see photo at right). The herbaceous layer is typically a low cover (less than 50%) of annual grasses. Average canopy height is typically less than 3 feet.

Desert shrub vegetation occurs on cobble strands and similar geomorphic surfaces throughout the planning area. Although these areas are not generally adjacent to the river channel and soils are typically dry, desert shrub appears to occur where there is infrequent inundation and scour from very high flow events, at relative elevations of 5 to 18 feet. They are also frequently subject to disturbance from off-road vehicles. Some of these same surfaces are mapped as cobble/gravel/sand, where vegetation cover is less than 10%. The margins of desert shrub vegetation tend to grade into increasingly high densities of saltcedar. In the previous vegetation map of the planning area, desert shrub vegetation was not acknowledged and, instead, these areas

were mapped as "cobble strand." This vegetation type presents an opportunity to replace removed saltcedar with an assemblage of native plants that appear well suited for drier portions of the planning area and present much lower resistance to high flow events. While desert shrub vegetation is typically very sparse, the County's seeding of various *Atriplex* species after the Buck Fire in 2008 indicates that, when seeded or planted very densely, these species may help suppress the re-sprouting and re-establishment of saltcedar in drier portions of the planning area where more mesic riparian vegetation will not persist (see photo above).

2.8.2.4 Marsh and saltcedar/marsh

Marsh and saltcedar/marsh vegetation occurs in patches in and along the wetted channel (see photo at right). These areas are generally densely vegetated by cattail (*Typha* spp.), chairmaker's bulrush (*Schoenoplectus americanus*), common reed (*Phragmites australis*), or giant reed (*Arundo donax*). Many of these areas appear to be in the process of transitioning toward saltcedar vegetation, as young (seedlings or saplings) saltcedar is frequently present, from 5–60% cover.

Dense marsh (cattails) vegetation upstream of Buckeye (Photo by Stillwater Sciences)

It is notable that, with very few exceptions, marsh vegetation in the planning area is limited to the perennially wet sub-reaches. In some areas, the river channel transitions entirely to marsh vegetation as a result of ponding and very low streamflow. It is likely that marsh vegetation in the planning area is transitory, since the areas where marsh vegetation persists within the floodway are subject to scour under high flow events. Away from the channel, and when paired with excavation of gravel-mining pits, marsh vegetation may present an opportunity to reduce nitrate levels from stormwater and agricultural return-flows in the planning area.

2.8.2.5 Mesquite/palo verde and saltcedar/mesquite

Mesquite is a characteristic riparian tree of the Sonoran Desert, as is palo verde, which also occurs in more upland areas (see photo at right). Areas mapped at these vegetation types in the planning area support a sparse cover (10–50%) of mesquite and/or palo verde trees, as well as a relatively diverse assemblage of native shrubs, such as creosote, rabbitbrush, desert-thorn (*Lycium andersonii*), and desertbroom (*Baccharis sarothroides*). Saltcedar is also present at 5–15% cover. Areas that are dominated by saltcedar but support at least 10% cover of mesquite and/or palo verde are mapped as saltcedar/mesquite. Screwbean mesquite (*Prosopis pubescens*) is reported within the Gila River bottom from Liberty to Buckeye (*e.g.*, SEINet 2015b), and it historically formed thickets along the Gila River east of Yuma (Marks 1950, Haase

Mesquite/palo verde along upland boundary of riparian corridor (Photo by Stillwater Sciences)

1972). It was not documented during the plot surveys, however, and appears to be underrepresented despite the fact that it can tolerate higher salinity than velvet mesquite (Miyamoto *et al.* 2004; Appendix E).

Mesquite/palo verde and saltcedar/mesquite vegetation types tend to occur at relative elevations of at least 5 feet (see Figure 12). As such, they are subjected only infrequently to flood events. In the planning area, they are typically found on terraces at the deltas of tributary washes. Like desert shrubs, mesquite/palo verde vegetation presents an opportunity to replace removed saltcedar with an assemblage of native plants that appear well suited for drier portions of the planning area, present much lower resistance to high flow events, and provide habitat and food for a number of native wildlife species.

2.9 Wildlife

The planning area supports a diverse patchwork of habitat types utilized by numerous fish and wildlife species. While conducting protocol-level surveys for these species is not considered to be critical to the development of the Plan (since vegetation and water availability can serve as proxy for species presence), we reviewed several documents (Stantec 2003, Wilcox and Wade 2014, Bateman *et al.* 2015, USFWS 2015a) to understand which special-status wildlife species occur or have potential to occur in the planning area. Special-status wildlife species are considered to be those listed, or candidates for listing, as endangered or threatened under the federal ESA, and/or considered a species of greatest conservation need (SGCN) by AGFD. Table 5 lists all of the special-status wildlife species that the U.S. Fish and Wildlife Service (USFWS) identifies as having potential to occur in the planning area region. Most of these species, however, have been extirpated from the planning area or require habitat that is no longer present. Three avian species—southwestern willow flycatcher , western yellow-billed cuckoo (*Coccyzus americanus*), and Yuma clapper rail (*Rallus longirostris yumanensis*)—are the primary special-status species that have been documented to occur or have potential to occur in the planning area; these species are discussed in more detail below. Mexican garter snake (*Thamnophis eques megalops*) and narrow-headed garter snake (*Thamnophis rufipunctatus*) are both federally threatened reptiles species that have not been identified as having potential to occur; however, their apparent absence may be due to lack of suitable habitat conditions in the planning area, which could present opportunities for species recruitment through habitat enhancement. An understanding of these species and their habitat preferences can be used to guide revegetation efforts to enhance habitat for these species under the Plan, as well as to identify measures that may be necessary to minimize impacts on these species during management activities.

In addition to the flycatcher, cuckoo, and the clapper rail, there are several species of migratory birds that use this area. Those species include: bald eagle (*Haliaeetus leucocephalus*), Bell's vireo (*Vireo bellii*), Bendire's thrasher (*Toxostoma bendirei*), black-chinned sparrow (*Spizella atrogularis*), Brewer's sparrow (*Spizella breweri*), burrowing owl (*Athene cunicularia*), common black-hawk (*Buteogallus anthracinus*), Costa's hummingbird (*Calypte costae*), elf owl (*Micrathene whitneyi*), Gila woodpecker (*Melanerpes uropygialis*), gilder flicker (*Colaptes chrysoides*), golden eagle (*Aquila chrysaetos*), Le Conte's thrasher (*Toxostoma lecontei*), least bittern (*Ixobrychus exilis*), Lewis's woodpecker (*Melanerpes lewis*), loggerhead shrike (*Lanius ludovicianus*), Lucy's warbler (*Oreothlypis luciae*), mountain plover (*Charadrius montanus*), peregrine falcon (*Falco peregrinus*), prairie falcon (*Falco mexicanus*), snowy plover (*Charadrius nivosus*), Sonoran yellow warbler (*Setophaga petechial sonorana*), and Swainson's hawk (*Buteo*

Table 5. Special-status wildlife species with potential to occur in the planning area or vicinity (source: USFWS 2015a).

Species	Status [A]	Habitat association	Potential to occur in Planning Area
California least tern (*Sterna antillarum browni*)	FE	Nearshore ocean areas, estuaries, and barren to sparsely vegetated sandbars along rivers, sand and gravel pits.	**Moderate**; one breeding pair has been observed in the Glendale Recharge Ponds adjacent to the confluence of the New and Agua Fria rivers (Marschalek 2010). Some potentially suitable nesting habitat may be present in the planning area.
Southwestern willow flycatcher (*Empidonax traillii extimus*)	FE; SGCN	Multilayered dense stands of riparian vegetation with flooded or saturated understory substrate.	**High**; species has been observed in the planning area (Wilcox and Wade 2014) and suitable breeding habitat is present
Sprague's pipit (*Anthus spragueii*)	FC; SGCN	Native prairie and grasslands.	**None**; no suitable habitat in the planning area (USFWS 2014a)
Yellow-billed cuckoo (*Coccyzus americanus*)	FT; SGCN Proposed CH	Large cottonwood/willow stands with openings and dense understory.	**High**; species has been observed in the planning area (Stantec 2003) and some potentially suitable habitat is present
Yuma clapper rail (*Rallus longirostris yumanensis*)	FE; SGCN	Requires wet substrate (mudflat, sandbar) with dense herbaceous or woody vegetation for nesting and foraging. Fresh-water marshes dominated by cattail or bulrush are preferred habitat.	**High**; species has been observed near the confluence of Agua Fria and Gila rivers (Wilcox and Wade 2014) and some potentially suitable habitat is present in the planning area
Desert pupfish (*Cyprinodon macularius*)	FE; SGCN; CH	Clear shallow waters with soft substrate in springs and pools.	**None**; species has been extirpated from the Gila River basin (USFWS 2010a)
Roundtail Chub (*Gila robusta*)	FC; SGCN	Deep pools and eddies of large streams and rivers.	**None**; species has been extirpated from the Gila River basin (USFWS 2013a)
Lesser long-nosed bat (*Leptonycteris curasoae yerbabuenae*)	FE; SGCN	Requires caves and mines for roosting. Forages on cactus fruits and nectar in desert scrub and oak woodland vegetation.	**None**; no suitable habitat in the planning area (USFWS 2007)
Sonoran pronghorn (*Antilocapra americana sonoriensis*)	FE; SGCN	Flat open terrain containing desert scrub vegetation.	**None**; planning area is outside the species' current range (USFWS 2015b)
Sonoran desert tortoise (*Gopherus morafkai*)	FC; SGCN	Steep slopes, upland and desert scrub habitat.	**None**; no suitable habitat in the planning area (USFWS 2013b)

Table footnotes:
[A] FT = federally threatened, FE = federally endangered, FC = federal candidate for listing, CH = critical habitat designated, SGCN = AGFD species of greatest conservation need.

swainsoni). Migratory birds are protected by the Migratory Bird Treaty Act (MBTA) and the Bald and Golden Eagle Protection Act. Any activity which results in the take of migratory birds or eagles is prohibited unless authorized by the USFWS.

A number of other non-special-status wildlife species are also known to occur in the planning area, including collared peccary (*Pecari tajacu*), beaver (*Castor canadensis*), jackrabbits (*Lepus* spp.), cottontail rabbits (*Sylvilagus* spp.), roadrunners (*Geococcyx californianus*), herons (family Ardeidae), and numerous other birds and reptiles. Shrubs and herbs in the planning area provide habitat for pollinators, which benefit native plant reproduction as well as agriculture, and the planning area may host monarch butterflies on their annual migrations from Mexico to Canada. Continuing to provide cover, habitat, food resources, and movement corridors for these other native species will also be important to consider in development and implementation of the Plan. Additionally, the occurrence of some wildlife (*e.g.*, species of birds and reptiles) in the planning area following restoration can be used as measures of increased diversity, habitat complexity, and ecosystem function (Bateman *et al.* 2015). Therefore, monitoring the response of wildlife to management and restoration activities can provide documentation of ecological benefits associated with habitat changes following vegetation removal. Consultation with USFWS will be necessary prior to implementing the Plan to ensure vegetation management activities avoid or sufficiently minimize potential impacts to threatened and endangered species (these are discussed in greater detail in the sections below), as well as migratory birds.

2.9.1 Southwestern willow flycatcher

The southwestern willow flycatcher was listed as endangered in 1995 (USFWS 1995) and critical habitat was designated in 1997 (USFWS 1997). Critical habitat for flycatcher does not occur in the planning area. The flycatcher is also an Arizona species of greatest conservation need.

The flycatcher is a neotropical migratory bird. It is a riparian obligate with its nesting habitat in relatively dense stands of trees and shrubs in riparian ecosystems in the arid southwestern United States and possibly extreme northwestern Mexico. Flycatchers build a small open cup nest, constructed of leaves, grass, fibers, feathers, and animal hair. They typically establish nesting territories, build nests, and forage where mosaics of relatively dense and expansive growths of trees and shrubs are established near or adjacent to surface water and/or underlain by saturated soil (Sogge *et al.* 2010). Flycatchers commonly utilize saltcedar vegetation for nesting if it is the dominant species (USFWS 2002) (see photo at right); however, if willow is dominant and standing water is available, flycatchers will prefer willow for nesting (Ahlers and Moore 2009).

Southwestern willow flycatcher and nest in dense saltcedar (Photo by USGS)

Flycatchers spend only three to four months on their breeding grounds. The remainder of the year is spent on migration and in wintering areas in Mexico and Central America (Sedgwick 2000). Flycatchers typically arrive on breeding grounds between early May and early June,

although a few individuals may establish territories in very late April (Willett 1912, Ligon 1961, Maynard 1995, Skaggs 1996, Sferra *et al.* 1997). A solitary male flycatcher was observed by Wilcox and Wade (2014) at the confluence of the irrigation canal (east side of Aqua Fria River) and Gila River, which is just east of the planning area boundary.

A multi-scaled model was developed through the USGS and AGFD to map and rank potential flycatcher breeding habitat in Arizona in order to prioritize surveys and to detect changes in habitat over time (Hatten *et al.* 2010). This model was recently updated using Landsat imagery from July 2015 to extend throughout the species' range, which includes the Buckeye Valley (Hatten 2015, unpubl. data). The results from this modeling in the planning area are presented graphically in Figure 13, which shows the top three probability-of-occurrence classes. The updated modeling results indicate that suitable breeding habitat may be present in the planning area, but concentrated in the more vegetated and perennially wet lower half of the reach (*i.e.*, between Tuthill Rd and Highway 85 bridges).

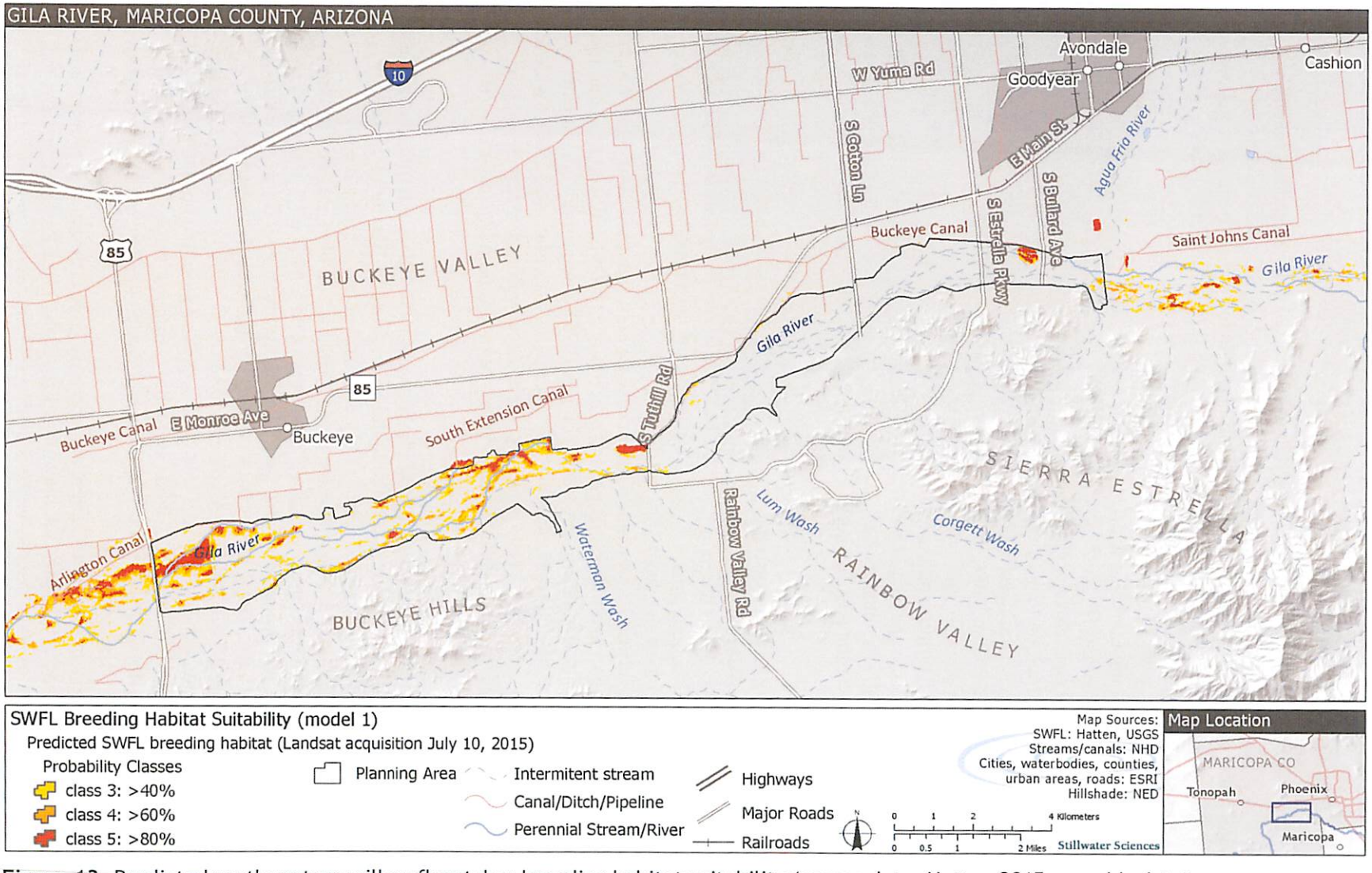


Figure 13. Predicted southwestern willow flycatcher breeding habitat suitability (source data: Hatten 2015, unpubl. data).

2.9.2 Yellow-billed cuckoo

The western distinct population segment of the yellow-billed cuckoo was listed as federally threatened in 2014 (USFWS 2014b) and critical habitat was proposed for the Gila River throughout much of Buckeye Valley (USFWS 2014c). Designated critical habitat for yellow-billed cuckoo is proposed along the entire planning area. Western yellow-billed cuckoo is an Arizona species of greatest conservation need.

Cuckoos are neotropical migrants that winter in South and Central America (Hughes 1999). They historically nested in riparian areas from western Washington to northern Mexico, including Oregon, southwestern Idaho, California, Nevada, Utah, western Colorado, Arizona, New Mexico, and western Texas (American Ornithologists' Union 1983), but their range and numbers have declined substantially in much of the western United States over the past 50 years (USFWS 2014b).

Western yellow-billed cuckoo (Photo by USFWS)

Cuckoos arrive at nesting areas in western North America from late April to early July, with most birds arriving in June (Laymon 1998, USFWS 2014b). Breeding pairs establish territories ranging in size from 10–100 acres but do not actively defend territories after nests are built (Laymon 1998, USFWS 2014b). Cuckoos are a riparian obligate that generally prefer open woodland with trees and low, dense shrubs, often associated with riparian areas (Hughes 1999). The primary constituent elements (PCE) of critical habitat for cuckoo include: (1) riparian woodlands >325-feet wide and ≥200 acres in extent, (2) an adequate prey base (*e.g.*, large insects and insect larvae and tree frogs), and (3) dynamic river processes that maintain riparian vegetation patches at a variety of successional stages (USFWS 2014b).

Cuckoos nest in large patches of structurally complex riparian habitat with tall trees and a dense understory of woody vegetation, such as is often found in cottonwood-Goodding's willow woodlands (Hughes 1999, Laymon *et al.* 1997). They are also known to breed in early successional cottonwood/willow habitat (Johnson *et al.* 2008, McNeil *et al.* 2013). The main nest-tree species in Arizona are Goodding's willow (*S. gooddingii*), cottonwood (*P. fremontii*), and saltcedar, although other trees or large shrubs, such as mesquite and seep willow, may also be used (McNeil *et al.* 2012). Increasing proportions of saltcedar decrease the suitability of the habitat for the cuckoo (USFWS 2014b). In Arizona, Johnson *et al.* (2010) found cuckoo detection rates to be highest in cottonwood-willow-ash (*Fraxinus* spp.) and mesquite bosque–hackberry (*Celtis* spp.) habitats and much lower in Arizona sycamore (*Platanus wrightii)*–cottonwood habitat, sycamore-alder (*Alnus* spp.) habitat, and areas with more than 75 percent saltcedar cover.

Cuckoos eat a wide variety of prey items. These are primarily large arthropods such as cicadas, katydids, grasshoppers, and caterpillars, but may also include small lizards, frogs, spiders, tent caterpillars, and a variety of other insects. There is evidence to suggest that population levels and

breeding may be closely tied to abundance of certain food items (Bent 1940, Preble 1957, Hamilton and Hamilton 1965, Nolan and Thompson 1975, Laymon 1980, Koenig and Liebhold 2005, Halterman 2009, McNeil *et al.* 2013).

Loss and fragmentation of suitable riparian nesting habitat patches of adequate size is the primary threat to cuckoo populations. Loss of habitat is attributed to riparian and floodplain land conversion for agricultural and urban development, water management that alters the hydrologic regime of rivers and precludes the renewal and establishment of riparian vegetation preferred as nesting habitat (*e.g.*, dams, channelization, ground water pumping, diversions), grazing in riparian habitat, and naturalization of non-native species such as saltcedar and giant reed.

Johnson et al. (2012) noted that conservation of the cuckoo requires detailed information about its breeding habitat requirements. Specifically, efforts to conserve and restore high quality cuckoo breeding habitat should include conserving and/or creating habitat patches that are at least 1,570-feet in radius (~180 acres) with a core area of at least 400-feet radius (~10 acres). The core area should be comprised of dense cottonwood-willow vegetation with a surrounding habitat patch conserve and/or to minimize or eliminate saltcedar cover, minimize dense shrubby cover, minimize fragmentation, and have heterogeneity in canopy closure and density. The latter criterion could be met by planting cottonwood and willow in a manner that mimics the pattern of alternating, arcuate bands of dense cottonwood-willow patches of different ages and more open areas that are typically produced by natural flow dynamics and episodic regeneration of these tree species.

In support of Plan development, James Hatten of the USGS utilized a multi-scaled model similar to the flycatcher model (Figure 13) to create a map of potential yellow-billed cuckoo breeding habitat within the El Rio reach. The model utilized Landsat imagery from April 2016. Additional details on the modeling methods are presented in Appendix F. The results from this modeling effort are presented graphically in Figure 14. The five probability classes depicted in the map represent the predicted relative quality of cuckoo breeding habitat, with higher class numbers indicating potentially better habitat. The modeling results indicate that breeding habitat suitability is predicted to be low throughout the planning reach, with the highest quality areas having only a 40–50 percent probability of being suitable breeding habitat. Like the flycatcher habitat suitability results (see section above), the most suitable cuckoo habitat areas are predicted to be concentrated in the more vegetated and perennially wet lower half of the reach (*i.e.*, downstream of the Tuthill Rd bridge).

Cuckoos historically occurred in the planning area (Stantec 2003). However, Wilcox and Wade (2014) did not observe this species during 2014 when conducting focused surveys at the upstream end of the planning area. As the habitat suitability model (Figure 14) illustrates, habitat for the cuckoo in the planning area is generally considered to be marginal at best. Saltcedar is the dominant vegetation cover type in the planning area, representing 5,151 acres, but 1,574 acres of that is low density (Table 4) and would not be suitable cuckoo habitat. Intermittent patches of saltcedar-cottonwood-willow vegetation that could provide suitable cuckoo habitat represent only 517 acres of the planning area (Table 4). Due to the lack of suitable habitat, cuckoos are likely limited in the planning area. The designation of critical habitat throughout the planning area (if adopted; it is currently only proposed and could take several years to adopt) will not preclude implementation of the Plan, but will require that vegetation management activities assess the potential to affect suitable habitat, as well as individual cuckoos. The habitat suitability model results will be helpful in this assessment and can be used to help guide the District and other

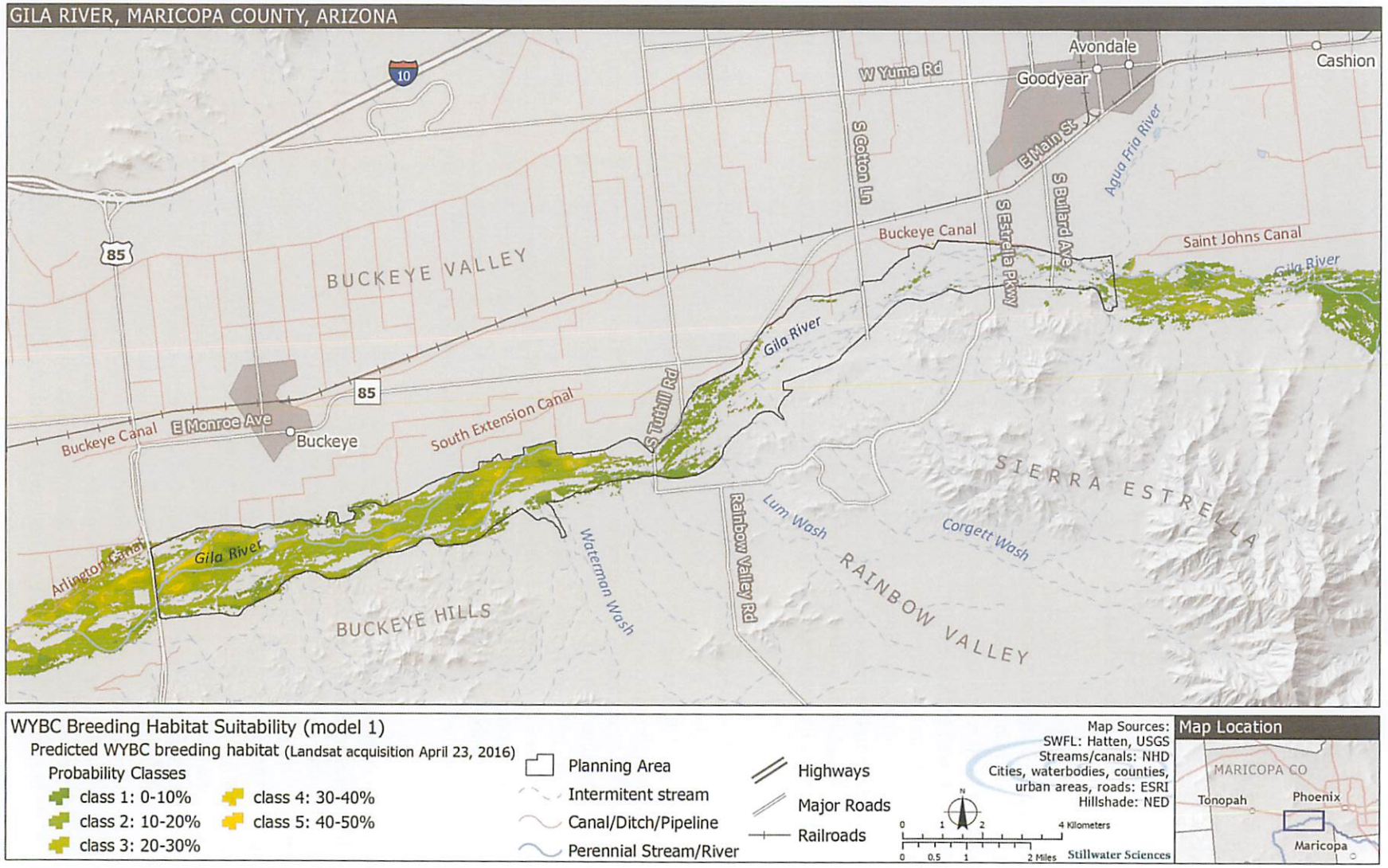


Figure 14. Predicted western yellow-billed cuckoo breeding habitat suitability (source data: Hatten 2016, unpubl. data).

property owners on how best to implement and phase the Plan to avoid impacts, as well as obtain any necessary permits and conduct other compliance activities with the USACE and USFWS.

2.9.3 Yuma clapper rail

The Yuma clapper rail was federally listed as endangered in 1967 (USFWS 1967) and is an Arizona species of greatest conservation need. Critical habitat has not been designated for this species. The clapper rail occurs along the lower Colorado River and tributaries (*e.g.*, Virgin River, Bill Williams River, lower Gila River) in Arizona, California, Nevada, and Utah; the Salton Sea in California; and the Cienega de Santa Clara and Colorado River Delta in Mexico (USFWS 2010b).

Yuma clapper rail (Photo by USFWS)

The Yuma clapper rail is one of seven North American subspecies of clapper rail[3]. They breed from mid-April to mid-September after which most individuals migrate to Mexico for the winter. Although this migration behavior was believed to be normal, recent data suggests that a number of birds in Arizona reside year-round. This species requires wet substrate (mudflat, sandbar) with dense herbaceous or woody vegetation for nesting and foraging. Fresh-water marshes dominated by cattail or bulrush are preferred habitat. Early successional marshes with little residual vegetation may be preferred as well. Habitat should be in a mosaic of vegetated areas interspersed with shallow (less than 12-inch deep) open water areas.

The requirements of site availability, prey diversity and abundance, and protection from avian predators can be satisfied in a relatively small area of marsh, often no larger than 0.3 acre (Dickey 1923, as cited in Stantec 2003). They feed primarily on crayfish, with small fish, frogs, and aquatic invertebrates also taken.

Threats to clapper rail include loss of marsh habitat through channelization, dredging/filling activities, declining quality of marsh habitat due to build-up residual vegetation (dead stems and leaves of cattails or bulrush) that clogs movement through the vegetation, and selenium contamination of the prey base (USFWS 2015c).

Two clapper rails were observed in 2014 at the confluence of the Aqua Fria and Gila rivers (Wilcox and Wade 2014). Marsh and saltcedar marsh vegetation (*i.e.*, cattail, chairmaker's bulrush, common reed, or giant reed) occur along the river channel in the planning area and appear to be transitioning toward saltcedar vegetation. Suitable habitat for the clapper rail may occur in the planning area but is expected to be limited to the perennially wet river channel.

[3] Recent taxonomic studies have led to the Yuma clapper rail (*Rallus longirostris yumanensis*) being reclassified as Yuma Ridgway's rail (*R. obsoletus yumanensis*) (http://blog.aba.org/2014/07/2014-aou-check-list-supplement-is-out.html). However, in this report we retain use of the older name for consistency with prior studies and usage by regulatory agencies.

3 IMPLICATIONS FOR VEGETATION MANAGEMENT

The implications of the results reported for vegetation management in the planning area are summarized for each major natural resource. These discussion summaries were refined based input received from the TAC. The salient findings were subsequently used to inform the identification of the vegetation management actions and spatial units presented in Volume 3.

3.1 Land Uses

Land ownership in the planning area is roughly split evenly between public and private entities (*i.e.*, 47% versus 53%). Many areas just outside the planning area are anticipated to be developed for residential and commercial uses in the future. Therefore, most opportunities for Plan implementation will be found on the public-owned lands, of which the District, BLM, and AGFD collectively own about 3,990 acres. **Vegetation management should be prioritized on District, BLM, AGFD, and other public lands to ensure that habitat enhancement is adequately protected from future land use changes.**

Additionally, much of the privately-owned land is zoned for gravel mining and may be mined in the future. Conversion of portions of the floodway to open water features from gravel mining will potentially reduce flood risk and have implications on the types of vegetation management that are appropriate in and around gravel mining operations. **The Plan will need to incorporate flexibility in any recommended management actions on and adjacent to private lands to accommodate possible gravel mining activities**. Reclamation plans for reinitiated or new gravel mining operations should be developed so that they are consistent with the flood-risk reduction and habitat enhancement objectives of the Vegetation Management Plan.

Implementation of the Plan should also be done in coordination with planning recreational and scenic attractions for the community and adjacent residential developments. Recreational attractions could include walking and biking trails, boardwalk trails in wetland areas, picnic areas, bird observation platforms, and fishing pears. These facilities should be strategically arranged to provide an adequate buffer around natural areas with endangered species habitat. Specifically, creation of vegetation communities and associated water features should be done in coordination with planning recreational and scenic attractions for the community and adjacent residential developments.

Plan implementation should continue communication and coordination with other entities that have previously conducted vegetation-management-related activities in the planning area to ensure that future vegetation-management activities do not conflict with one another and, ideally, can be conducted in ways that save or share costs and increase mutual benefits. Such other entities include the cities of Avondale, Buckeye, and Goodyear, Audubon Society, The Nature Conservancy, Arizona State University, University of Arizona, Salt River Project, Arizona Department of Transportation (ADOT), Arizona Game and Fish Department (AGFD), U.S. Bureau of Land Management (BLM), and U.S. Fish and Wildlife Service (USFWS).

3.2 Climate

The implications of the observed (and predicted future) increases in regional and local air temperatures, along with attendant changes in precipitation patterns, on the local riparian habitat

will require the Plan to incorporate flexibility in any recommended management action. **Air temperature and drought tolerances for native plant species will need to be considered when designing revegetation plans** (see Table E-1 in Appendix E). Recent work by others, such as Perry *et al.* (2015), has begun to outline various approaches to restoration planning in light of climate change, including planning for the most sensitive species and habitat types and, where possible, incorporating adaptive management methods for planting, invasive species control, channel and floodplain reconstruction, and water management.

3.3 Flood hydrology and geomorphology

The Gila River in the Buckeye Valley naturally experiences a wide variation of flows, punctuated episodically by short-duration but intensive high-flow events capable of dramatically repositioning the dominant channel trace(s) and scouring large swaths of vegetation. These flashy discharge dynamics, which are common to large, dryland riverine systems, periodically result in dramatic geomorphic change (Graf 1988). And while climate change models predict less total precipitation for the southwest region, increased frequency of intense storms and more precipitation falling as rain versus snow are expected to make southwest rivers more susceptible to flooding (USGCRP 2009). **Thus, any restoration planning effort on the lower Gila River demands consideration of flood dynamics to best ensure long-term success.**

Appropriate strategies for saltcedar treatment and native species revegetation within the flood reset zone, considered here to be tantamount to the 2002 active channel area delineated by JE Fuller (2005), will be developed for the Plan (see Figure 9). For example, more intensive active treatment and revegetation would be recommended in areas outside of the reset zone, or even within dense patches of saltcedar that are setback from the main channel trace(s), thereby hydraulically "shielding" the management areas from flood disturbance. Lower effort management strategies should still be considered throughout the remainder of the planning area following disturbance from floods (or fires) that have removed much of the saltcedar biomass. Post-flood-scour management actions can take advantage of newly cleared areas to treat remaining saltcedar and/or revegetate with native species prior to re-establishment of saltcedar or other invasive plants.

3.4 Ecological flows

Baseflows are naturally sourced from rising groundwater, particularly in the lower half of the planning reach, and are further supplemented by a number of stormwater, wastewater, and agricultural return-flow canals located throughout the reach. The outfalls of several of these water sources support some of the largest and most diverse stands of native riparian vegetation in the planning area. While these inputs could be used to prioritize where saltcedar removal and habitat enhancement occurs, since plantings would have a higher likelihood of being successful, the volume, timing, and constancy of these water sources are highly subject to change in light of land-use changes outside the planning area. As residential development replaces agriculture, agricultural return flows will decrease while stormwater and wastewater discharges will increase. **Vegetation management actions that are potentially dependent on the stormwater, wastewater, and agricultural drainage water supplies will need to evaluate and likely monitor potential changes in the future.**

Another potential source of water in the planning area is the Salt River Project (SRP), which regulates upstream water supply. **It is recommended that discussions with SRP, as well as Buckeye Water Conservation and Drainage District, take place on the possibility of purchasing agricultural water rights when the associated agricultural activity ends, and transferring the water for restoration purposes.** Discussions with SRP should also include the potential for storing water in the flood pool behind Roosevelt Dam and then releasing that water at a time that would facilitate natural recruitment of native riparian vegetation.

3.5 Soils

Analysis of soils data contributes to more realistic expectations of potential woody riparian vegetation establishment under various management scenarios, as we can identify revegetation areas based on suitable soil conditions for particular desired native species, and understand where soil conditions may limit the potential for natural recruitment of native plants.

Salinity, *pH*, and other physical tolerance levels reported for some of the native plant species that occur or would be appropriate to plant in the planning area are described in Appendix E. For example, species such as cottonwood and narrowleaf willow have a "None" to "Low" tolerance for saline soils but can tolerate a range of *pH* levels, whereas other species may have a "High" tolerance for salinity (*e.g.*, *Atriplex* spp.) or require more neutral to slightly acidic soils (*e.g.*, Goodding's willow) (see Table E-1 in Appendix E). **Given general plant soil preferences and tolerance levels, suitable areas for active restoration of many native riparian trees and shrubs include those with soils having non-saline to very slightly saline conditions, while areas with soils having slightly saline to strongly saline conditions are better suited for desert shrub species.**

Overall, the soil sampling results and NRCS soil information indicate that soil texture, salinity, and alkalinity levels in the planning area are within the tolerance ranges of most native woody riparian, desert wash, and upland species that would be appropriate for revegetation, and should not preclude the natural recruitment of these species. The portions of the floodway near soil locations S-2 and, to a lesser extent, S-6 may, however, be too saline and/or alkaline to support plantings of native species with low tolerance for salinity or higher *pH* (see Table E-1 in Appendix E). Plantings in these areas may require soil amendment techniques to condition soil during establishment of native species (*e.g.*, tall pots, pole plantings, seeding).

3.6 Groundwater

Native riparian plant species tend to occur in particular topographic positions relative to the river channel. Specifically, we have found that relative elevation above the low-flow, or baseflow, water surface in the river channel is a useful indicator for revegetation potential. Relative elevation in a floodplain is generally correlated with depth to groundwater, and frequency of surface saturation and inundation. Thus relative-elevation surfaces, which combined with other spatial-data layers, provides a powerful tool for assessing revegetation potential via passive (natural recruitment processes) or active (horticultural restoration) approaches. In the absence of a Planning Area-wide compilation of recently observed, shallow groundwater levels, relative-elevation surfaces generated using the 2015 LiDAR dataset can serve as a very useful proxy. Our vegetation-transect surveys found that native cottonwood and willow trees are most numerous upon surfaces situated within 2 to 10 feet of the low-flow channel water surface (see Figure 12).

And, desert scrub vegetation is most numerous at relative elevations of 5 to 18 feet (see Figure 12). **Therefore, criteria used to establish planting suitability for native woody riparian trees and native desert scrub should include surfaces with relative elevations of <10 feet and 5–18 feet, respectively.**

3.7 Vegetation

The following is a summary of considerations that should be incorporated into riparian restoration planning, based on the vegetation transect-plot data collected and general observations made during the assessment of ecohydrological conditions:

- Biocontrol of saltcedar by the tamarisk beetle will not be sufficient to reduce flood risk in the planning area in the timeframe desired because saltcedar defoliation and mortality from the beetle will not remove standing saltcedar biomass (*i.e.*, the remaining trunks and branches). **It is thus important to plan now for the arrival of the tamarisk beetle in the El Rio reach by restoring native plant communities and habitat, both to take advantage of the expected biocontrol benefits and to mitigate for its indirect impacts to southwestern willow flycatcher and other sensitive wildlife.**
- While removal of saltcedar will provide multiple benefits to the El Rio reach and surrounding lands, **replacement of removed saltcedar with native vegetation will be necessary to mitigate lost habitat structure, reduce re-sprouting of saltcedar and establishment of secondary weeds, and offset impacts for regulatory compliance.**
- Very few instances of natural recruitment of native riparian trees and shrubs were observed during the plot surveys. Recruitment potential under current conditions appears to be limited by high density of saltcedar coverage and insufficient water availability. **This condition indicates that active planting will be needed to replace saltcedar with native species in most areas and instances.** A variety of strategies developed specifically for optimizing revegetation following control of saltcedar will need to be implemented, including: (1) developing a plan for managing standing dead saltcedar, (2) protecting cottonwood and willow plantings from grazing, (3) protecting remnant native vegetation from fires, (4) suppressing aggressive plants such as arrowweed and seepweed (*Suaeda moquinii*), and (5) planting highly competitive species, such as quailbush (*Atriplex lentiformis*), after less competitive desirable species, such as screwbean mesquite, have established (Shafroth *et al.* 2008). The impacts of restoration to habitats of the three listed birds and other birds in the planning area will need to be explicitly incorporated into restoration planning and monitoring (Sogge *et al.* 2008), especially in consideration of the potential for tamarisk beetles to arrive in the area in the near future (Paxton *et al.* 2011).
- Current locations of native riparian plant species are indicative of where these species, once restored, should persist in the future. However, many other areas are likely to have suitable biophysical conditions for successful restoration as well but natural recruitment of natives is not occurring and/or saltcedar has out-competed all other species. **As such, it is recommended that the physical conditions under which native species have been documented to occur be used to help select restoration sites, rather than the locations of natives themselves, which is likely to underestimate the area potentially suitable for restoration.** Figure 12, which presents the range of relative elevations under which several native riparian trees and shrubs were observed during the plot surveys, were specifically developed for this purpose. In addition, the height of the current vegetation canopy, even in

saltcedar-dominated stands, provides a useful indicator of likely site productivity for native woody species (see canopy height maps in Appendix D).

- **Propagule (seed source) islands of underrepresented desired woody species, such as Fremont cottonwood, Goodding's willow, coyote willow, and screwbean mesquite, should be protected and strategically planted throughout the planning area.** These native woody riparian islands can provide seed sources to promote establishment during floodplain reset events in the project area (Shafroth *et al.* 2008, Dudley and Bean 2012, Orr *et al.* 2014).
- The conversion of agricultural lands to urban development around the planning area is likely to change the location and magnitude of agricultural return-flows. Many occurrences of native trees and shrubs in the planning area appear to be highly influenced by, if not dependent upon, channelized stormwater, treated wastewater effluent, and/or agricultural return flows. The presence of such flows should be a factor considered in the selection of revegetation sites, since they offer opportunities to successfully establish and grow native species without the need for irrigation. However, during this consideration, **the seasonality and constancy of the stormwater, wastewater effluent, and/or agricultural return flows should be further assessed, as flow patterns may vary depending upon the water year type and crop(s) being grown, as well as urban development plans for the associated agricultural lands, which could highly alter the magnitude or patterns of return flows, or even eliminate them.** The strong influence of channelized tributary and/or agricultural return flows suggests that, outside of these zones of influence, irrigation may be needed to establish some native species in certain areas.
- Mesquite, palo verde, and native desert shrub vegetation types occur in the planning area. These vegetation types, which can tolerate relatively drier conditions, may be appropriate for revegetation in areas without suitable conditions for more hydrophytic native vegetation, such as cottonwood and willow. Two woody riparian species that are of low abundance in the planning area, coyote willow and screwbean mesquite, probably historically formed thickets in the area and should be reintroduced to improve wildlife habitat and provide competition with saltcedar. Coyote willow is advantageous for higher tolerance to salinity (Warrence and Bauder 2001) and fire (Mount *et al.* 1996) compared to Goodding's willow, and it can spread clonally and expand thickets in the absence of scouring floods (Mortenson and Weisjberg 2010). Screwbean mesquite is slightly more tolerant of salinity compared to velvet mesquite (Miyamoto *et al.* 2004, Felker *et al.* 1981), and has been successfully used in restoration of saltcedar cleared areas with a 4-foot deep water table in New Mexico (Taylor and McDaniel 1998). Screwbean mesquite is generally confined to the upper first terrace of riparian habitat (Meyer 2005), and it can be propagated by long-stem deep plantings (up to 5 feet deep from 4×30 inch tall pots) that require minimal to no irrigation (Dreeson and Fenchel 2008). Seepwillow baccharis can serve as nurse plants for cottonwood seedlings through their stabilization of nursery bar habitats in Arizona (Brady *et al.* 1985, Richter 1992). **Establishing velvet mesquite, palo verde, screwbean mesquite, seepwillow baccharis, and native desert shrub vegetation, in addition to cottonwood and both Goodding's and coyote willow types, would enhance native vegetation and habitat diversity.** To help inform such planning, the growing requirements for many of the native plant species that may be appropriate to restore in the planning area are summarized in Appendix E.
- **Post-fire contingency actions, such as herbicide applications on re-sprouting saltcedar, mechanical removal, and/or active planting of native species should be planned to take advantage of the removal of saltcedar biomass by wildfire.** The

suppression of saltcedar cover for just a few years may be sufficient to allow native species that are planted shortly after a fire to grow above the saltcedar canopy. The success of the District's dense seeding of Atriplex species after the Buckeye fire suggests that such plantings may be useful in limiting saltcedar re-growth and spread after fires. It is important to note, however, that the intensity of burns may influence the type of post-burn management activities that are appropriate; such dense seeding may not be needed if a very hot burn results in complete mortality of saltcedar and/or the soil seed bank.

- **Creation of a variety of water features may be considered to facilitate expansion of diverse open water/marsh and riparian woodland habitats, especially in support of the three listed birds:** (1) low-flow side channels and side-channel pools that can expand aquatic fish habitat and hydrologically connect the floodplain to facilitate cottonwood/willow plantings and support a variety of wetlands, including open water, emergent marsh and wet meadows (USACE 2011) important for the Yuma clapper rail; (2) creation of moderate to high-flow backwater channels (USACE 2011) and embayment areas to facilitate development of open/water marsh habitats next to restored riparian woodland; (3) high-flow ephemeral channels (USACE 2011), or inundation channels that can serve as willow swales supporting willow flycatcher habitat or upper terrace screwbean and velvet mesquite woodlands which are important habitat components for yellow-billed cuckoos (Halterman at al. 2015); and (4) bankline benches or terraces (USACE 2011) that would allow for increased inundation for cottonwood/willow plantings, which has been observed to facilitate habitat for willow flycatcher along the Gila River in New Mexico (Boucher *et al.* 2003).
- Flood-risk mitigation activities undertaken to improve the FEMA Community Rating System should be explicitly coordinated with riparian vegetation restoration plans to maximize their mutual benefits. Flood risk mitigation activities include: (1) clearing of saltcedar in areas subject to overbank flooding in the spring to provide opportunities for development of secondary channels which support the growth of cottonwood and willow seedlings (Taylor *et al.* 1999) and cottonwood/willow pole plantings; (2) newly created low-flow conveyance secondary channels for improving the movement of water and sediments through the reach can also support development of marsh wetland habitats as has been observed along the low-flow conveyance channel of the middle Rio Grande River (Gorbach 1999); and (3) current and future urban stormwater and treated wastewater management in the floodplain development area should be planned to support and develop constructed wetland and riparian woodland habitats (City of Tucson and Pima County 2009).
- A number of different entities have previously conducted, or have plans to conduct, vegetation-management-related activities in the planning area. This is likely to continue and increase as urban development mitigation projects become required and pressure to remove saltcedar increases. **Continued communication and coordination with these entities, such as USFWS, BLM, AGFD, ADOT, Lower Gila River Restoration Collaborative, and the cities of Buckeye, Goodyear, and Avondale, will be important to ensure that vegetation management activities do not conflict with one another and, ideally, can be conducted in ways that save or share costs and increase each other's benefits.** Such communication and coordination would be facilitated by spatially-explicit mapping of various vegetation management activities in the planning area, regardless of the project sponsor.

3.8 Wildlife

Three avian species—southwestern willow flycatcher, western yellow-billed cuckoo, and Yuma clapper rail—are the primary special-status species that have been documented to occur or have potential to occur in the planning area. These birds, as well as other migratory birds (that are protected under the federal MBTA) and native wildlife, can utilize saltcedar for habitat in the absence of native trees and shrubs. **All clearing and grubbing activities will be performed outside of the nesting season of most migratory birds (mid-April to mid-September).**

The arrival of tamarisk beetle is anticipated to dramatically reduce the dense saltcedar cover that these birds and other wildlife species may currently use in the planning area. As such, **it is necessary to quickly establish beetle-resilient native habitat for these species to use.** Saltcedar removal for vegetation management will similarly reduce the habitat that these species use. Therefore, **replanting saltcedar-treatment areas with native vegetation types will be necessary to mitigate for the potential impacts of vegetation management.** To minimize the impacts of vegetation management, saltcedar removal and subsequent native revegetation should be conducted in phases, so that the amount of habitat removed is relatively small in any given year and there is time for native habitat to grow to sufficient height, complexity, and density to suitable provide habitat before additional saltcedar is removed.

The recently updated multi-scaled models for flycatcher and cuckoo indicate that suitable breeding habitat may be present in the planning area, which is concentrated in the lower half of the reach (*i.e.*, downstream of Tuthill Rd bridge) within densely vegetated areas in close proximity to low-lying areas and/or adjacent to perennial water bodies and the low-flow channel. **There is a need to perform pre-treatment surveys and use extra caution to avoid working in dense stands that may be potentially suitable for flycatchers, cuckoos, and other migratory birds, particularly during the nesting season from early-May to late-September.** The flycatcher and cuckoo model results may also be used to inform habitat restoration efforts intended to directly benefit these species in the planning area.

Suitable habitat for the clapper rail may occur in the planning area but is expected to be limited to the perennially wet river channel. Clapper rails prefer marsh vegetation for nesting. Given that two clapper rails were observed in 2014 at the confluence of the Aqua Fria and Gila rivers **pre-treatment surveys for clapper rails should be conducted in the planning area.** Caution should be used to avoid potentially suitable habitats when working in the project area, particularly during breeding season from mid-April to mid-September.

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Appendix A

Land Ownership Maps

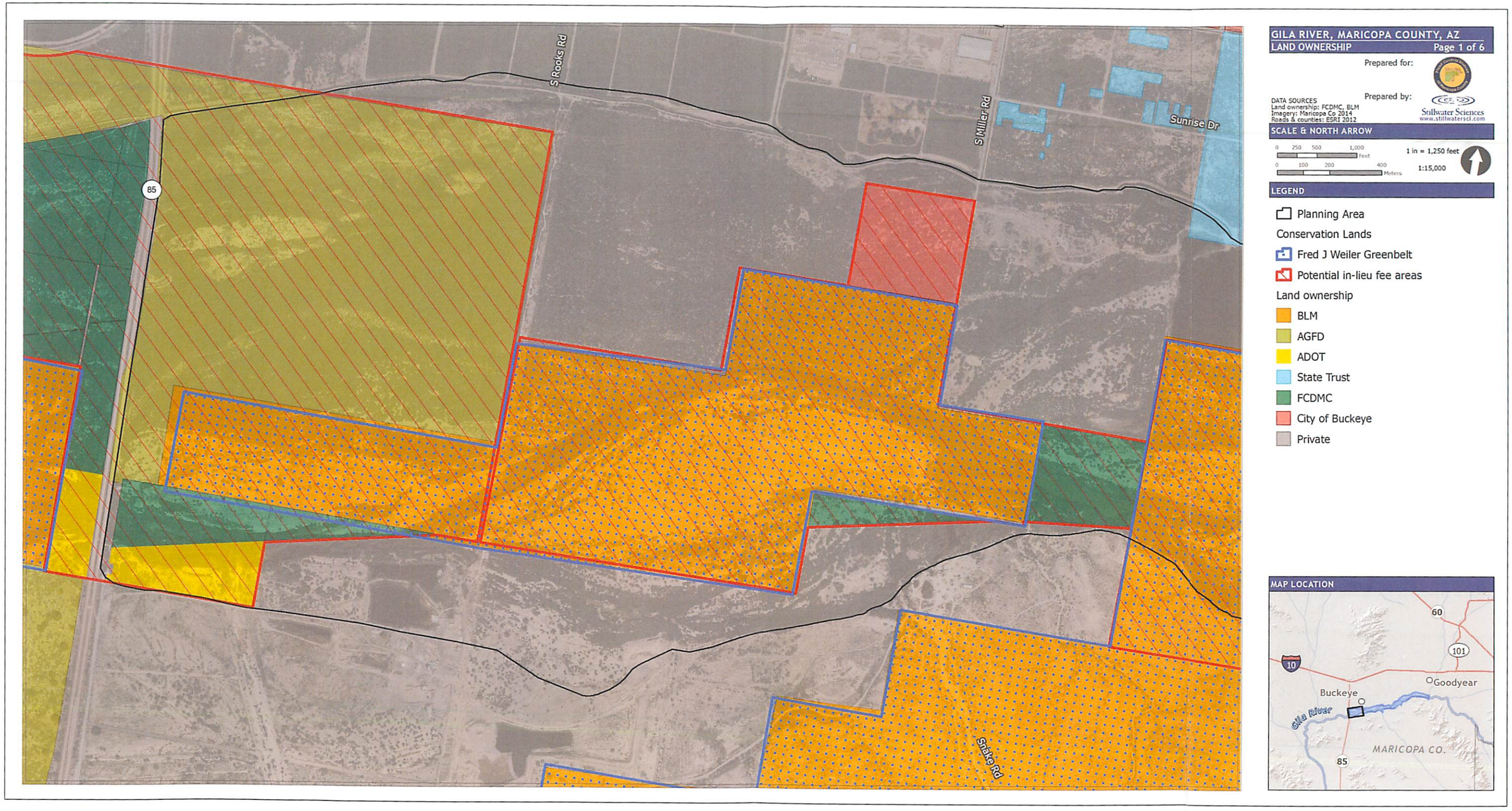


Figure A-1. Land ownership map (tile 1 of 6) of the planning area.

Figure A-2. Land ownership map (tile 2 of 6) of the planning area.

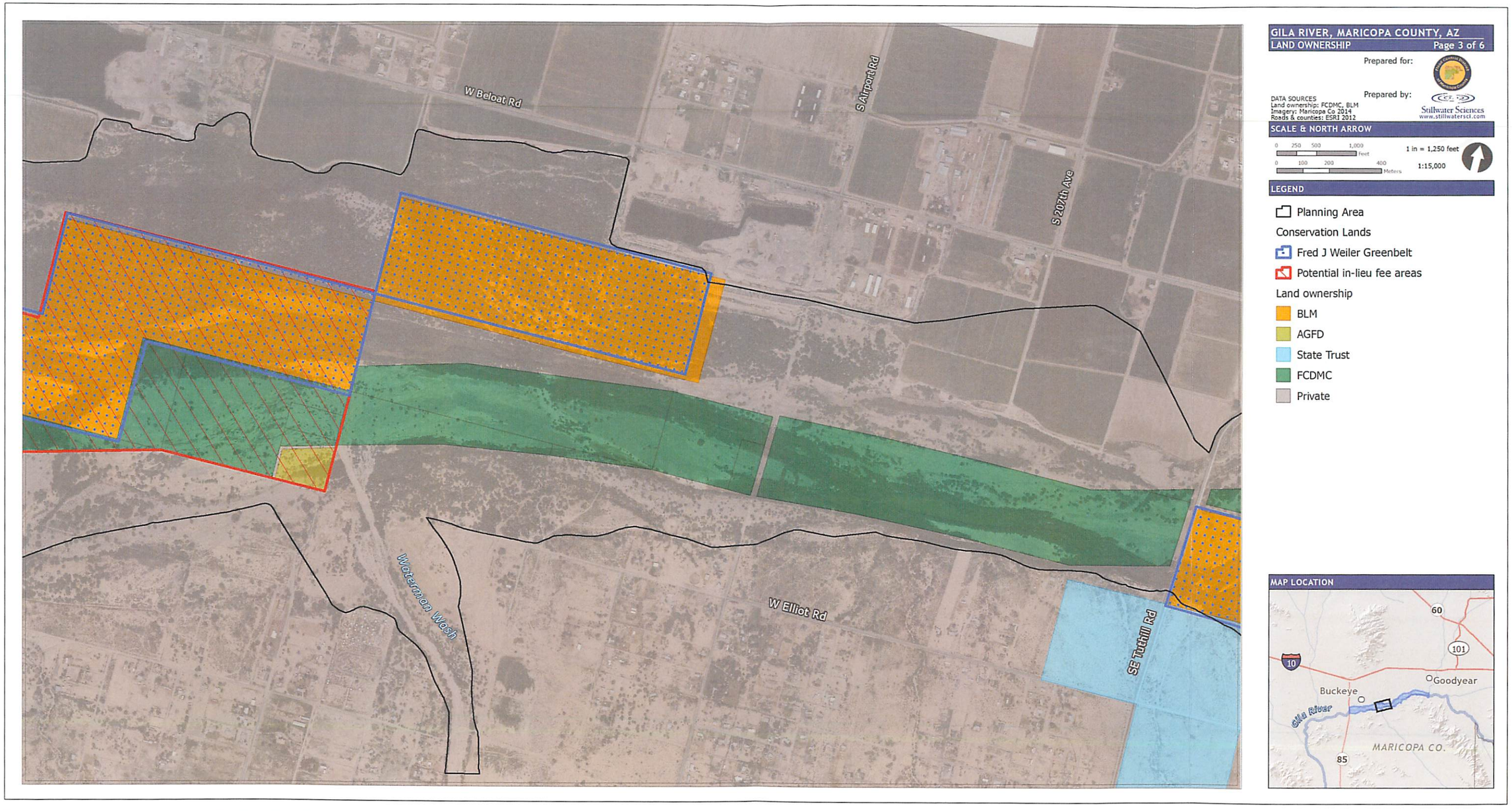


Figure A-3. Land ownership map (tile 3 of 6) of the planning area.

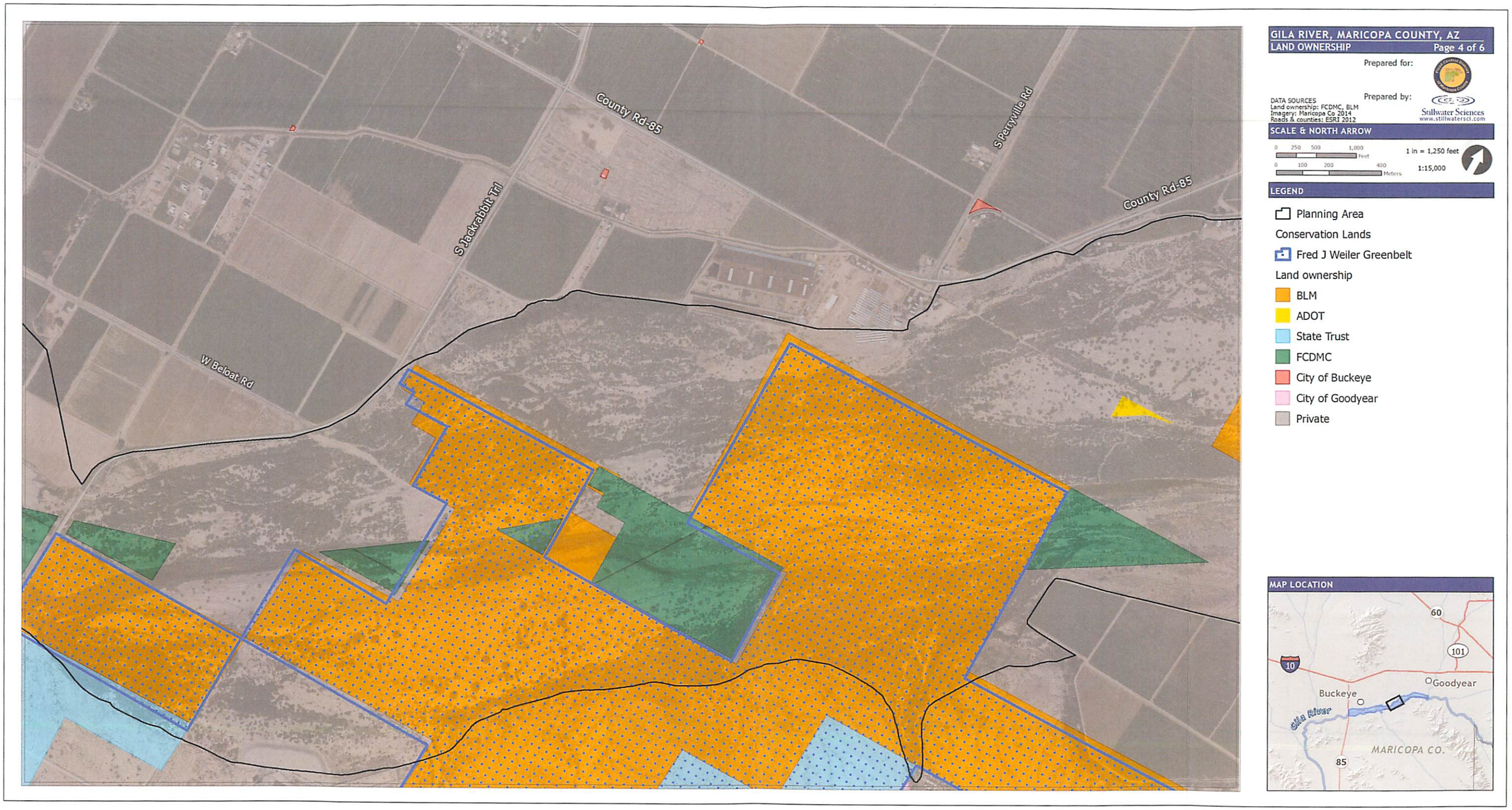


Figure A-4. Land ownership map (tile 4 of 6) of the planning area.

GILA RIVER, MARICOPA COUNTY, AZ
LAND OWNERSHIP Page 5 of 6

Prepared for:

Prepared by:

DATA SOURCES
Land ownership: FCDMC, BLM
Imagery: Maricopa Co 2014
Roads & counties: ESRI 2012

Stillwater Sciences
www.stillwaterscl.com

SCALE & NORTH ARROW

0 250 500 1,000 Feet
0 100 200 400 Meters

1 in = 1,250 feet
1:15,000

LEGEND

- Planning Area

Conservation Lands

- Fred J Weiler Greenbelt

Land ownership

- BLM
- State Trust
- FCDMC
- City of Buckeye
- Private

MAP LOCATION

Figure A-5. Land ownership map (tile 5 of 6) of the planning area.

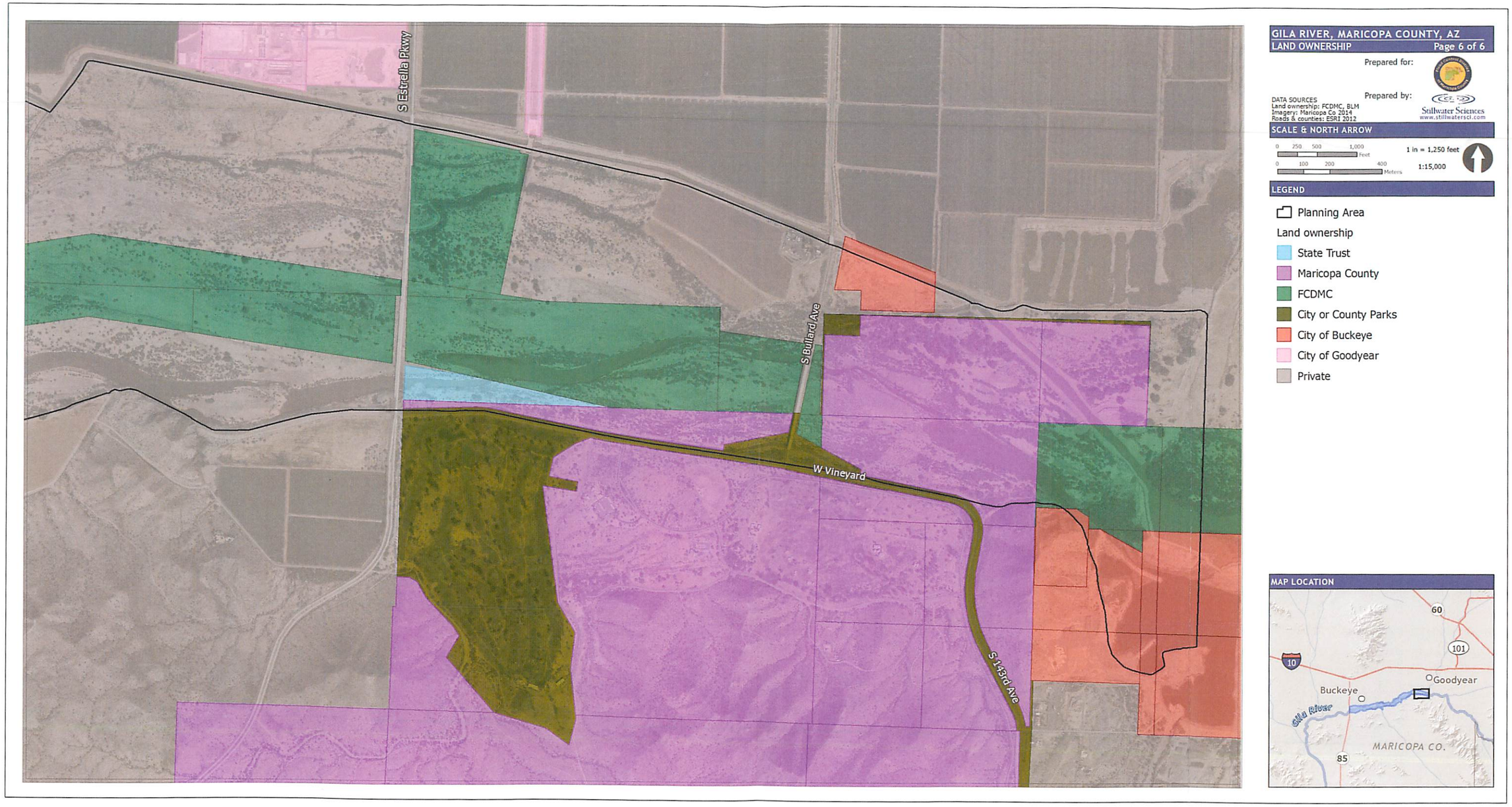


Figure A-6. Land ownership map (tile 6 of 6) of the planning area.

Appendix B

Soil Unit Descriptions, Soil Salinity Maps, and Laboratory Reports

Soil Unit Descriptions

The following tabular summary of dominant soil units (Table B-1), soil salinity map tiles (Figures B-1 through B-6), and field sample laboratory results have been presented here to support the summary of soil conditions in the El Rio planning area presented in Section 2.6 Soils.

Table B-1. Description of dominant soil units present in the planning area. (Source: NRCS 2007)

Soil Type		Soil Properties and Qualities				
Symbol	**Name**	**Texture** [A]	**Hydrologic Soil Group** [B]	**Infiltration Rate, *Ksat*** [C]	**Reaction, *pH*** [D]	**Salinity, *EC*** [E]
Br	"Brios Loamy Sand"	0–152 cm (0–60 in): Gravelly sand	A	28–92 um/s	8.2	1 mmhos/cm
CF	"Carrizo and Brios Soils"	0–152 cm (0–60 in): Gravelly sand	A	28–423 um/s	8.2	1 mmhos/cm

Table footnotes (continues on next page):

[A] Material types within the profile, as measured in cm below grade surface (bgs) (see Section 618.46 Particle Size of NRCS Soil Properties and Qualities of the National Soil Survey Handbook [NRCS 2015a]):

i. Clay: As a soil separate, the mineral soil particles less than 0.002 millimeter (mm) in diameter. As a soil textural class, soil material that is 40% or more clay, less than 45% sand, and less than 40% silt.

ii. Silt: As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 mm) to the lower limit of very fine sand (0.05 mm). As a soil textural class, soil that is 80% or more silt and less than 12% clay.

iii. Sand: As a soil separate, individual rock or mineral fragments from 0.05–2.0 mm in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85% or more sand and not more than 10% clay.

iv. Gravel: As a soil separate, individual rock or mineral fragments from 2.0–75 mm in diameter, though is recognized to extend only up to 64 mm by the Udden-Wentworth grain-size scale.

v. Loam: Soil material that is 7–27% clay particles, 28–50% silt particles, and <52% sand particles.

[B] Hydrologic soil group refers to soils grouped according to their runoff potential (see Section 618.39 Hydrologic Group in NRCS 2015a). The soil properties that influence this potential are those that affect the minimum rate of water infiltration on a bare soil during periods after prolonged wetting when the soil is not frozen. These properties include depth to a seasonal high water table, the infiltration rate, and depth to a layer that significantly restricts the downward movement of water. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff.

i. Group A (low runoff potential): The soils have a high infiltration rate even when thoroughly wetted. They chiefly consist of deep, well drained to excessively drained sands or gravels. They have a high rate of water transmission.

ii. Group B: The soils have a moderate infiltration rate when thoroughly wetted. They chiefly are moderately deep to deep, moderately well drained to well drained soils that have moderately fine to moderately coarse textures. They have a moderate rate of water transmission.

iii. Group C: The soils have a slow infiltration rate when thoroughly wetted. They chiefly have a layer that impedes downward movement of water of have moderately fine to fine texture. They have a slow rate of water transmission.

iv. Group D (high runoff potential): The soils have a very slow infiltration rate when thoroughly wetted. They chiefly consist of clay soils that have a high swelling potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and shallow soils over nearly impervious material. The have a very slow rate of water transmission.

[C] Infiltration rate is the rate at which water penetrates the surface of the soil at any given instant, usually expressed in micrometers per hour (um/hr) (see Section 618.53 Hydrologic Group in NRCS 2015a). The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface. *Also*, saturated hydraulic conductivity, or *Ksat*, is the ease with which pores of a saturated soil transmit water. Formally, the proportionality coefficient that expresses the relationship of the rate of water movement to hydraulic gradient in Darcy's Law, a

law that describes the rate of water movement through porous media. Classes of saturated hydraulic conductivity, as measured in micrometers per second (um/s), are:

i. Very high: >100 um/s (>14.17 in/hr)
ii. High: 10–100 um/s (1.417–14.17 in/hr)
iii. Moderately high: 1–10 um/s (0.1417–1.417 in/hr)
iv. Moderately low: 0.1–1 um/s (0.01417–0.1417 in/hr)
v. Low: 0.01–0.1 um/s (0.001417–0.01417 in/hr)
vi. Very low: <0.01 um/s (<0.001417 in/hr)

D Soil reaction, or *pH*, is a numerical expression of the relative acidity or alkalinity of a soil (see Section 618.51 Reaction, Soil [pH] in NRCS 2015a). Soil *pH* affects availability of plant nutrients. Acidic soils have low extractable calcium and magnesium, and typically have a low availability of nitrogen and phosphorus. Alkaline soils may have an inadequate availability of iron, manganese, copper, zinc, phosphorus and boron. Classes of soil pH are:

i. Ultra acid: 1.8–3.4
ii. Extremely acid: 3.5–4.4
iii. Very strongly acid: 4.5–5.0
iv. Strongly acid: 5.1–5.5
v. Moderately acid: 5.6–6.0
vi. Slightly acid: 6.1–6.5
vii. Neutral: 6.6–7.3
viii. Slightly alkaline: 7.4–7.8
ix. Moderately alkaline: 7.9–8.4
x. Strongly alkaline: 8.5–9.0
xi. Very strongly alkaline: 9.1–11.0

E Salinity is the concentration of water-soluble salts in soils as measured by electrical conductivity, or *EC* (see Section 618.20 Electrical Conductivity in NRCS 2015a). High concentrations of neutral salts, such as sodium chloride and sodium sulfate, may interfere with the absorption of water by plants and may also interfere with the exchange capacity of nutrient ions. Classes of salinity, as measured in millimhos per centimeter (mmhos/cm), are:

i. Non-saline: 0–<2 mmhos/cm
ii. Very slightly saline: 2–4 mmhos/cm
iii. Slightly saline: 4–8 mmhos/cm
iv. Moderately saline: 8–16 mmhos/cm
v. Strongly saline: >16 mmhos/cm

Soil Salinity Maps

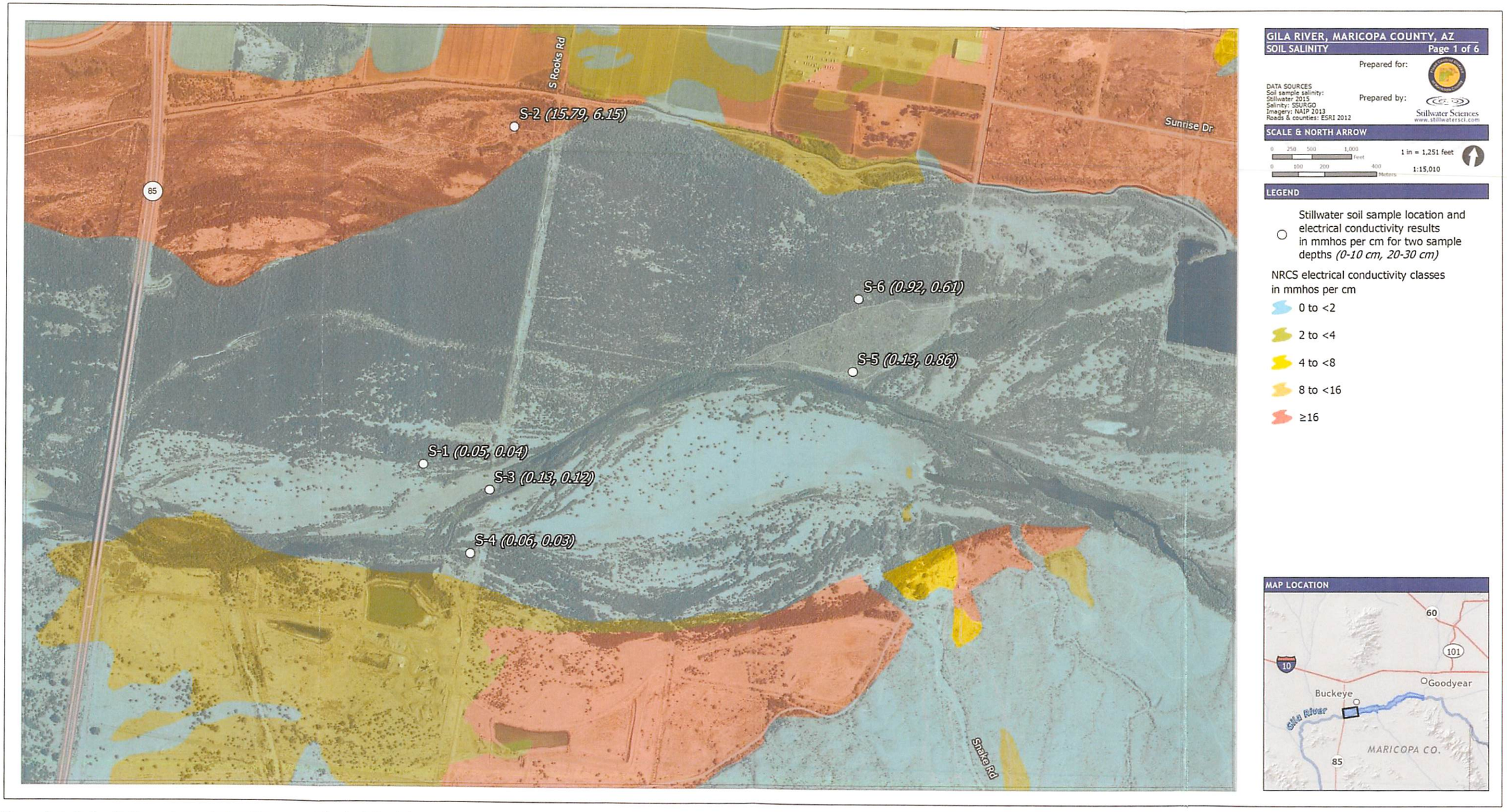
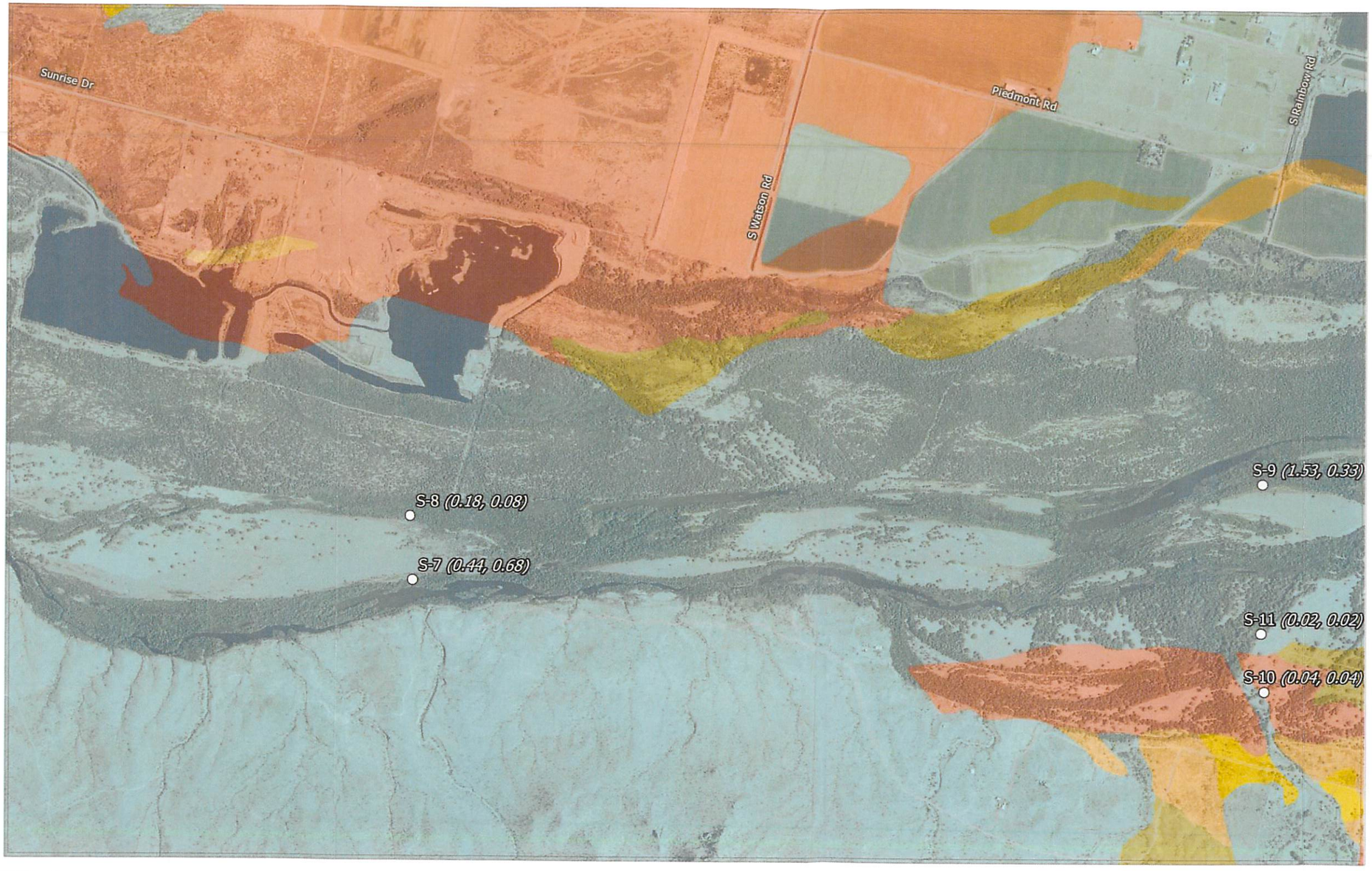


Figure B-1. Soil salinity and sample location map (tile 1 of 6) of the planning area.



GILA RIVER, MARICOPA COUNTY, AZ
SOIL SALINITY
Page 2 of 6

Prepared for:

DATA SOURCES
Soil sample salinity:
Stillwater 2015
Salinity: SSURGO
Imagery: NAIP 2013
Roads & counties: ESRI 2012

Prepared by:
Stillwater Sciences
www.stillwatersci.com

SCALE & NORTH ARROW

0 250 500 1,000 Feet
0 100 200 400 Meters
1 in = 1,251 feet
1:15,010

LEGEND

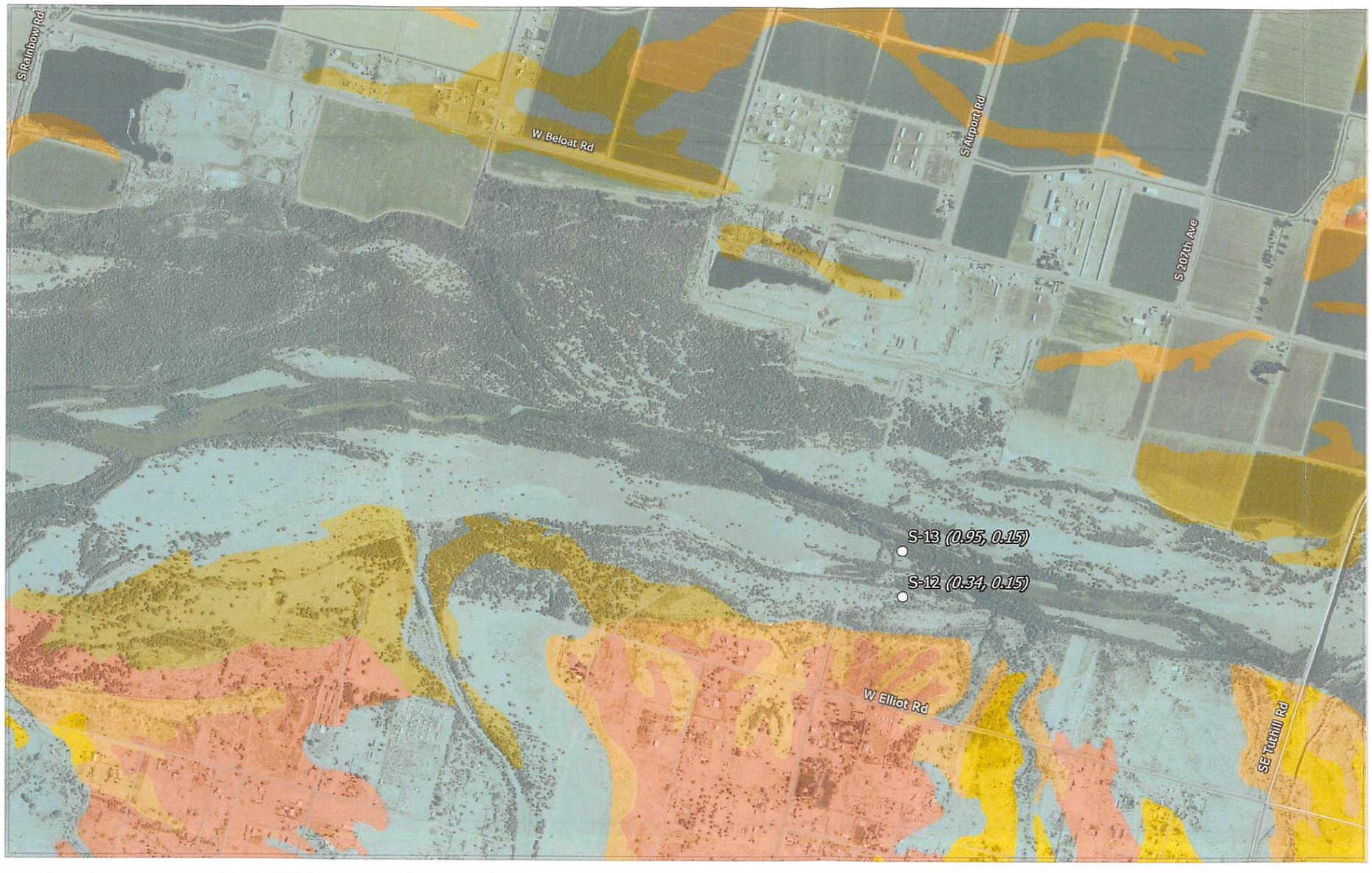
Stillwater soil sample location and electrical conductivity results in mmhos per cm for two sample depths *(0-10 cm, 20-30 cm)*

NRCS electrical conductivity classes in mmhos per cm

- 0 to <2
- 2 to <4
- 4 to <8
- 8 to <16
- ≥16

MAP LOCATION

Figure B-2. Soil salinity and sample location map (tile 2 of 6) of the planning area.



GILA RIVER, MARICOPA COUNTY, AZ
SOIL SALINITY
Page 3 of 6

Prepared for:

Prepared by:

Stillwater Sciences
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DATA SOURCES
Soil sample salinity:
Stillwater 2015
Salinity: SSURGO
Imagery: NAIP 2013
Roads & counties: ESRI 2012

SCALE & NORTH ARROW

0 250 500 1,000 Feet
0 100 200 400 Meters
1 in = 1,273 feet
1:15,280

LEGEND

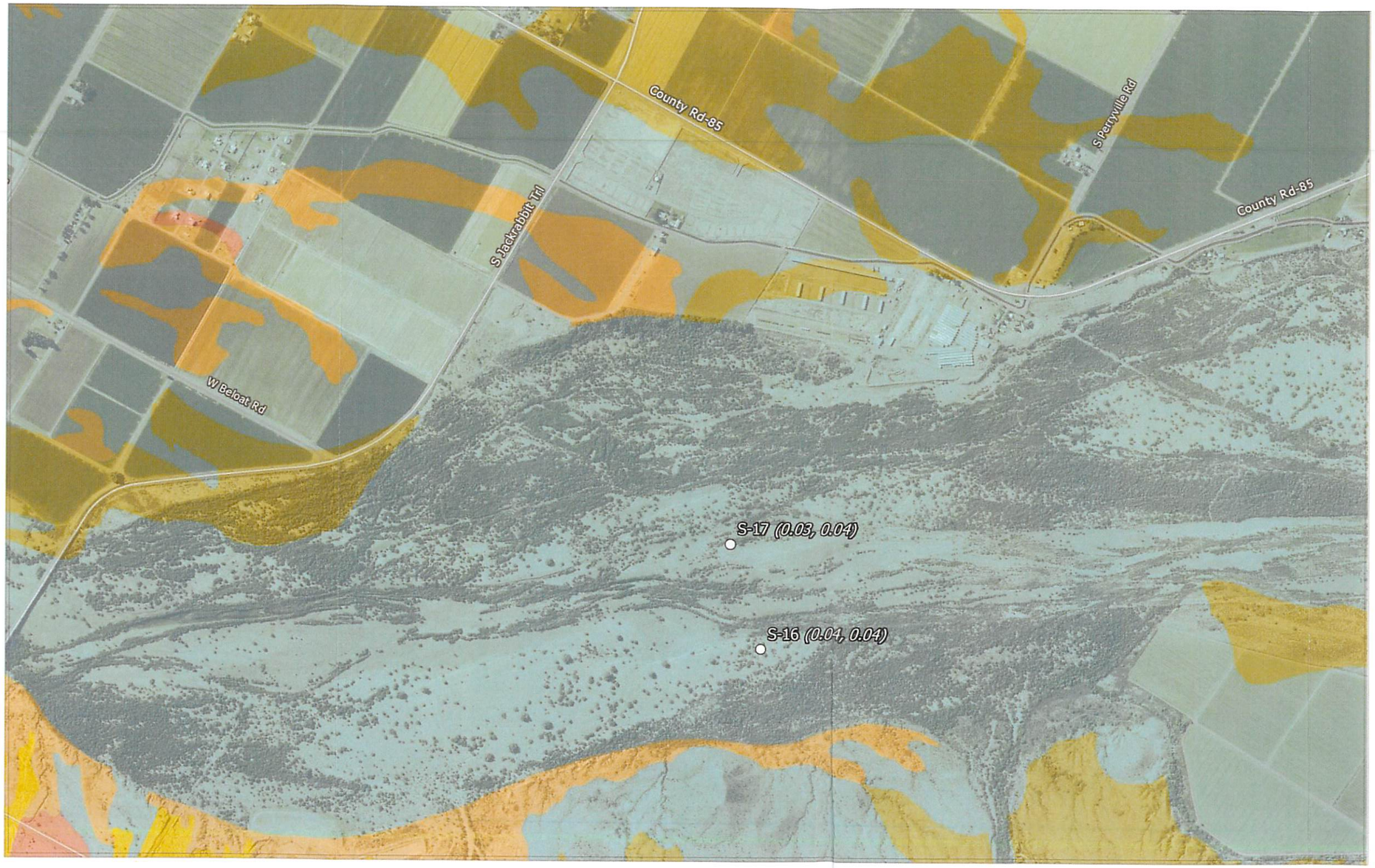
Stillwater soil sample location and electrical conductivity results in mmhos per cm for two sample depths *(0-10 cm, 20-30 cm)*

NRCS electrical conductivity classes in mmhos per cm

- 0 to <2
- 2 to <4
- 4 to <8
- 8 to <16
- ≥16

MAP LOCATION

Figure B-3. Soil salinity and sample location map (tile 3 of 6) of the planning area.



GILA RIVER, MARICOPA COUNTY, AZ
SOIL SALINITY Page 4 of 6

Prepared for:

Prepared by: Stillwater Sciences www.stillwatersci.com

DATA SOURCES
Soil sample salinity:
Stillwater 2015
Salinity: SSURGO
Imagery: NAIP 2013
Roads & counties: ESRI 2012

SCALE & NORTH ARROW

0 250 500 1,000 Feet
0 100 200 400 Meters
1 in = 1,251 feet
1:15,010

LEGEND

Stillwater soil sample location and electrical conductivity results in mmhos per cm for two sample depths *(0-10 cm, 20-30 cm)*

NRCS electrical conductivity classes in mmhos per cm

- 0 to <2
- 2 to <4
- 4 to <8
- 8 to <16
- ≥16

MAP LOCATION

Figure B-4. Soil salinity and sample location map (tile 4 of 6) of the planning area.

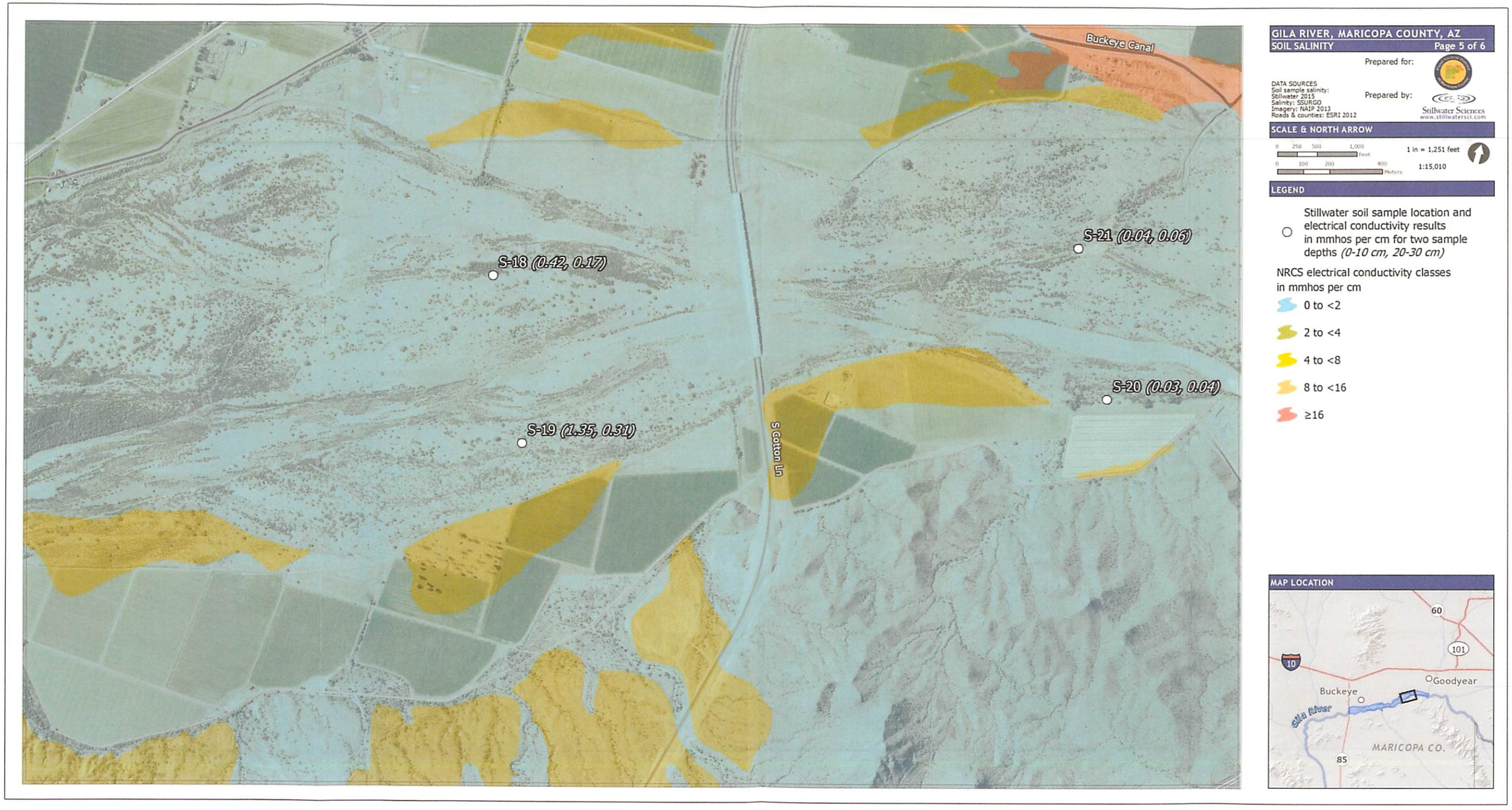
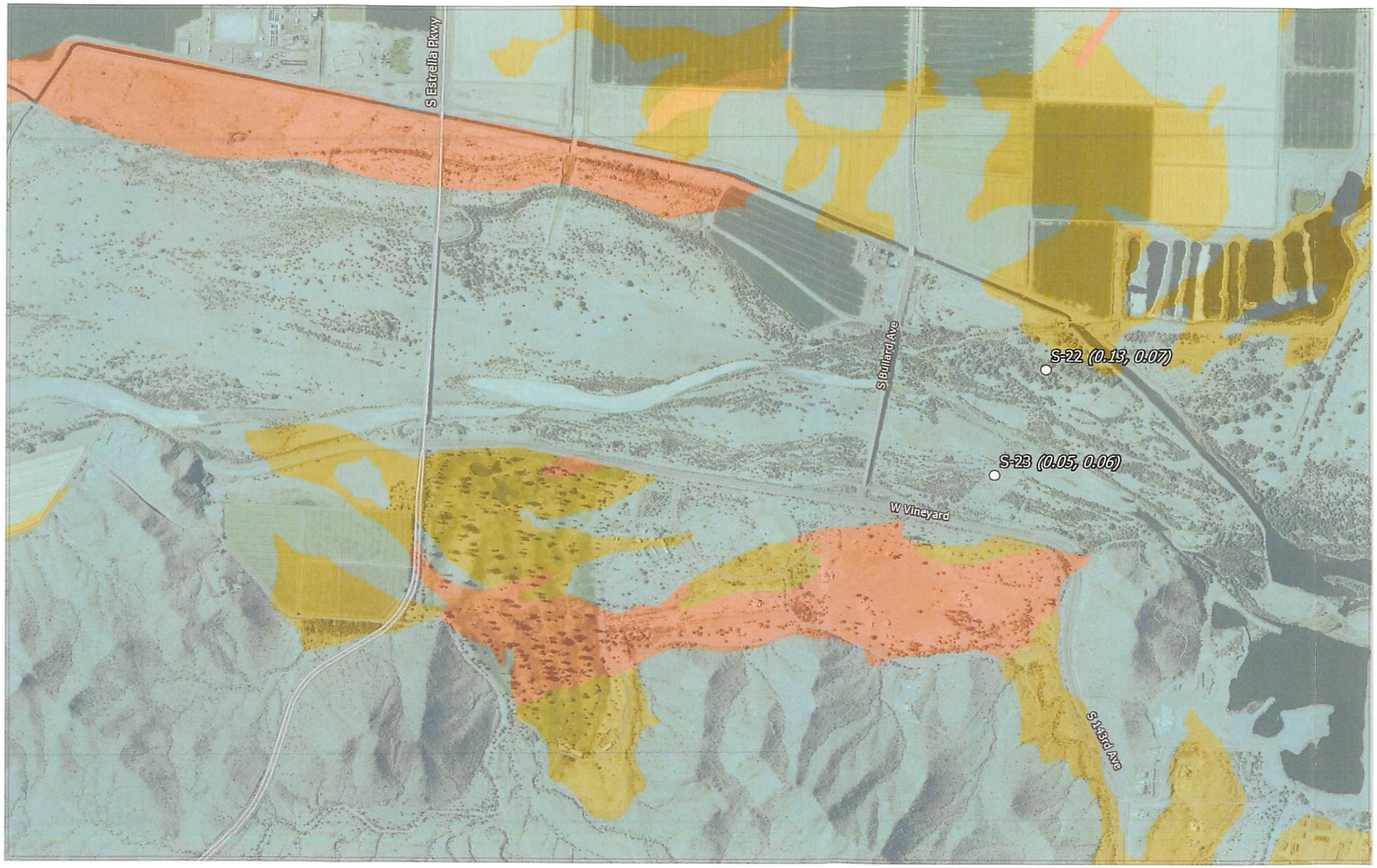


Figure B-5. Soil salinity and sample location map (tile 5 of 6) of the planning area.



GILA RIVER, MARICOPA COUNTY, AZ
SOIL SALINITY
Page 6 of 6

Prepared for:

Prepared by:

Stillwater Sciences
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DATA SOURCES
Soil sample salinity:
Stillwater 2015
Salinity: SSURGO
Imagery: NAIP 2013
Roads & counties: ESRI 2012

SCALE & NORTH ARROW

0 250 500 1,000 Feet
0 100 200 400 Meters
1 in = 1,251 feet
1:15,010

LEGEND

Stillwater soil sample location and electrical conductivity results in mmhos per cm for two sample depths *(0-10 cm, 20-30 cm)*

NRCS electrical conductivity classes in mmhos per cm

- 0 to <2
- 2 to <4
- 4 to <8
- 8 to <16
- ≥16

MAP LOCATION

Figure B-6. Soil salinity and sample location map (tile 6 of 6) of the planning area.

				Electrical Conductivity (µS)				pH				Soil Texture								
Soil_Sample_ID	Date	Time	Wt (g) of Particles >2 mm	1	2	Avg.	Temp	1	2	Avg.	Temp	40 sec	7 hours	Corrected 40 Sec*	Corrected 7 hour*	Corrected 40 Sec Density +T**	Corrected 7 Hour Density +T**	% Clay	% Silt	% Sand
S-1 @ 0-10 cm	6/28/2015	8:45	26.21	50.1	57.4	53.8	21.5	7.01	7.06	7.04	23.3	5	4	5.6	4.6	6.6	5.6	14.0	2.5	83.5
S-1 @ 20-30 cm	6/28/2015	8:46	17.68	36.5	38.8	37.7	22.9	6.92	7.01	6.97	23.1	4	4	4.6	4.6	5.6	5.6	14.0	0.0	86.0
S-2 @ 0-10 cm	6/28/2015	10:16	17.42	15450	16120	15785.0	22.4	7.25	7.58	7.42	29.1	27	7	27.6	7.6	28.6	8.6	21.5	50.0	28.5
S-2 @ 20-30 cm	6/28/2015	10:18	17.12	5920	6380	6150.0	22	7.76	8.07	7.92	22.2	27	6	27.6	6.6	28.6	7.6	19.0	52.5	28.5
S-3 @ 0-10 cm	6/29/2015	6:32	33.34	123.6	127	125.3	22.4	6.68	6.79	6.74	22.3	8	5	8.6	5.6	9.6	6.6	16.5	7.5	76.0
S-3 @ 20-30 cm	6/29/2015	6:34	17.22	110.8	125.8	118.3	23.6	6.79	6.86	6.83	22.6	6	4	6.6	4.6	7.6	5.6	14.0	5.0	81.0
S-4 @ 0-10 cm	6/29/2015	~06:30	99.6	56.2	58.8	57.5	22.9	7.4	7.42	7.41	21.7	5	4	5.6	4.6	6.6	5.6	14.0	2.5	83.5
S-4 @ 20-30 cm	6/29/2015	~06:30	178.05	31.8	33.4	32.6	23.2	7.07	7.11	7.09	22.7	5	5	5.6	5.6	6.6	6.6	16.5	0.0	83.5
S-5 @ 0-10 cm	6/29/2015	7:26	9.4	129.2	136.4	132.8	22.1	7.97	7.91	7.94	21.7	16	5	16.6	5.6	17.6	6.6	16.5	27.5	56.0
S-5 @ 20-30 cm	6/29/2015	7:28	22.39	794	924	859.0	23.4	6.53	6.75	6.64	22.8	14	5	14.6	5.6	15.6	6.6	16.5	22.5	61.0
S-6 @ 0-10 cm	6/29/2015	8:14	15.67	882	966	924.0	23	7.04	7.08	7.06	21.7	22	5	22.6	5.6	23.6	6.6	16.5	42.5	41.0
S-6 @ 20-30 cm	6/29/2015	8:16	20.01	595	620	607.5	21.7	7.37	7.51	7.44	21.8	25	5	25.6	5.6	26.6	6.6	16.5	50.0	33.5
S-7 @ 0-10 cm	6/29/2015	10:10	510.22	421	468	444.5	21.5	6.6	6.76	6.68	22.7	11	5	11.6	5.6	12.6	6.6	16.5	15.0	68.5
S-7 @ 20-30 cm	6/29/2015	10:12	864.71	672	682	677.0	22.7	7.52	7.59	7.56	21.9	18	5	18.6	5.6	19.6	6.6	16.5	32.5	51.0
S-8 @ 0-10 cm	6/29/2015	10:26	1179.79	179.2	189.4	184.3	22.8	6.89	6.88	6.89	22.5	10	5	10.6	5.6	11.6	6.6	16.5	12.5	71.0
S-8 @ 20-30 cm	6/29/2015	10:28	55.47	77.2	80.4	78.8	22.7	6.78	6.86	6.82	22.8	6	4	6.6	4.6	7.6	5.6	14.0	5.0	81.0
S-9 @ 0-10 cm	6/29/2015	12:08	78.4	1485	1582	1533.5	22.8	7.37	7.48	7.43	21.9	12	4	12.6	4.6	13.6	5.6	14.0	20.0	66.0
S-9 @ 20-30 cm	6/29/2015	12:10	722.19	314	353	333.5	22	7.62	7.61	7.62	21.4	5	5	5.6	5.6	6.6	6.6	16.5	0.0	83.5
S-10 @ 0-10 cm	6/30/2015	5:00	6.82	29	43.2	36.1	23.3	6.84	6.92	6.88	22.6	7	4	7.6	4.6	8.6	5.6	14.0	7.5	78.5
S-10 @ 20-30 cm	6/30/2015	5:00	0.92	39.6	43.7	41.7	22.8	7.4	7.44	7.42	21.8	6	4	6.6	4.6	7.6	5.6	14.0	5.0	81.0
S-11 @ 0-10 cm	6/30/2015	5:45	3.25	22.3	25.3	23.8	22.3	6.86	6.93	6.90	23	5	4	5.6	4.6	6.6	5.6	14.0	2.5	83.5
S-11 @ 20-30cm	6/30/2015	5:50	28.78	21.4	21.9	21.7	23	7.21	7.24	7.23	23.2	4	4	4.6	4.6	5.6	5.6	14.0	0.0	86.0
S-12 @ 0-10 cm	6/30/2015	8:00	93	298	377	337.5	23.6	6.68	6.76	6.72	22.5	14	5	14.6	5.6	15.6	6.6	16.5	22.5	61.0
S-12 @ 20-30 cm	6/30/2015	27.26	527.82	137.7	155.2	146.5	22.8	7.58	7.54	7.56	21.4	10	5	10.6	5.6	11.6	6.6	16.5	12.5	71.0
S-13 @ 0-10 cm	6/30/2015	8:40	27.26	902	997	949.5	22.6	7.62	7.52	7.57	21.9	8	4	8.6	4.6	9.6	5.6	14.0	10.0	76.0
S-13 @ 20-30 cm	6/30/2015	8:45	12.31	106.7	186.1	146.4	22.1	6.96	6.98	6.97	22.7	5	5	5.6	5.6	6.6	6.6	16.5	0.0	83.5
S-16 @ 0-10 cm	7/1/2015	5:30	1.1	35.5	40.2	37.9	23.1	7.89	7.88	7.89	21.9	5	3	5.6	3.6	6.6	4.6	11.5	5.0	83.5
S-16 @ 20-30 cm	7/1/2015	5:30	5.74	40.2	42.6	41.4	23.6	6.89	6.95	6.92	23.2	6	5	6.6	5.6	7.6	6.6	16.5	2.5	81.0
S-17 @ 0-10 cm	7/1/2015	5:55	1.4	30.9	31	31.0	21.2	6.79	6.85	6.82	23	4	4	4.6	4.6	5.6	5.6	14.0	0.0	86.0
S-17 @ 20-30 cm	7/1/2015	5:57	7.86	36	37.7	36.9	23.1	6.9	6.96	6.93	22.9	5	5	5.6	5.6	6.6	6.6	16.5	0.0	83.5
S-18 @ 0-10 cm	7/1/2015	8:50	0.43	404	434	419.0	23.1	6.84	6.96	6.90	23.2	9	5	9.6	5.6	10.6	6.6	16.5	10.0	73.5
S-18 @ 20-30 cm	7/1/2015	8:52	1.17	166.8	166.6	166.7	22	6.78	6.85	6.82	22.7	4	4	4.6	4.6	5.6	5.6	14.0	0.0	86.0
S-19 @ 0-10 cm	7/1/2015	9:40	0	1336	1371	1353.5	22.6	7.35	7.37	7.36	21.6	9	5	9.6	5.6	10.6	6.6	16.5	10.0	73.5
S-19 @ 20-30 cm	7/1/2015	9:45	22.91	298	317	307.5	21.6	6.76	6.86	6.81	22.7	9	5	9.6	5.6	10.6	6.6	16.5	10.0	73.5
S-20 @ 0-10 cm	7/1/2015	10:20	4.3	21.6	32.8	27.2	23.5	7.26	7.25	7.26	23.3	4	4	4.6	4.6	5.6	5.6	14.0	0.0	86.0
S-20 @ 20-30 cm	7/1/2015	10:22	2.4	35	38.4	36.7	22.5	6.89	6.98	6.94	22.9	4	4	4.6	4.6	5.6	5.6	14.0	0.0	86.0
S-21 @ 0-10 cm	7/1/2015	10:55	64.74	31.5	44.8	38.2	23.3	6.89	6.94	6.92	23	6	4	6.6	4.6	7.6	5.6	14.0	5.0	81.0
S-21 @ 20-30 cm	7/1/2015	11:00	14.92	63.5	63.4	63.5	21.6	6.89	6.94	6.92	22.9	12	5	12.6	5.6	13.6	6.6	16.5	17.5	66.0
S-22 @ 0-10 cm	7/1/2015	5:15	0.1	130.3	135	132.7	22.2	6.67	6.78	6.73	22.6	7	4	7.6	4.6	8.6	5.6	14.0	7.5	78.5
S-22 @ 20-30 cm	7/1/2015	5:17	0.5	62.6	75.9	69.3	23.1	7.01	7.06	7.04	21.3	13	5	13.6	5.6	14.6	6.6	16.5	20.0	63.5
S-23 @ 0-10 cm	7/2/2015	5:40	120.29	51.5	53.7	52.6	23	7.02	6.98	7.00	22.5	9	4	9.6	4.6	10.6	5.6	14.0	12.5	73.5
S-23 @ 20-30 cm	7/2/2015	5:42	80.7	59	56.8	57.9	21.5	7.32	7.34	7.33	21.1	7	5	7.6	5.6	8.6	6.6	16.5	5.0	78.5

Notes
* Corrected for temperature of samples above 67 degrees C
** Corrected using density of blank test

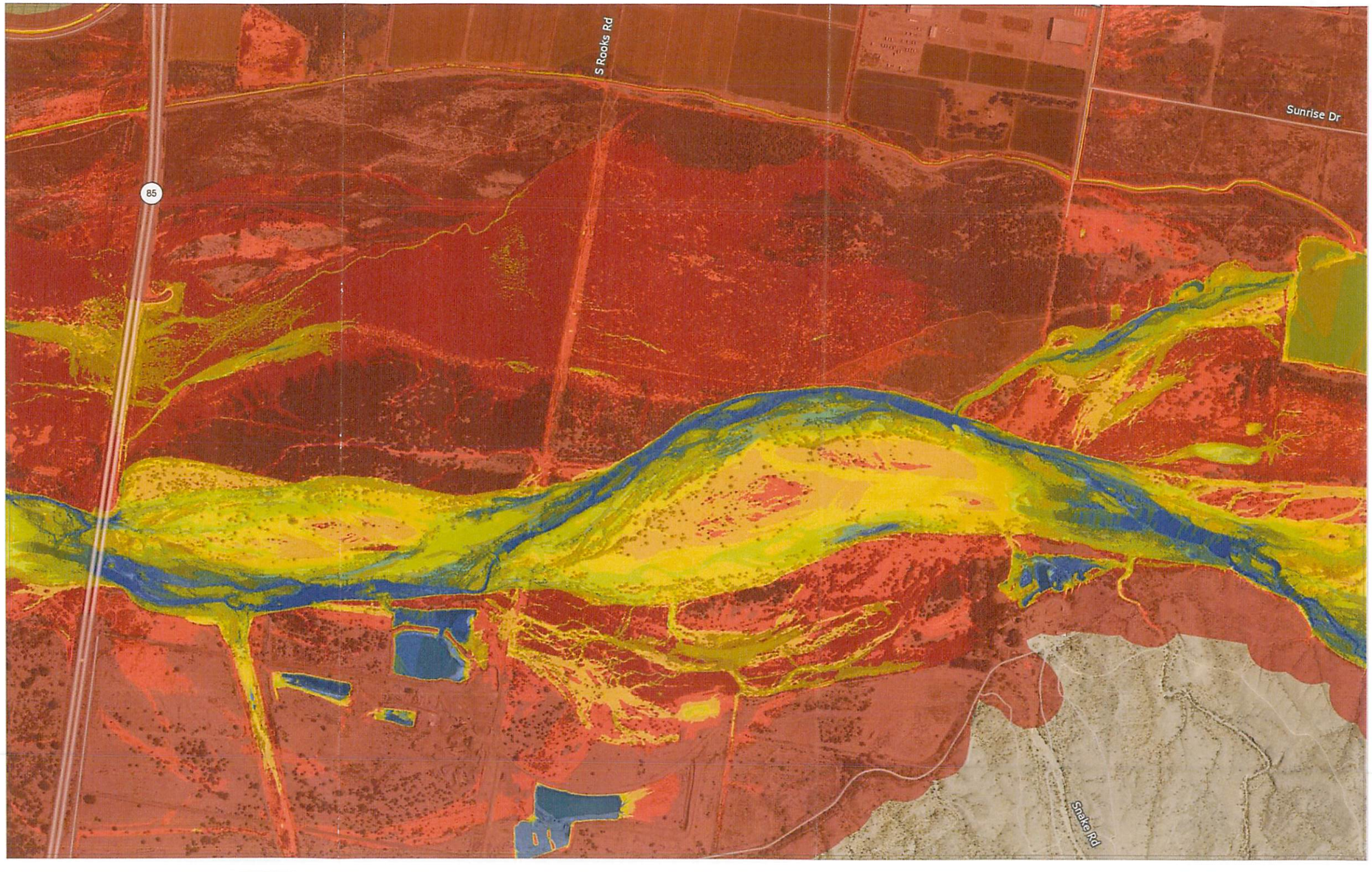
REFERENCES

NRCS (Natural Resources Conservation Service). 2007. Soil Survey Geographic (SSURGO) database. Available at: http://websoilsurvey.sc.egov.usda.gov/ [Accessed August 20, 2015].

NRCS. 2015a. National soil survey handbook, title 430-VI. U.S. Department of Agriculture, Natural Resources Conservation Service. Available at: http://soils.usda.gov/technical/handbook/ [Accessed August 20, 2015].

Appendix C

Relative-Elevation Surface Maps



GILA RIVER, MARICOPA COUNTY, AZ
RELATIVE ELEVATION Page 1 of 6

Prepared for:

DATA SOURCES
Relative elevation:
GPSi 2015, Stillwater 2015
Imagery: NAIP 2013
Roads & counties: ESRI 2012

Prepared by:
Stillwater Sciences
www.stillwatersci.com

SCALE & NORTH ARROW

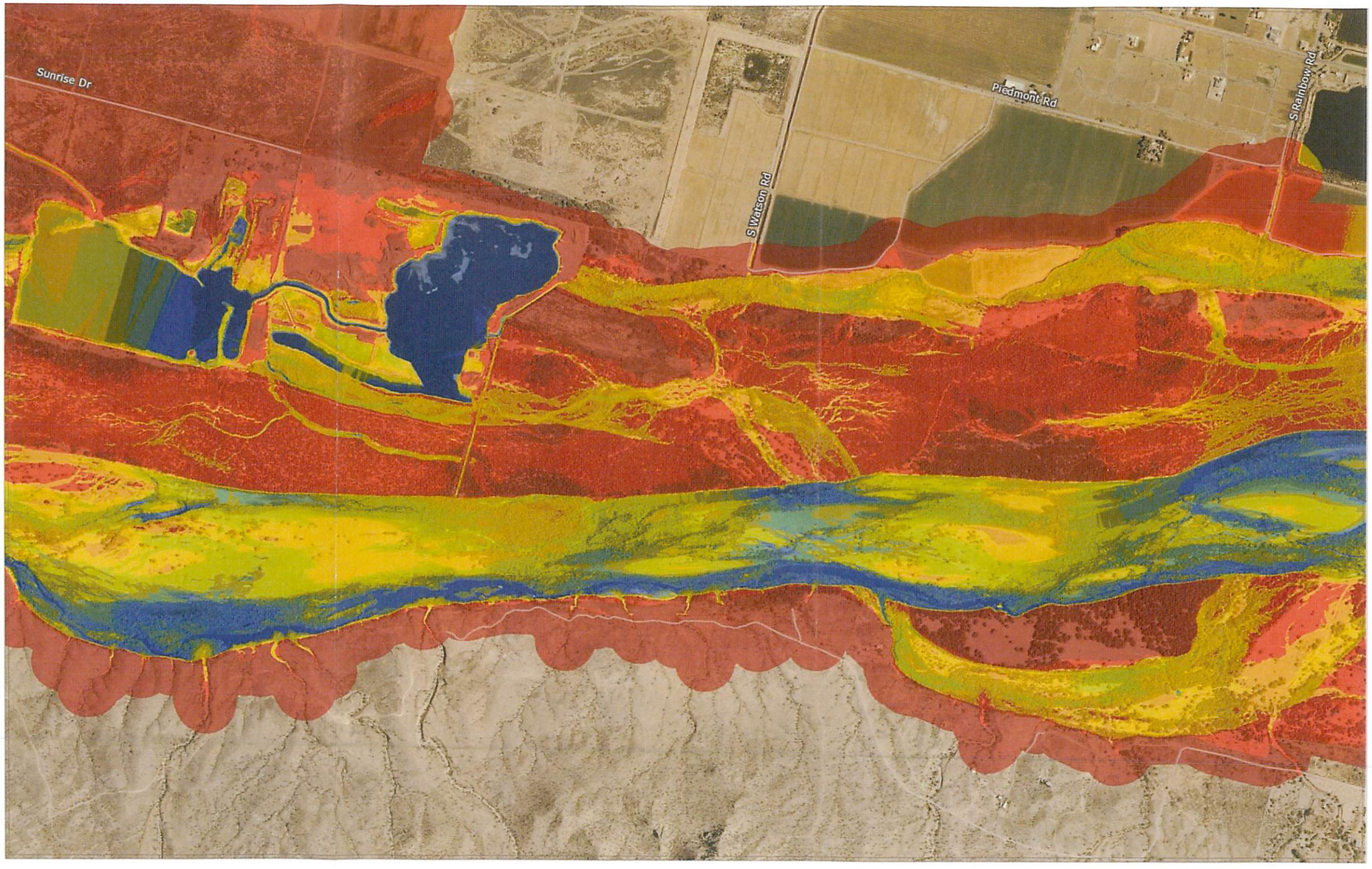
0 250 500 1,000 Feet
0 100 200 400 Meters
1 in = 1,250 feet
1:15,000

LEGEND

Relative Elevation
- < 0.1 ft
- 0.1 - 1 ft
- 1.1 - 2 ft
- 2.1 - 3 ft
- 3.1 - 5 ft
- 5.1 - 7.5 ft
- 7.6 - 10 ft
- 10.1 - 15 ft
- > 15 ft

MAP LOCATION

Figure C-1. Relative-elevation surface map (tile 1 of 6) of the planning area.



GILA RIVER, MARICOPA COUNTY, AZ
RELATIVE ELEVATION
Page 2 of 6

Prepared for:

Prepared by:
Stillwater Sciences
www.stillwatersci.com

DATA SOURCES
Relative elevation:
GPSi 2015, Stillwater 2015
Imagery: NAIP 2013
Roads & counties: ESRI 2012

SCALE & NORTH ARROW

0 250 500 1,000 Feet
0 100 200 400 Meters
1 in = 1,250 feet
1:15,000

LEGEND

Relative Elevation
- < 0.1 ft
- 0.1 - 1 ft
- 1.1 - 2 ft
- 2.1 - 3 ft
- 3.1 - 5 ft
- 5.1 - 7.5 ft
- 7.6 - 10 ft
- 10.1 - 15 ft
- > 15 ft

MAP LOCATION

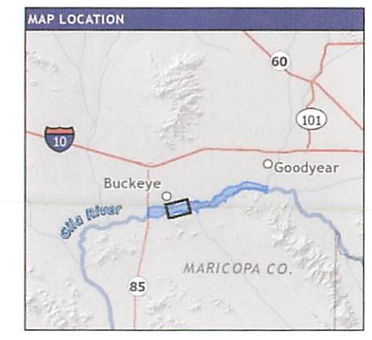


Figure C-2. Relative-elevation surface map (tile 2 of 6) of the planning area.

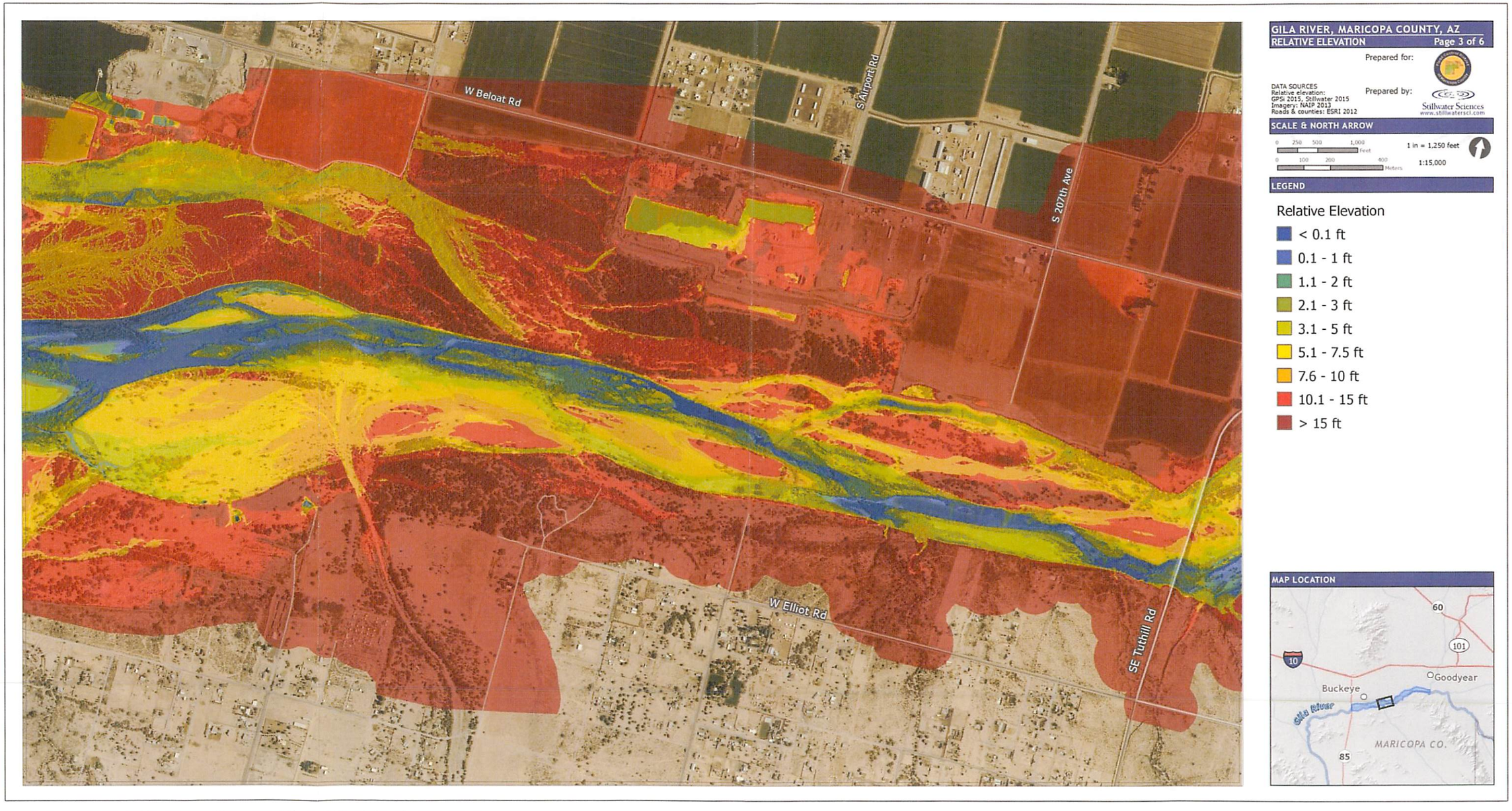
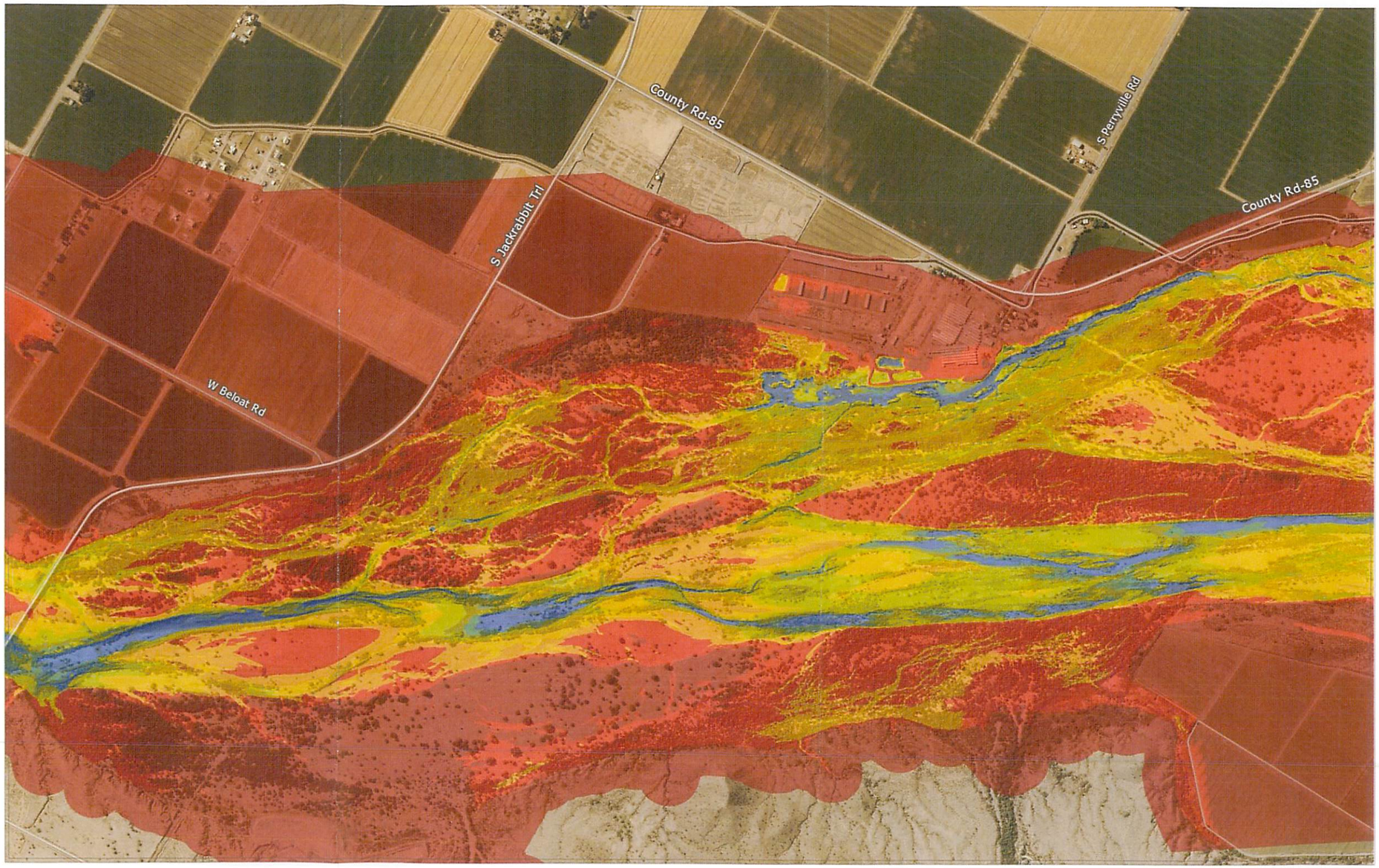


Figure C-3. Relative-elevation surface map (tile 3 of 6) of the planning area.



GILA RIVER, MARICOPA COUNTY, AZ
RELATIVE ELEVATION
Page 4 of 6

Prepared for:

DATA SOURCES
Relative elevation:
GPSi 2015, Stillwater 2015
Imagery: NAIP 2013
Roads & counties: ESRI 2012

Prepared by:
Stillwater Sciences
www.stillwatersci.com

SCALE & NORTH ARROW

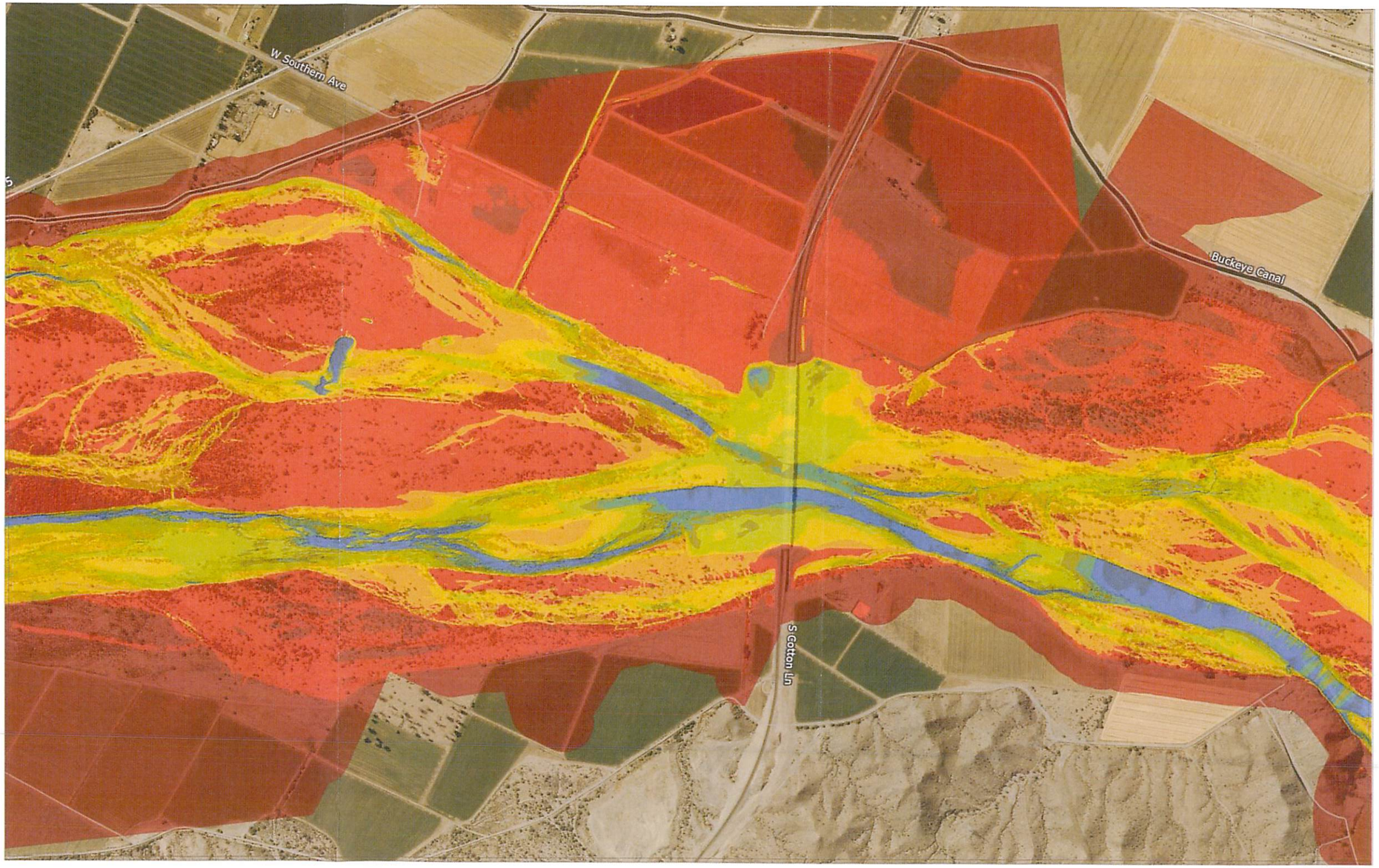
0 250 500 1,000 Feet
0 100 200 400 Meters
1 in = 1,250 feet
1:15,000

LEGEND

Relative Elevation
- < 0.1 ft
- 0.1 - 1 ft
- 1.1 - 2 ft
- 2.1 - 3 ft
- 3.1 - 5 ft
- 5.1 - 7.5 ft
- 7.6 - 10 ft
- 10.1 - 15 ft
- > 15 ft

MAP LOCATION

Figure C-4. Relative-elevation surface map (tile 4 of 6) of the planning area.



GILA RIVER, MARICOPA COUNTY, AZ
RELATIVE ELEVATION
Page 5 of 6

Prepared for:

Prepared by:
Stillwater Sciences
www.stillwatersci.com

DATA SOURCES
Relative elevation:
GPSi 2015, Stillwater 2015
Imagery: NAIP 2013
Roads & counties: ESRI 2012

SCALE & NORTH ARROW

0 250 500 1,000 Feet
0 100 200 400 Meters
1 in = 1,250 feet
1:15,000

LEGEND

Relative Elevation
- < 0.1 ft
- 0.1 - 1 ft
- 1.1 - 2 ft
- 2.1 - 3 ft
- 3.1 - 5 ft
- 5.1 - 7.5 ft
- 7.6 - 10 ft
- 10.1 - 15 ft
- > 15 ft

MAP LOCATION

Figure C-5. Relative-elevation surface map (tile 5 of 6) of the planning area.

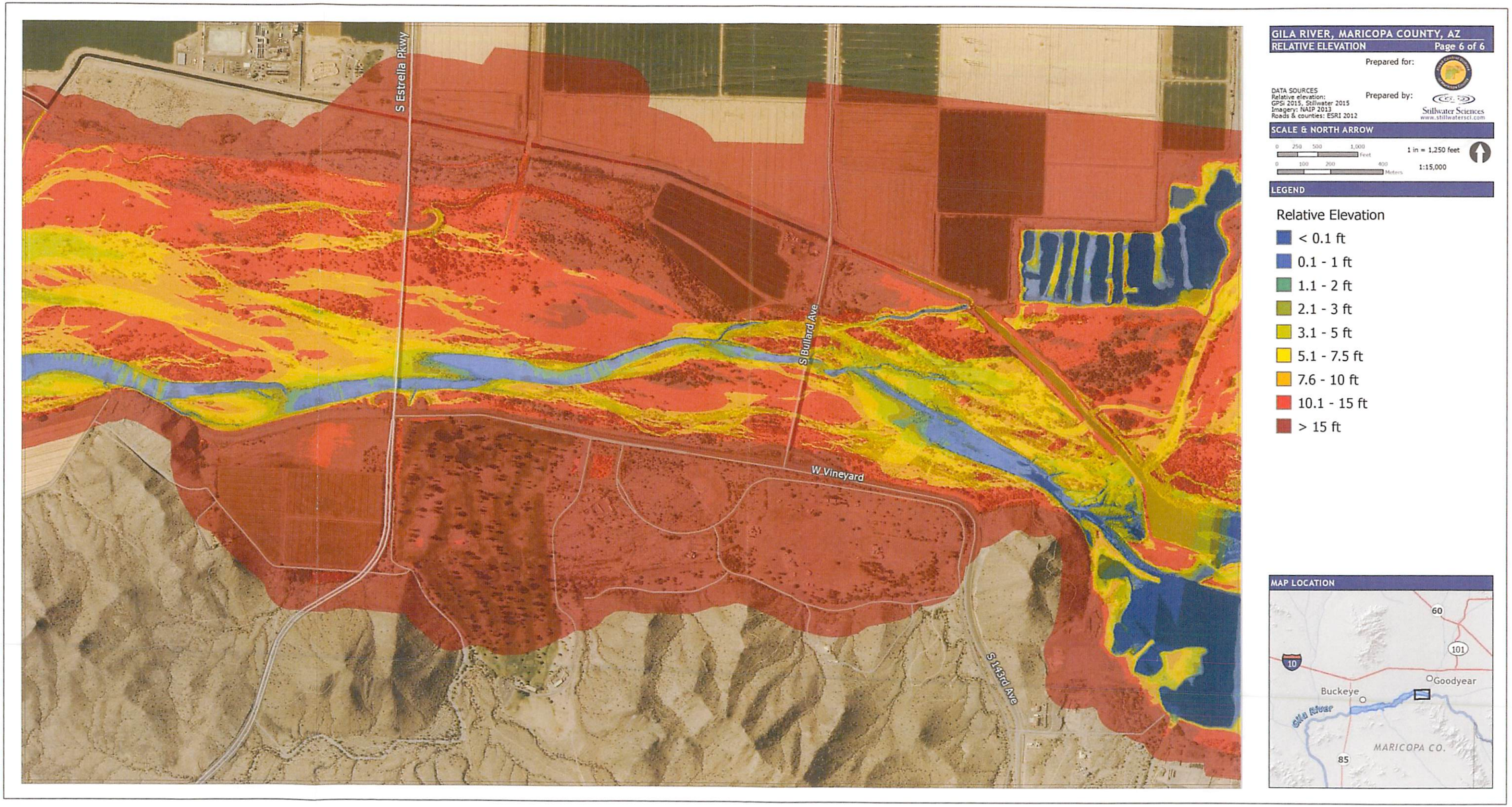


Figure C-6. Relative-elevation surface map (tile 6 of 6) of the planning area.

Appendix D

Vegetation Plot Data, Vegetation Type Maps, and Canopy Height Maps

Vegetation Plot Data

Plot Number	Plot Dimensions (m)			Plot topography		Soil Texture	Hydrology		Disturbance Types and Intensities (if Present)					Relative Percent Cover in Plot						Vegetation in Plot				Species in Plot																							
	Width	Length	Radius	Local form	Relative elevation (ft)		Flood evidence?	Ag return flow evidence?	Fire evidence?	Disturbance type 1	Intensity of type 1	Disturbance type 2	Intensity of type 2	H2O	Vegetation	Litter	Boulder/ cobble	Gravel	Fines	Total vegetation cover	Dominated by	Canopy height (ft)	Vegetation type	Species 1	Species 1 age[1]	Species 1 % cover	Species 2	Species 2 age[1]	Species 2 % cover	Species 3	Species 3 age[1]	Species 3 % cover	Species 4	Species 4 age[1]	Species 4 % cover	Species 5	Species 5 age[1]	Species 5 % cover	Species 6	Species 6 age[1]	Species 6 % cover	Species 7	Species 7 age[1]	Species 7 % cover
1	10	10		convex	5.77	Clay/Silt	no	no	yes	Trails/ compaction/	Low			0	20	60	0	0	20	90	Shrub	3.95	Saltcedar/mesquite	*Tamarix* sp	S3	25	*Prosopis velutina*	T3	20	*Pluchea sericea*	S2	30	*Atriplex lentiformis*	S2	15										
2	10	20		convex	0.11	Clay/Silt	yes	no	no					0	40	50			10	90	Herbs	5.40	Saltcedar/marsh	*Typha sp.*	H3	50	*Phragmites* sp	H2	20	*Tamarix* sp	S2	50												
3	30	30		flat	14.20	Clay/Silt	no	no	no	ORV activity	Low			0	20	40	0	0	40	70	Shrubs	1.59	Desert shrub (Saltbush)	*Atriplex canescens*	S2	50	*Atriplex lentiformis*	S2	5	*Encamena nauseosa*	S2	10	*Larrea tridentata*	S1	5										
4	10	10		undulating	0.88	Sand	yes	no	no	Powerline maintenance	Medium			5	30	32	1	0	32	98	Herb	4.53	Marsh	*Phragmites* sp.	H2	95	*Tamarix* sp.	S1	5	*Pluchea sericea*	S1	2												
5	5	20		convex	3.86	Sand	yes	no	no	Powerline maintenance	Medium			2	30	20			48	98	Shrub	2.39	Saltcedar/arrowweed	*Pluchea sericea*	S3	95	*Tamarix* sp.	S2	10																
6	10	20		convex	4.84	Clay/Silt	no	no	no					0	15	40	0	5	40	90	Shrub	1.36	Saltcedar/cottonwood	*Populus fremontii*	T5	20	*Tamarix* sp.	S2	90																
7			20	undulating	6.24	Sand	no	no	no					0	5	5	0	5	85	50	Shrub	7.97	Saltcedar	*Tamarix* sp	S2	50	Unknown grass and herb	H4	4																
8			38	flat	16.78	Clay/Silt	no	no	no	Grazing	Medium			0	10	15	0	0	75	80	Shrub	1.67	Mesquite/Palo verde	*Prosopis velutina*	T4	20	*Suaeda nigra*	S2	70	*Atriplex canescens*	S2	5	*Lycium andersonii*	S3	2	*Tamarix* sp.	S3	5							
9	15	30		convex	12.08	Clay/Silt	no	yes	no					15	20	25			40	100	Shrub	5.24	Saltcedar/cottonwood/willow	*Populus fremontii*	T4	10	*Salix gooddingii*	T4	10	*Tamarix* sp	S2	70	*Atriplex lentiformis*	S2	15	*Pluchea sericea*	S2	5	*Baccharis salicifolia*	S2	5	*Suaeda nigra*	S2	2
10	10	38		undulating	8.02	Clay/Silt	yes	no	no	ORV activity	Medium			0	20	20	0	0	60	95	Shrub	7.73	Saltcedar/cottonwood	*Populus fremontii*	T5	10	*Tamarix* sp	S2	80	*Pluchea sericea*	S2	20												
11	38	38		flat	8.49	Sand	no	no	no					0	10	10	0	0	80	20	Shrub	0.36	Desert shrub (Wirelettuce)	*Tamarix* sp.	S2	10	*Stephanomeria paucifiora*	S2	10																
12	20	40		concave	2.62	Sand	yes	no	no					0	15	20	0	0	65	90	Shrub	5.12	Saltcedar/willow	*Tamarix* sp.	S2	90	*Salix gooddingii*	S3	15	*Pluchea sericea*	S2	5												
13	30	30		flat	12.62	Sand	no	no	no					0	10	5	10	10	65	40	Shrub	1.78	Desert shrub (Rabbitbrush)	*Tamarix* sp.	S2	10	*Larrea tridentata*	S2	5	*Encamena nauseosa*	S2	10	*Baccharis sarothroides*	S2	5									
14	30	30		concave	1.26	Clay/Silt	no	no	no					0	15	20	0	0	65	95	Shrub	6.02	Saltcedar/arrowweed	*Tamarix* sp.	S2	90	*Pluchea sericea*	S2	10	*Atriplex lentiformis*	S2	5												
15	10	30		concave	0.30	Gravel	yes	uncertain	no	ORV activity	Medium			25	20		5	25	25	70	Shrub	10.94	Saltcedar/marsh	*Tamarix* sp	S2	60	*Schoenoplectus americanus*	H2	60	*Typha sp*	H2	5												
16			15	flat	13.36	Clay/Silt	no	no	no	ORV activity	Low			0	20	20	0	0	60	60	Shrub	1.29	Desert shrub (Saltbush)	*Tamarix* sp	S2	20	*Atriplex lentiformis*	S2	30	*Encamena nauseosa*	S2	10	Unknown grass	H4	25										
17	30	30		flat	17.77	Clay/Silt	no	no	no	ORV activity	Low	Vegetation clearing	Low	0	20	20	0	0	60	100	Shrub	5.31	Desert shrub (Saltbush)	*Atriplex canescens*	S2	75	*Atriplex lentiformis*	S2	5	*Tamarix* sp	S2	25												
18	10	10		undulating	15.29	Clay/Silt	no	no	yes					0	10	20	0	0	70	80	Shrub	4.51	Saltcedar	*Tamarix* sp	S2	75	Unknown grass	H4	10	*Brassica tournefortii*	H4	2												
19	5	20		convex	4.26	Gravel	no	no	no	Trails/ compaction/ trampling	Medium			10	10	10	10	30	30	90	Shrub	3.33	Saltcedar	*Heliotropium curassavicum*	H2	5	*Atriplex lentiformis*	S2	5	*Tamarix* sp	S2	90	*Encamena nauseosa*	S2	5										
20	30	30		flat	10.02	Clay/Silt	no	no	no	ORV activity	Low			0	10	10	0	0	80	70	Shrub	1.16	Desert shrub (Saltbush)	*Tamarix* sp	S2	20	*Atriplex canescens*	S2	30	Unknown grass	H4	20	*Stephanomeria paucifiora*	S2	5										
21	30	50		undulating	7.98	Cobble	yes	no	no	ORV activity	Low			0	5	5	40	25	25	20	Shrub	1.87	Desert shrub (Wirelettuce)	*Tamarix* sp	S2	15	*Stephanomeria paucifiora*	S2	15	*Populus fremontii*	T5	1												
22	50	50		flat	5.61	Cobble	no	no	no	ORV activity	Low			0	5	5	75	10	5	30	Shrub	0.38	Desert shrub (Wirelettuce)	*Tamarix* sp	S2	15	*Salix gooddingii*	T5	5	*Populus fremontii*	T5	1	*Stephanomeria paucifiora*	S2	15	*Baccharis sarothroides*	S2	2						
23	10	30		convex	0.67	Clay/Silt	yes	no	no					5	15	15	0	0	65	90	Shrub	8.61	Saltcedar/willow	*Salix gooddingii*	S2	20	*Tamarix* sp.	S2	80	*Typha sp.*	H2	15												
24			30	flat	5.06	Cobble	yes	no	no					0	10	10	70	0	10	50	Shrub	2.65	Saltcedar	*Tamarix* sp	S2	20	*Tamarix* sp	S1	20																
25	30	30		undulating	2.22	Clay/Silt	no	uncertain	no					0	25	30	8	0	45	98	Shrub	8.55	Saltcedar/willow	*Tamarix* sp.	S2	90	*Salix gooddingii*	T4	15	*Cynodon dactylon*	H2	1												
26	18	30		flat	1.31	Cobble	no	uncertain	no					0	30	20	30	0	20	100	Shrub	4.84	Saltcedar/cottonwood/willow	*Salix gooddingii*	T4	15	*Prosopis velutina*	T3	25	*Populus fremontii*	T4	5	*Tamarix* sp	S2	70	*Cynodon dactylon*	H2	70	*Polypogon monspeliensis*	H2	10		
27	10	30		flat	0.27	Cobble	yes	no	no					50	50					100	Herbs	2.71	Marsh	*Typha sp*	H2	100																		
28	20	30		undulating	1.72	Clay/Silt	yes	no	no	ORV activity	Low			0	30	20	0	0	50	90	Shrub	5.85	Saltcedar/cottonwood/willow	*Populus fremontii*	T5	20	*Salix gooddingii*	T2	10	*Tamarix* sp	S2	30	*Pluchea sericea*	S2	30									
29	10	50		undulating	4.56	Clay/Silt	yes	no	no					0	15	15	10	10	50	95	Shrub	3.14	Saltcedar/cottonwood/willow	*Populus fremontii*	T4	10	*Populus fremontii*	T3	10	*Salix gooddingii*	T5	30	*Tamarix* sp	S2	60	*Pluchea sericea*	S2	5	*Cynodon dactylon*	H2	5		
30			30	flat	8.69	Sand	yes	no	no	ORV activity	High	Vandalism/ dumping/ litter	Low	0	10	15	8	0	75	50	Shrub	5.57	Saltcedar/cottonwood	*Populus fremontii*	T5	20	*Tamarix* sp	S2	20	*Prosopis velutina*	T4	5	*Larrea tridentata*	S2	10									
31			30	flat	11.57	Sand	no	no	no	ORV activity	Medium			0	10	10	0	0	80	60	Shrubs	0.43	Desert shrub (Rabbitbrush)	*Prosopis velutina*	T4	5	*Tamarix* sp	S2	10	*Salix gooddingii*	S3	1	*Encamena nauseosa*	S2	30	*Larrea tridentata*	S2	1	Unknown grass	H4	10		
32	20	30		flat	9.45	Sand	no	no	no					0	20	20	0	0	60	100	Shrub	15.34	Saltcedar/cottonwood	*Populus fremontii*	T5	30	*Tamarix* sp	S2	60	*Pluchea sericea*	S1	30												
33			15	flat	7.78	Sand	no	no	no	ORV activity	High	Vandalism/ dumping/ litter	Medium	1	5	10	0	0	84	60	Shrub	4.63	Saltcedar/cottonwood/willow	*Salix gooddingii*	T4	20	*Populus fremontii*	T5	15	*Tamarix* sp	S2	30	*Baccharis sarothroides*	S2	5	*Brassica tournefortii*	H4	5						
34			30	flat	6.09	Sand	yes	no	no	ORV activity	Medium			0	5	10	0	0	85	70	Shrub	0.11	Desert shrub (Sandpaper plant)	*Parkinsonia florida*	T4	5	*Tamarix* sp.	S1	5	*Salix gooddingii*	S2	1	*Petalonyx thurberi*	S2	10	*Stephanomeria paucifiora*	S2	5	Unknown grass	H4	50		
35			10	flat	4.71	Sand	yes	no	no	ORV activity	High			0	5	10	0	0	85	40	Tree	7.55	Saltcedar/cottonwood	*Populus fremontii*	T5	20	*Tamarix* sp.	S2	20	*Prosopis velutina*	T4	15	*Baccharis sarothroides*	S2	2	Unknown grass	H4	10						
36			15	flat	10.31	Sand	no	no	no	ORV activity	Low			0	10	10	0	0	80	80	Shrub	8.48	Saltcedar/mesquite	*Prosopis velutina*	T4	20	*Tamarix* sp.	S2	60	*Encamena nauseosa*	S2	5	Unknown grass	H4	5									
37	15	15		undulating	10.41	Sand	no	no	no					0	15	20	0	0	65	90	Shrubs	9.96	Saltcedar	*Tamarix* sp	T4	90	Unknown grass	H4	10																
38			15	undulating	7.05	Clay/Silt	yes	no	no					0	10	15	0	0	75	90	Shrub	13.59	Saltcedar/willow	*Salix gooddingii*	S3	10	*Prosopis velutina*	T4	5	*Tamarix* sp	S2	30	*Baccharis sarothroides*	S2	15	*Atriplex lentiformis*	S2	1	Unknown grasses/herbs	H4	30		
39			30	flat	9.06	Cobble	no	no	no	ORV activity	Low			0	5	10	30	25	30	15	Shrub	0.06	Cobble/gravel/sand	*Prosopis velutina*	T4	2	*Tamarix* sp.	S2	3	*Parkinsonia florida*	T4	3	*Chilopsis linearis*	S2	1	*Stephanomeria paucifiora*	S2	1	*Bebbia juncea*	S2	2	*Hymenoclea monogyra*	S2	3
40	10	30		flat	0.58	Sand	yes	no	no					0	15	15	0	0	70	100	Shrub	11.99	Saltcedar/cottonwood/willow	*Tamarix* sp	S2	90	*Populus fremontii*	T4	10	*Salix gooddingii*	T4	15												
41	30	30		flat	23.09	Clay/Silt	no	no	no	ORV activity	Medium			0	10	10	0	5	75	70	Tree	6.26	Mesquite/Palo verde	*Prosopis velutina*	T4	50	*Tamarix* sp	S2	15	*Brassica tournefortii*	H4	5	Unknown grass	H4	2	*Baccharis sarothroides*	S2	1						
42	50	50		flat	2.65	Cobble	yes	no	no	ORV activity	Low			0	10	10	70	5	5	95	Shrub	14.72	Saltcedar/cottonwood/willow	*Populus fremontii*	T5	10	*Salix gooddingii*	T5	10	*Tamarix* sp.	S2	80												
43	10	30		flat	0.62	Cobble	no	no	yes					0	10	10	60	10	10	95	Shrub	11.34	Saltcedar	*Salix gooddingii*	T4	5	*Tamarix* sp	S2	90	*Populus fremontii*	T4	1												
44	10	30		flat	6.40	Loam	yes	yes	yes	Vandalism/ dumping/ litter	Low			0	10	15	0	0	75	100	Trees	14.41	Saltcedar/cottonwood/willow	*Salix gooddingii*	T4	10	*Populus fremontii*	T4	10	*Tamarix* sp.	S2	30	*Baccharis salicifolia*	S2	20	*Typha sp*	H2	20	*Salix laevigata*	T4	30		
45			15	flat	17.26	Clay/Silt	no	no	no					0	5	10	0	0	85	60	Shrub	0.49	Desert shrub (Saltbush)	*Tamarix* sp.	S2	5	*Atriplex canescens*	S2	50	Unknown grasses and	H4	15												
46	20	20		concave	6.79	Cobble	no	yes	no					5	15	15	30	15	20	100	Shrub	8.91	Saltcedar/cottonwood/willow	*Populus fremontii*	T4	20	*Salix laevigata*	T4	10	*Prosopis velutina*	T4	10	*Tamarix* sp	S2	30	*Baccharis salicifolia*	S1	20	*Atriplex lentiformis*	S2	5	*Typha sp.*	H2	10
47			15	undulating	13.45	Sand	no	no	uncertain	ORV activity	Medium			0	5	10	0	0	85	50	Shrub	1.20	Saltcedar (low density)	*Tamarix* sp	S2	30	Unknown grass	H4	15	*Brassica tournefortii*	H4	2	*Cryptantha sp*	H4	15									
48			15	flat	8.23	Cobble	no	no	no					0	5	5	50	20	20	20	Shrub	0.76	Desert shrub	Unknown grasses	H4	2	*Atriplex sp.*	S3	15	*Tamarix* sp	S2	5												
49			15	undulating	8.39	Cobble	yes	no	no					0	10	10	40	5	35	40	Shrub	3.13	Saltcedar	*Tamarix* sp	S2	40	Unknown grasses	H4	5	*Cryptantha sp*	H4	5												
50	15	30		flat	2.51	Sand	yes	no	no					0	15	15	20	20	30	100	Shrub	10.16	Saltcedar/cottonwood	*Populus fremontii*	T5	15	*Tamarix* sp.	S2	90	Unknown grass	H4	3	*Cryptantha sp.*	H4	2									
51			15	flat	17.52	Sand	yes	no	no	Vandalism/ dumping/ litter	Medium			0	5	10	0	10	75	60	Tree	1.97	Mesquite/Palo verde	*Parkinsonia microphylla*	T4	40	*Prosopis velutina*	T4	15	*Tamarix* sp	S2	5	*Larrea tridentata*	S2	10	*Brassica tournefortii*	H4	5						
52			15	flat	14.67	Loam	yes	uncertain	no	Vandalism/ dumping/ litter	Low			0	10	20	0	0	10	90	Shrub	10.38	Saltcedar/willow	*Salix gooddingii*	T4	30	*Tamarix* sp.	S2	50	*Prosopis velutina*	T4	10												
53			30	flat	11.61	Sand	no	no	no	ORV activity	Low			0	5	5	0	0	90	30	Herbs	0.02	Saltcedar (low density)	*Tamarix* sp	S2	10	Unknown grass	H4	10	*Stephanomeria paucifiora*	S2	5	*Cryptantha sp*	H4	10								
54	15	15		concave	5.49	Clay/Silt	yes	yes	no	Agricultural return flows (pipe)	High			0	15	5	0	0	80	95	Shrub	1.53	Desert shrub (Saltbush)	*Parkinsonia aculeata*	T3	5	*Tamarix* sp	S2	10	*Tamarix* sp	S1	10	*Atriplex lentiformis*	S2	60	*Dysphania ambrosioides*	H2	10	*Rumex crispus*	H3	5	*Heliotropium curassavicum*	H2	5
55			15	flat	9.37	Cobble	no	no	no					0	5	5	75	10	5	25	Shrub	0.08	Cobble/gravel/sand	*Tamarix* sp.	S2	5	*Hymenoclea monogyra*	S2	15	*Chamaesyce polycarpa*	H2	2	*Atriplex sp*	S2	5								
56			15	undulating	6.66	Sand	no	no	no	ORV activity	Medium			0	5	10	10	10	65	40	Shrub	1.04	Saltcedar (low density)	*Tamarix* sp	S3	20	Unknown grass	H4	5	*Stephanomeria paucifiora*	S2	5	*Matricaria discoidea*	H4	5	*Cryptantha sp*	H4	5						

Plot Number	Plot Dimensions (m)			Plot topography		Soil Texture	Hydrology		Disturbance Types and Intensities (If Present)					Relative Percent Cover in Plot						Vegetation in Plot			
	Width	Length	Radius	Local form	Relative elevation (ft)		Flood evidence?	Ag return flow evidence?	Fire evidence?	Disturbance type 1	Intensity of type 1	Disturbance type 2	Intensity of type 2	H2O	Vegetation	Litter	Boulder/ cobble	Gravel	Fines	Total vegetation cover	Dominated by	Canopy height (ft)	Vegetation type
57			10	flat	7.93	Clay/Silt	no	no	no					0	5	5	0	0	90	50	Shrub	1.39	Saltcedar/mesquite
58			15	flat	12.74	Clay/Silt	no	no	no	Vandalism/ dumping/ litter	Low			0	10	10	5	5	170	50	Shrub	0.27	Desert shrub (Saltbush)
59			10	concave	2.60	Sand	no	yes	no	Road/trail construction/ maintenance	Low			0	30	30	0	0	40	100	Shrub	2.52	Saltcedar/marsh
60			10	undulating	3.58	Cobble	yes	yes	no					0	10	10	30	25	25	60	Shrub	4.44	Saltcedar
61			15	flat	12.71	Sand	no	no	uncertain	ORV activity	Low			0	5	10	0	0	85	70	Shrub	10.70	Saltcedar
62			10	flat	2.17	Cobble	no	no	no					0	5	5	40	25	25	40	Shrub	1.09	Saltcedar
63			15	undulating	9.71	Gravel	yes	no	no					0	5	10	20	45	20	60	Shrub	2.59	Saltcedar
64			10	undulating	4.34	Sand	yes	no	no	Trails/ compaction/ trampling	Low			0	5	10	0	0	85	90	Shrub	11.11	Saltcedar/willow
65			10	flat	11.98	Gravel	no	no	no	Road/trail construction/ maintenance	Medium			0	5	5	20	50	20	50	Shrub	2.77	Mesquite/Palo verde
66			10	flat	11.45	Cobble	no	no	no					0	5	5	70	10	10	40	Shrub	1.23	Cobble/gravel/sand
67			15	undulating	12.01	Sand	yes	no	no					0	5	10	5	5	70	60	Shrub	3.03	Saltcedar
68			18	flat	16.98	Gravel	no	no	no	Road/trail construction/ maintenance	Low			0	5	5	0	50	40	30	Shrub	0.81	Desert shrub (Saltbush)

Plot Number	Species in Plot																								
	Species 1	Species 1 age[1]	Species 1 % cover	Species 2	Species 2 age[1]	Species 2 % cover	Species 3	Species 3 age[1]	Species 3 % cover	Species 4	Species 4 age[1]	Species 4 % cover	Species 5	Species 5 age[1]	Species 5 % cover	Species 6	Species 6 age[1]	Species 6 % cover	Species 7	Species 7 age[1]	Species 7 % cover
57	*Prosopis velutina*	T4	10	*Tamarix* sp	T5	30	*Bacchans sarothrodes*	S2	5	*Encamena nauseosa*	S2	5	Unknown grass	H4	5	*Matricaria discoidea*	H4	5			
58	*Prosopis velutina*	T4	15	*Encamenia nauseosa*	S2	20	*Atriplex canescens*	S2	20												
59	*Parkinsonia aculeata*	T2	10	*Tamarix* sp	S2	20	*Atriplex lentiformis*	S2	20	*Phalaris aquatica*	H4	75	*Rumex crispus*	H4	2	*Amaranthus sp.*	H2	2	*Portulaca oleracea*	H3	2
60	*Tamarix* sp.	S2	50	*Matricaria discoidea*	H4	10	*Brassica tournefortii*	H4	2												
61	*Tamarix* sp.	T5	60	*Brassica tournefortii*	H4	5	Unknown grass	H4	10												
62	*Tamarix* sp.	S1	40	*Matricaria discoidea*	H4	2															
63	*Tamarix* sp.	S3	55	*Matricaria discoidea*	H4	5	*Bacchans sarothrodes*	S2	2												
64	*Tamarix* sp.	S2	70	*Salix gooddingii*	T4	20	*Atriplex lentiformis*	S2	5	*Matricaria discoidea*	H4	5									
65	Unknown grass	H4	5	*Encelia sp.*	S3	30	*Larrea tridentata*	S2	5	*Baccharis sarothrodes*	S2	5	*Tamarix* sp.	S2	5	*Prosopis velutina*	T4	10			
66	*Bebbia juncea*	S2	35	*Encelia sp.*	S3	5															
67	*Tamarix* sp.	T5	50	*Brassica tournefortii*	H4	5	Unknown grass	H4	10	*Matricaria discoidea*	H4	5	*Baccharis sarothrodes*	S2	1						
68	*Encamenia nauseosa*	S2	5	*Larrea tridentata*	S2	5	*Baccharis sarothrodes*	S2	5	*Atriplex canescens*	S2	5	*Pluchea sericea*	S2	5	Unknown grass	H4	10			

[1]Age codes:

T1= Tree Seedling (0-1 yrs) S1= Seedling Shrub (≤1 yr old) H1 = Herb/Grass Seedling

T2= Tree Sapling (2-4 yrs) S2= Mature Shrub (>1 yr old) H2 = Mature Herb/Grass

T3= Pole Tree (5-10 yrs) S3= Decadent Shrub (≥20% dead) H3 = Decadent Herb/Grass

T4= Mature Tree (>10 yrs) S4 = Dead Shrub H4 = Dead Herb/Grass

T5= Decadent Tree (≥20% canopy dead)

Vegetation Type Maps

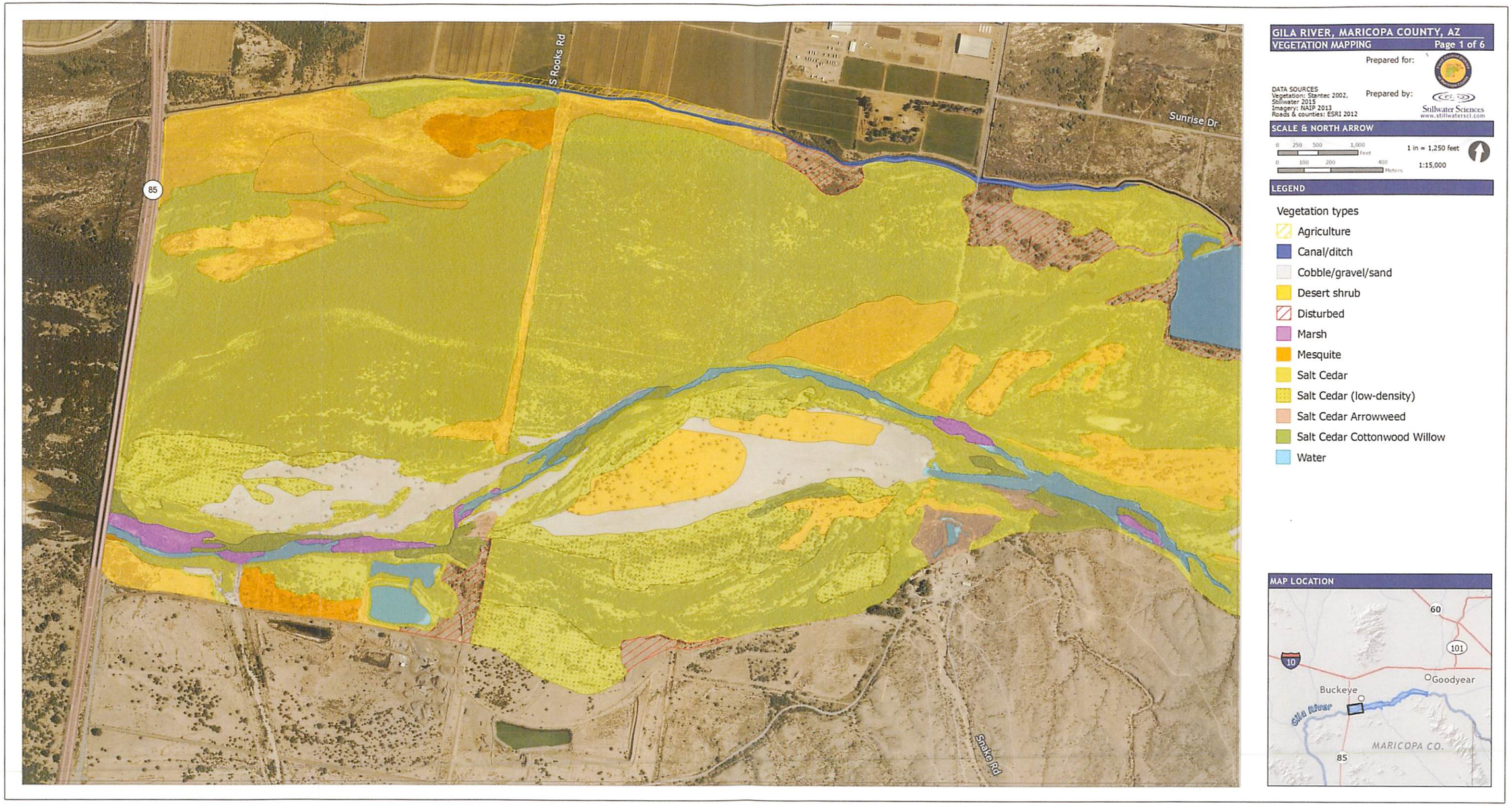
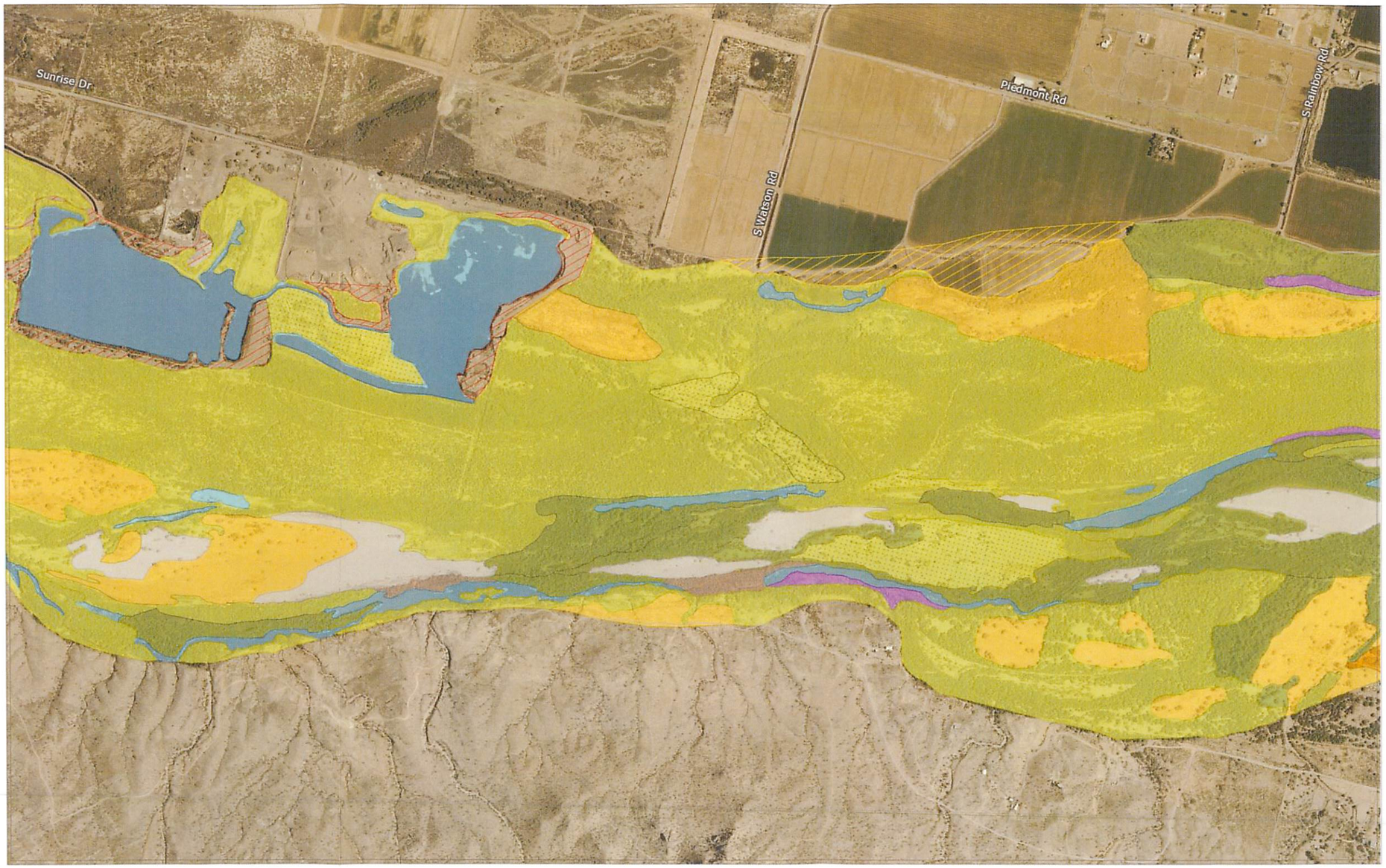


Figure D-1. Vegetation type map (tile 1 of 6) of the planning area.



GILA RIVER, MARICOPA COUNTY, AZ
VEGETATION MAPPING Page 2 of 6

Prepared for:

Prepared by: Stillwater Sciences www.stillwatersci.com

DATA SOURCES
Vegetation: Stantec 2002, Stillwater 2015
Imagery: NAIP 2013
Roads & counties: ESRI 2012

SCALE & NORTH ARROW

0 250 500 1,000 Feet
0 100 200 400 Meters
1 in = 1,250 feet
1:15,000

LEGEND

Vegetation types
- Agriculture
- Cobble/gravel/sand
- Desert shrub
- Disturbed
- Marsh
- Mesquite
- Salt Cedar
- Salt Cedar (low-density)
- Salt Cedar Arrowweed
- Salt Cedar Cottonwood Willow
- Water

MAP LOCATION

Figure D-2. Vegetation type map (tile 2 of 6) of the planning area.

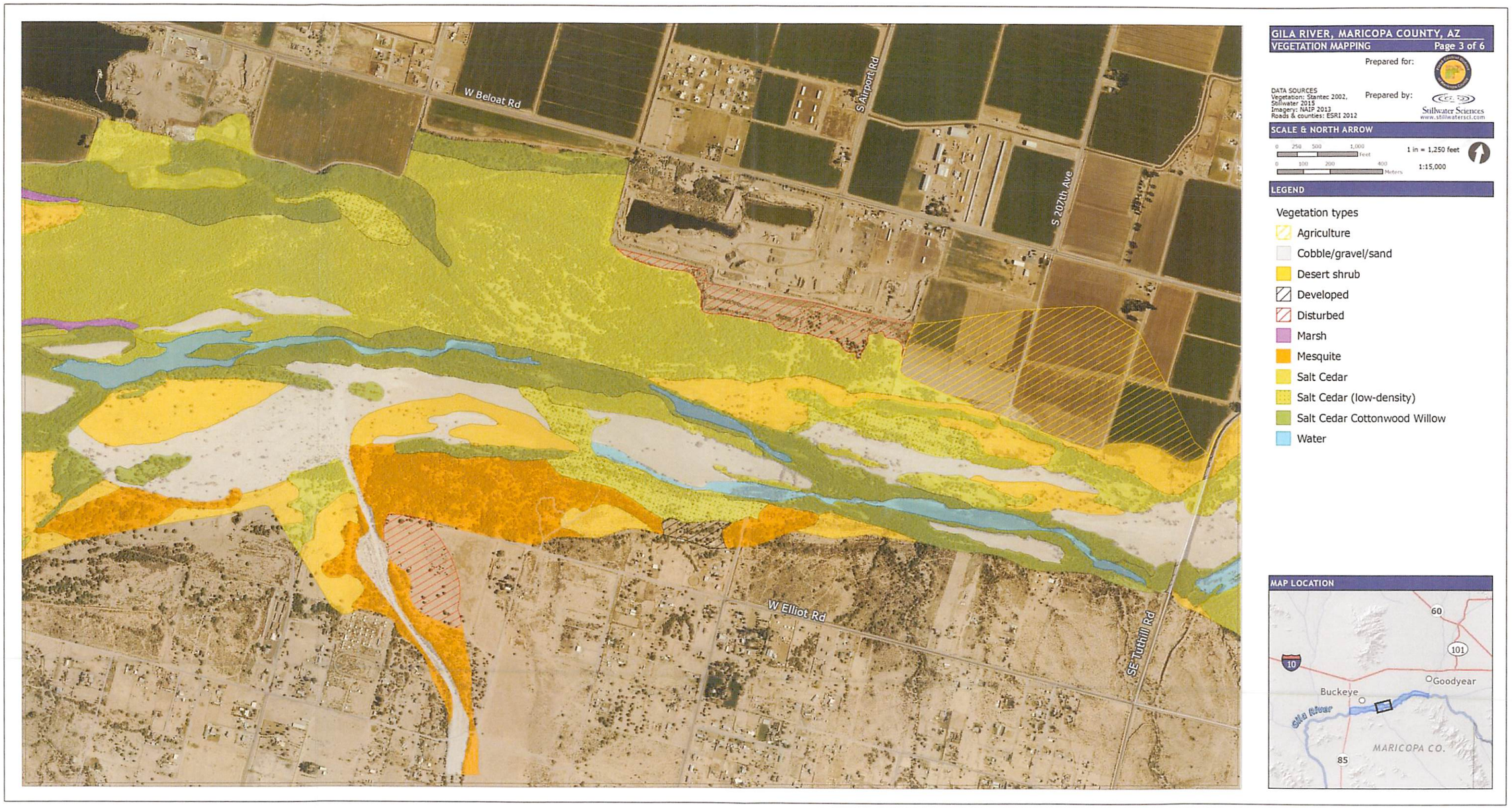
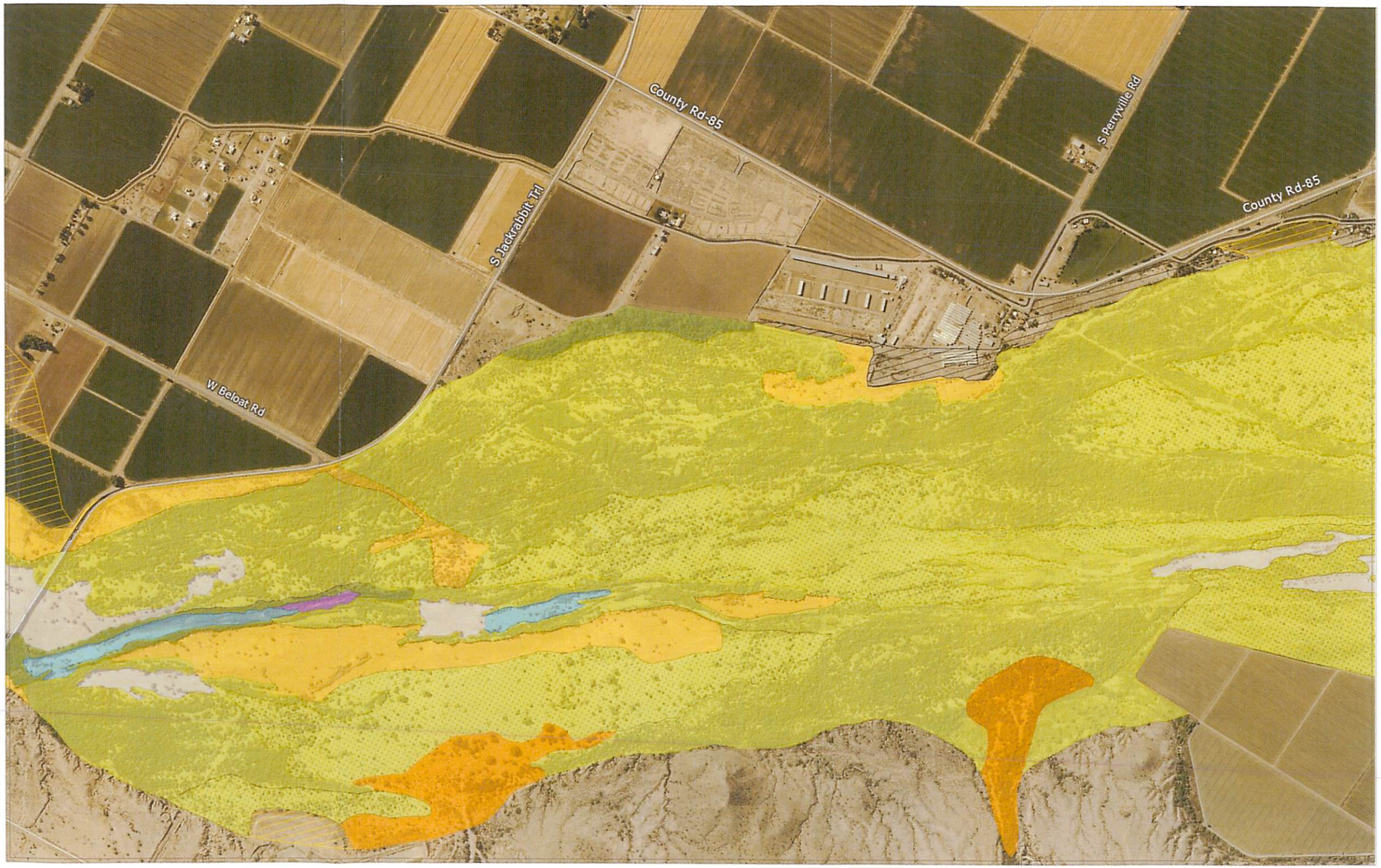


Figure D-3. Vegetation type map (tile 3 of 6) of the planning area.



GILA RIVER, MARICOPA COUNTY, AZ
VEGETATION MAPPING
Page 4 of 6

Prepared for:

DATA SOURCES
Vegetation: Stantec 2002, Stillwater 2015
Imagery: NAIP 2013
Roads & counties: ESRI 2012

Prepared by:
Stillwater Sciences
www.stillwatersci.com

SCALE & NORTH ARROW

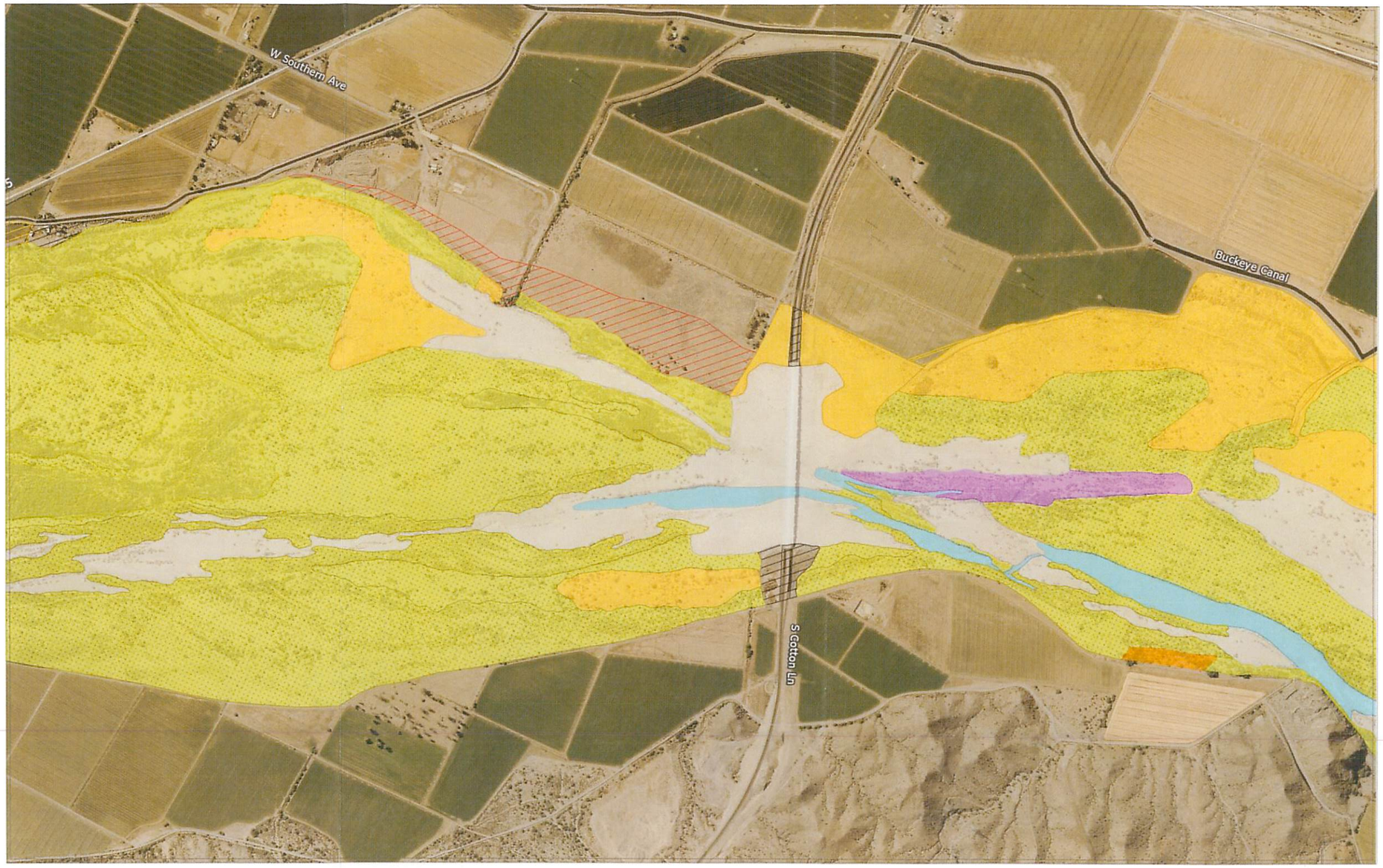
0 250 500 1,000 Feet
0 100 200 400 Meters
1 in = 1,250 feet
1:15,000

LEGEND

Vegetation types
- Agriculture
- Cobble/gravel/sand
- Desert shrub
- Developed
- Marsh
- Mesquite
- Salt Cedar
- Salt Cedar (low-density)
- Salt Cedar Cottonwood Willow
- Water

MAP LOCATION

Figure D-4. Vegetation type map (tile 4 of 6) of the planning area.



GILA RIVER, MARICOPA COUNTY, AZ
VEGETATION MAPPING
Page 5 of 6

Prepared for:

Prepared by:
Stillwater Sciences
www.stillwatersci.com

DATA SOURCES
Vegetation: Stantec 2002, Stillwater 2015
Imagery: NAIP 2013
Roads & counties: ESRI 2012

SCALE & NORTH ARROW

0 250 500 1,000 Feet
0 100 200 400 Meters

1 in = 1,250 feet
1:15,000

LEGEND

Vegetation types
- Agriculture
- Cobble/gravel/sand
- Desert shrub
- Developed
- Disturbed
- Marsh
- Mesquite
- Salt Cedar
- Salt Cedar (low-density)
- Water

MAP LOCATION

Figure D-5. Vegetation type map (tile 5 of 6) of the planning area.

Canopy Height Maps

Figure D-6. Vegetation type map (tile 6 of 6) of the planning area.

GILA RIVER, MARICOPA COUNTY, AZ
VEGETATION CANOPY HEIGHTS Page 1 of 6

Prepared for:

DATA SOURCES
Canopy heights: GPSi 2015, Stillwater 2015
Imagery: NAIP 2013
Roads & counties: ESRI 2012

Prepared by:
Stillwater Sciences
www.stillwatersci.com

SCALE & NORTH ARROW

0 250 500 1,000 Feet
0 100 200 400 Meters
1 in = 1,250 feet
1:15,000

LEGEND

Canopy Heights
- < 1 ft
- 1–3 ft
- 3–10 ft
- 10–20 ft
- > 20 ft

MAP LOCATION

Figure D-7. Canopy height map (tile 1 of 6) of the planning area.

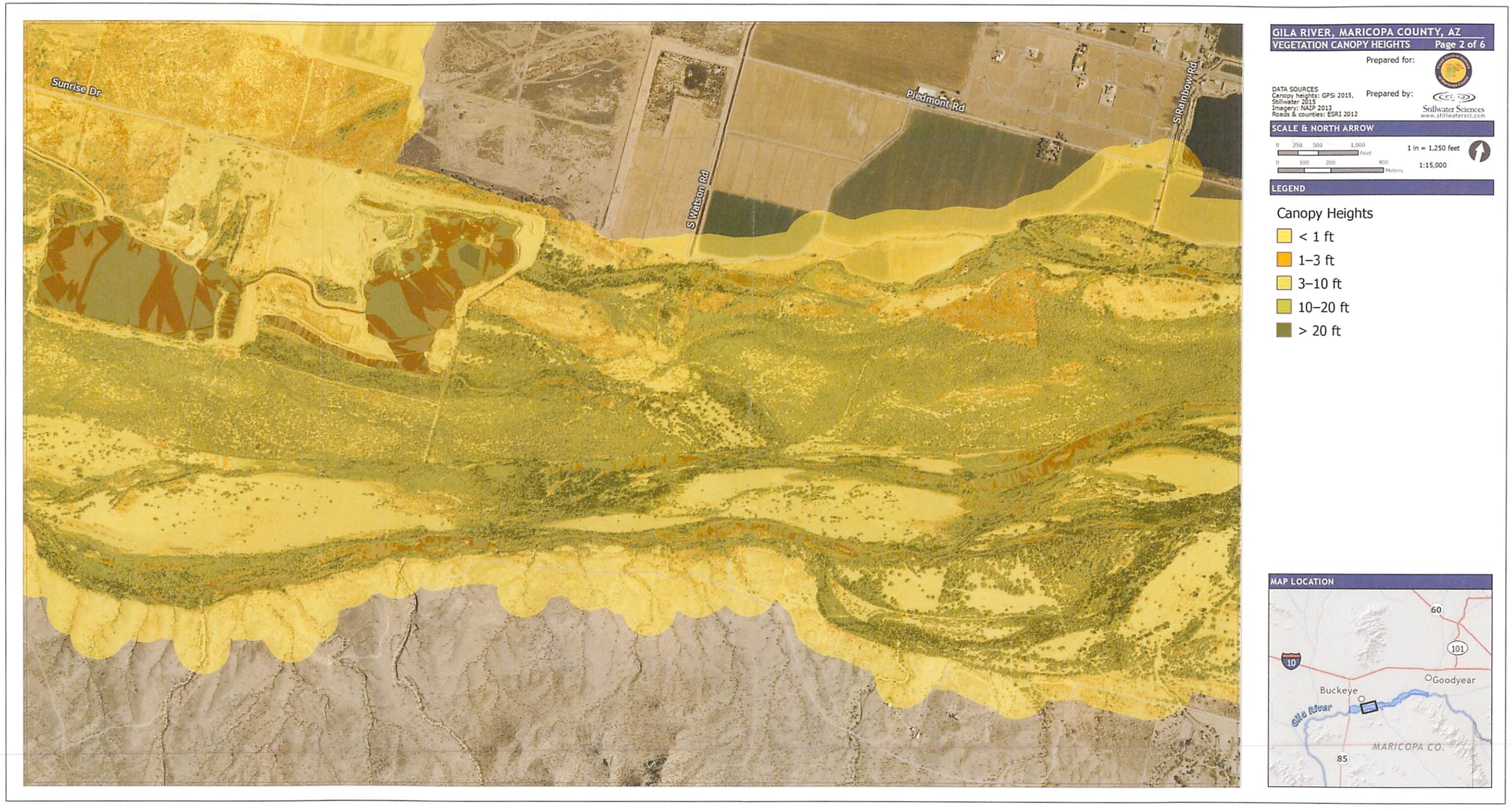


Figure D-8. Canopy height map (tile 2 of 6) of the planning area.

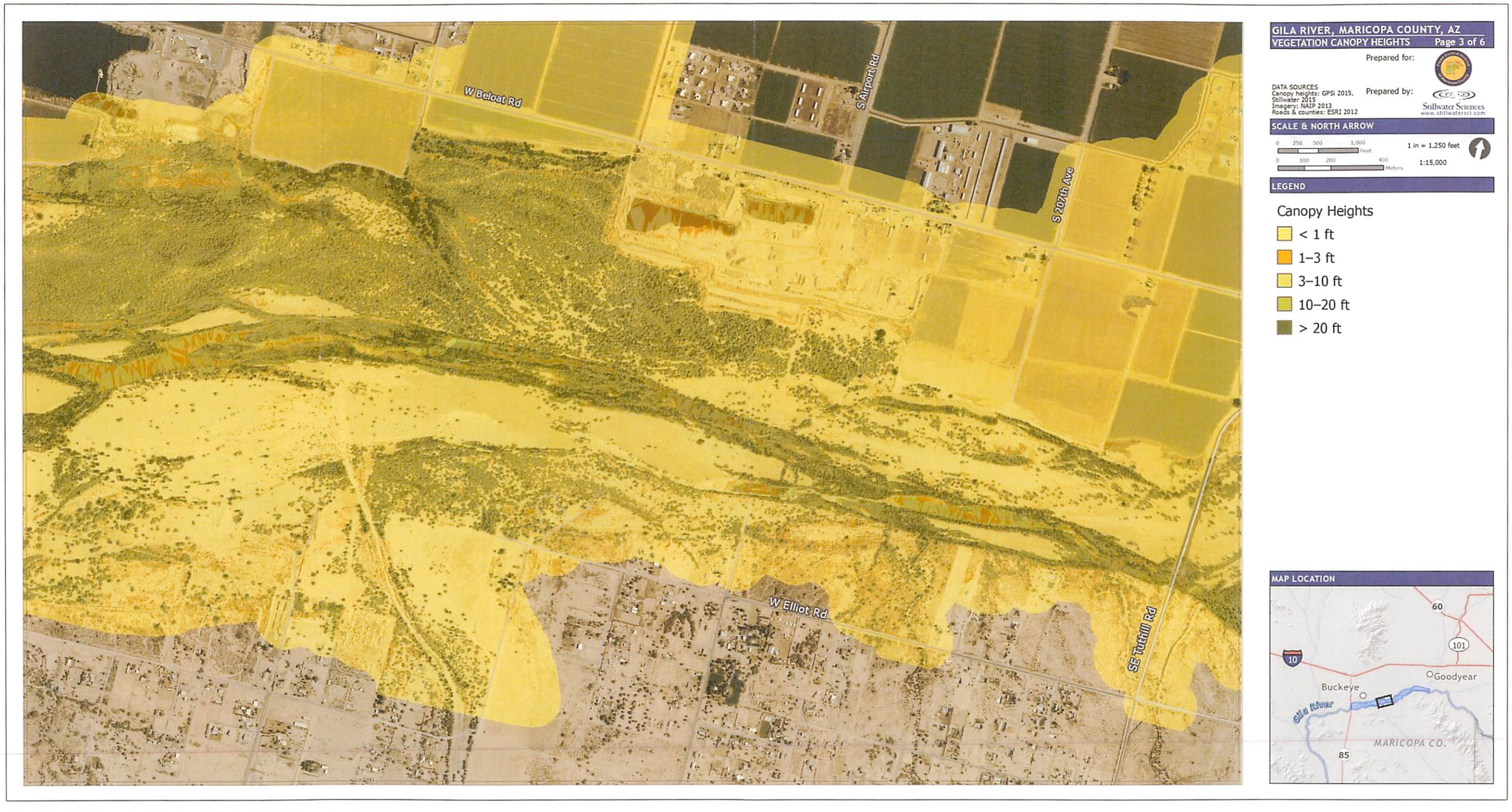


Figure D-9. Canopy height map (tile 3 of 6) of the planning area.

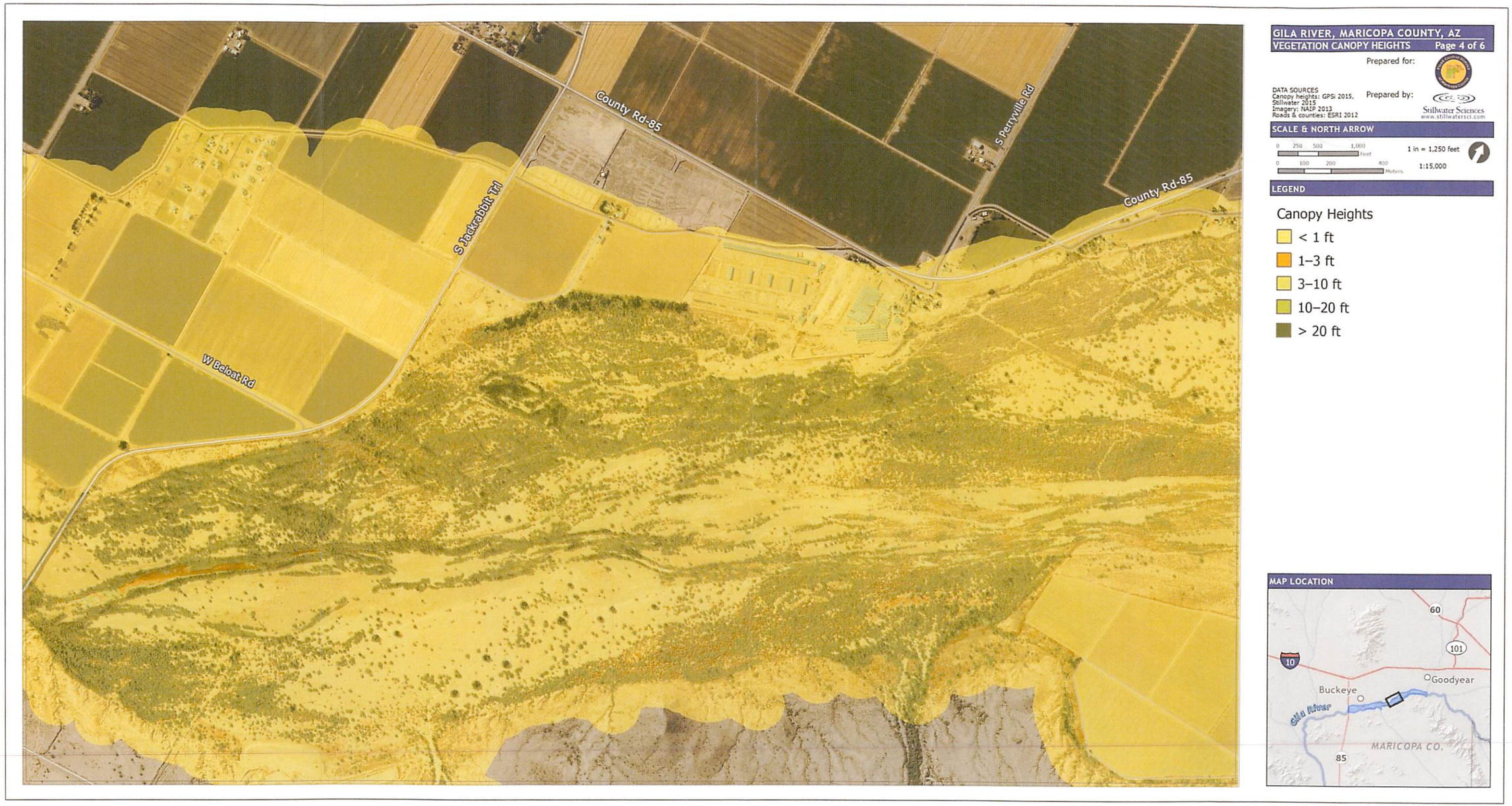
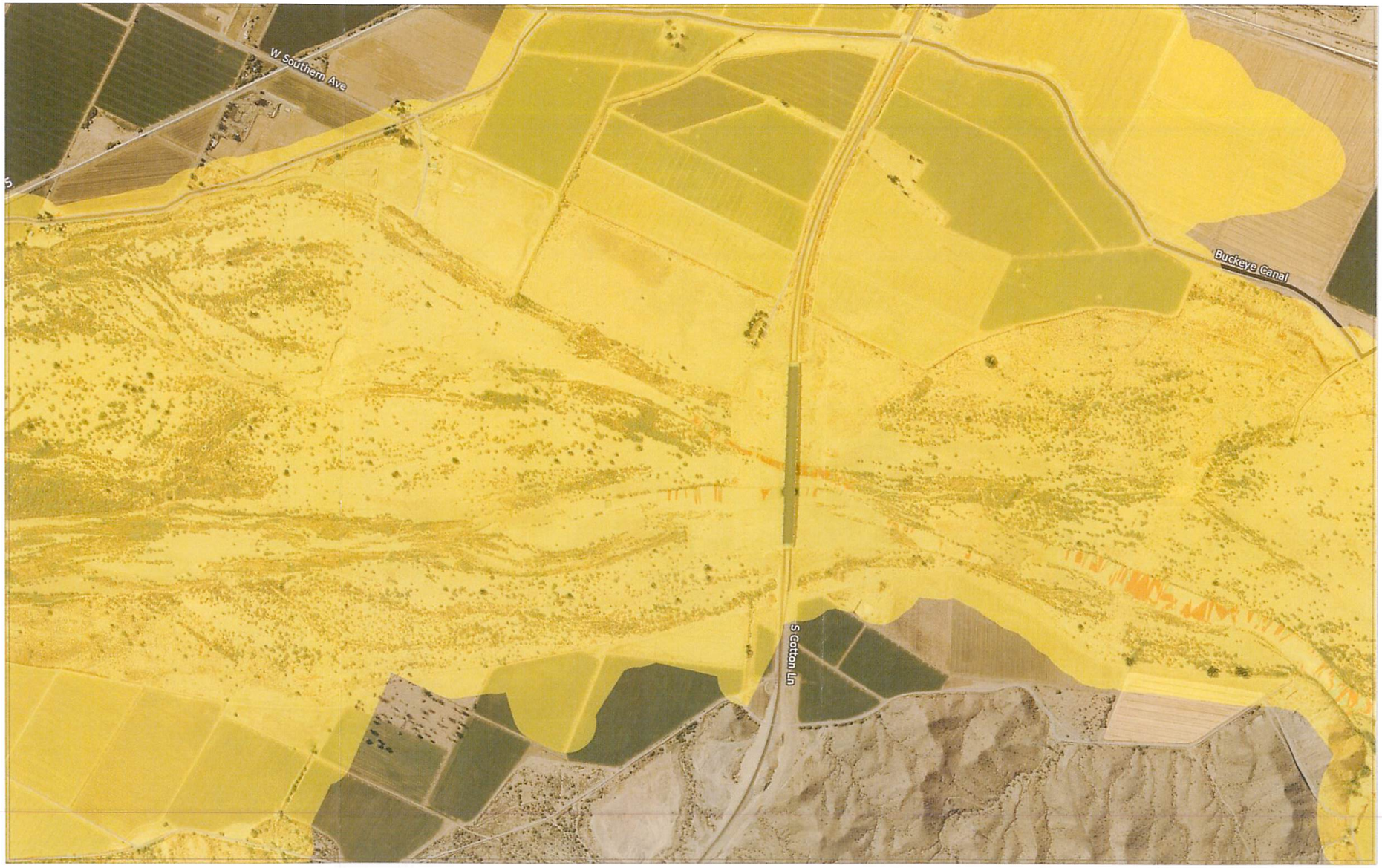


Figure D-10. Canopy height map (tile 4 of 6) of the planning area.



GILA RIVER, MARICOPA COUNTY, AZ
VEGETATION CANOPY HEIGHTS Page 5 of 6

Prepared for:

DATA SOURCES
Canopy heights: GPSi 2015, Stillwater 2015
Imagery: NAIP 2013
Roads & counties: ESRI 2012

Prepared by:
Stillwater Sciences
www.stillwatersci.com

SCALE & NORTH ARROW

0 250 500 1,000 Feet
0 100 200 400 Meters
1 in = 1,250 feet
1:15,000

LEGEND

Canopy Heights
- < 1 ft
- 1–3 ft
- 3–10 ft
- 10–20 ft
- > 20 ft

MAP LOCATION

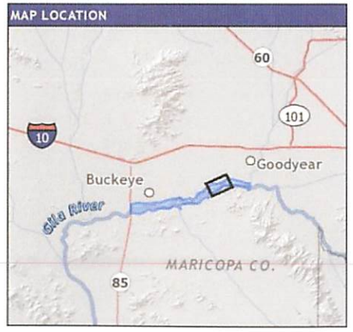


Figure D-11. Canopy height map (tile 5 of 6) of the planning area.

Figure D-12. Canopy height map (tile 6 of 6) of the planning area.

Appendix E

Riparian Plant Species Requirements

1 INTRODUCTION

This appendix presents supplemental information on growing requirements for many of the native riparian plant species that may be appropriate to plant in the El Rio reach planning area.

Wetland and riparian vegetation dynamics are tightly coupled with hydrogeomorphic processes. Inputs of water, sediment, nutrients, and other ecological factors provide the raw materials that are shaped by physical forces such as groundwater-surface water interactions, flooding, tidal forces, erosion, sediment deposition, and chemical exchanges to develop wetland, channel and floodplain habitats. These inputs strongly influence plant species composition, distribution, and physical structure. Vegetation structure and composition, in turn, provide habitat, shade, cover, food, energy, and organic matter inputs for wildlife and aquatic communities and influence their population and food web dynamics.

Plant species are distributed along gradients of resource availability (*e.g.*, light, water, nutrients), chronic environmental stress (*e.g.*, salinity, inundation duration), and episodic physical disturbance (*e.g.*, fire, flood, scour). Each plant species has evolved a unique suite of life history traits to cope with its environmental conditions, and its distribution across the landscape reflects the tradeoffs of its particular stress-tolerance and resource-capture strategies.

Riparian and wetland plants can be classified by their tolerances to drought, inundation, shade, salt, and herbivory. Other factors such as soil texture, rooting depth, and water use efficiency affect the ways plant species use below-ground resources and thus influence their distributions among suitable sites.

2 PLANT REQUIREMENTS AND DEFINITIONS

A list of native riparian trees, shrubs, forbs, and herbs found in the planning area was developed (Table E-1), and information on water availability/use factors, soil conditions, and other environmental characteristics (shade tolerance, tolerance to hedging, minimum temperature) necessary for growth and survival of each species were identified from the USDA PLANTS Database (NRCS 2002). Information has also been gathered for several species that are not included in the USDA PLANTS Database, as indicated below. The contents of Table E-1 are defined in the following sections. This information can be used to identify and prioritize potential riparian vegetation planting areas within the planning area based on physical and other biological factors.

Table E-1. Riparian plant species requirements.[A]

Species	Common name	Wetland indicator status in Arid West	Anaerobic tolerance	Drought tolerance	Moisture use	Root depth, minimum (inches)	Precipitation (min)	Precipitation (max)	Adapted to fine textured soils?	Adapted to medium textured soils?	Adapted to coarse textured soils?	Nitrogen fixation	Fertility requirement	CaCO3 tolerance	pH (min)	pH (max)	Salinity tolerance	Hedge tolerance	Shade tolerance	Temperature minimum (°F)
Acacia greggii	catclaw acacia	Not listed	None	High	Low	12	3	20	Yes	Yes	Yes	None	Low	High	6.5	8.5	None	High	Intolerant	-13
Acer negundo	boxelder	FACW	Medium	High	Medium	40	15	75	Yes	Yes	Yes	None	Medium	High	5	7.8	Medium	None	Tolerant	-46
Anemopsis californica	yerba mansa	OBL		None	High												Medium			
Atriplex canescens	fourwing saltbush	Not listed	None	High	Medium	20	5	18	Yes	Yes	Yes	None	Low	High	6.5	9.5	High	Medium	Intolerant	-43
Atriplex lentiformis [B]	big saltbush	FAC	High	High	Low	20	4	20	No	Yes	No	None	Medium	High	7	10	High	High	Intolerant	7
Baccharis salicifolia	mule-fat	FAC	Low	Low	Medium	12	10	18	Yes	Yes	Yes	None	Low	High	7	8.5	High	Low	Intolerant	-3
Baccharis sarothroides	desertbroom	FACU	Low	High	Low	12	2	10	Yes	Yes	Yes	None	Low	High	7	8.5	Medium	Low	Intolerant	28
Bolboschoenus maritimus[C]	cosmopolitan bulrush	OBL	High	Low	Medium	12	40	60	Yes	Yes	Yes	None	Low	Medium	4	7	High	None	Intolerant	-23
Bouteloua gracilis	blue grama	Not listed	None	High	Medium	16	8	22	Yes	Yes	Yes	None	Low	Medium	6.6	8.4	Medium	None	Intolerant	-43
Celtis laevigata	sugarberry	FAC	Medium	Low	High	24	20	80	Yes	Yes	No	None	Medium	Medium	4.4	7.7	Low	Low	Tolerant	-21
Chilopsis linearis	desert willow	FACU	Low	High	Low	12	4	37	No	No	Yes	None	Low	Medium	6.6	10	Low	High	Intermediate	-23
Distichlis spicata	saltgrass	FAC	High	Medium	Medium	2	5	70	Yes	Yes	No	None	Medium	High	6.4	10	High	None	Intolerant	-35
Encelia farinosa	brittlebush	Not listed	None	High	Low	12	5	10	Yes	Yes	Yes	None	Low	High	7	8.5	None	High	Intolerant	27
Fraxinus velutina	velvet ash	FAC	Low	Medium	Low	24	12	20	Yes	No	No	None	Low	None	5.8	7.5	None	Medium	Intolerant	-13
Heliotropium curassavicum	salt heliotrope	FACU	Low	Medium	Medium	10	10	24	Yes	Yes	No	None	Low	None	6.5	8.5	High	None	Intolerant	-28
Hymenoclea monogyra	singlewhorl burrobrush	Not listed	Medium	High	n/a	12	4	80	No	Yes	Yes	None	n/a	n/a	6.1	7.9	n/a	n/a	n/a	27
Juncus mexicanus [C]	Mexican rush	FACW	High	Low	Medium	8	8	20	Yes	Yes	No	None	Medium	Medium	6.2	8.2	High	None	Intolerant	-18
Muhlenbergia asperifolia	scratchgrass	FACW	Medium	Low	High	8	12	40	Yes	Yes	No	None	Low	High	6	8.4	High	None	Tolerant	-18
Populus fremontii [D]	Fremont cottonwood	Not listed	Medium	Medium	High	32	20	26	Yes	Yes	Yes	None	Medium	Medium	6	8	Low	None	Intolerant	-13
Prosopis pubescens [C]	Screwbean mesquite	FAC	None	Medium	Medium	24	6	15	Yes	Yes	Yes	Low	Low	Medium	7.5	9.0	High	High	Intermediate	-3
Salix exigua	narrowleaf willow	FACW	High	Medium	High	20	20	30	No	Yes	Yes	None	Low	High	6	8.5	Low	Medium	Intermediate	-38
Salix gooddingii	Goodding's willow	FACW	High	Medium	High	28	12	55	No	Yes	Yes	None	Medium	Low	5.7	7.4	None	None	Intolerant	-23
Sambucus nigra (mexicana)	blue elderberry	FACU	Medium	High	Low	12	10	60	No	Yes	Yes	None	Low	Medium	4.9	7.5	None	Low	Intermediate	-38
Schoenoplectus californicus [C]	California bulrush	OBL	High	Low	High	14	40	60	Yes	Yes	No	None	Medium	Medium	5	9	Low	None	Intolerant	17
Setaria leucopila	Plains bristlegrass	Not listed		High			10	26	Yes			None					Medium			
Sporobolus airoides	alkali sacaton	FAC	Medium	High	Low	16	5	13	Yes	Yes	Yes	None	Medium	High	6.6	9	High	None	Intolerant	-38
Sporobolus wrightii	big sacaton	FAC	None	Medium	Medium	20	5	20	No	Yes	Yes	None	Low	High	5.6	8	Low	None	Intolerant	-13
Typha latifolia [C]	broadleaf cattail	OBL	High	None	High	14	14	180	Yes	Yes	Yes	None	Medium	Medium	5.5	8.7	Low	None	Intermediate	-36

Table footnotes:
[A] Table information is from the UDA PLANTS database unless otherwise indicated.
[B] The "Casa" cultivar has no anaerobic tolerance, medium moisture use, min precip of 6, and temp min of -8 (F).
[C] Other species in this genus or related genera that may occur in the El Rio planning area are likely to have fairly similar requirements.
[D] *P. fremontii* is not listed in the 2013 wetland indicator status list, but the related *P. deltoides* is listed as FAC.

2.1 Wetland Indicator Status

The U.S. Fish and Wildlife Service (USFWS) has prepared a National List of Plant Species That Occur in Wetlands: 1988 National Summary (USFWS 1988) and the 2103 Updated List (Lichvar 2013). Indicator categories are:

- Obligate Wetland (OBL). Occur almost always (estimated probability >99%) under natural conditions in wetlands.
- Facultative Wetland (FACW). Usually occur in wetlands (estimated probability 67–99%), but occasionally found in non-wetlands.
- Facultative (FAC). Equally likely to occur in wetlands or non-wetlands (estimated probability 34–66%).
- Facultative Upland (FACU). Usually occur in non-wetlands (estimated probability 67–99%), but occasionally found in wetlands (estimated probability 1–33%).
- Obligate Upland (UPL). Occur in wetlands in another region, but occur almost always (estimated probability >99%) under natural conditions in non-wetlands in the region specified.

The wetland indicator categories should not be equated to degrees of wetness. Many Obligate Wetland species occur in permanently or semi-permanently flooded wetlands, but a number also occur and some are restricted to wetlands that are only temporarily or seasonally flooded. The Facultative Upland species include a diverse collection of plants that range from weedy species adapted to a number of environmentally stressful or disturbed sites (including wetlands) to species in which a portion of the gene pool (an ecotype) always occur in wetlands. Both the weedy and ecotype representatives of the facultative upland category occur in a variety of wetland habitats, ranging from the driest wetlands to semi-permanently flooded wetlands. Species not included in the 1988 or 2013 lists are typically considered non-wetland species.

2.2 Water Availability/Use Factors

Anaerobic Tolerance: What is the plant's tolerance of anaerobic conditions of the growth medium, relative to other species? (Low, Medium, High, None)

Drought Tolerance: What is the tolerance of the plant to drought conditions relative to other species in the same plant type and same geographical region? (Low, Medium, High, None)

Moisture Use: What is the degree to which this plant uses available soil moisture, relative to other species in the plant type? (Low, Medium, High)

Minimum Precipitation: The 2 in 10 year average minimum precipitation (inches) across years, of the driest climate station within the known geographical range of the plant. For cultivars, the geographical range is defined as the area to which the cultivar is well adapted rather than marginally adapted.

Maximum Precipitation: The annual average precipitation (inches) of the wettest climate station within the known geographical range of the plant. For cultivars, the geographical range is defined as the area to which the cultivar is well adapted rather than marginally adapted.

2.3 Soil-Related Factors

Minimum Root Depth: The minimum depth of soil required for good growth in inches. Plants that do not have roots such as rootless aquatic plants (floating or submerged) and epiphytes are assigned a minimum root depth value of zero.

Adapted To Fine/Medium/Coarse Textured Soils: Can this plant establish and grow in soil with a fine/medium/coarse textured surface layer? (Yes, No) Refer to Table E-2.

Table E-2. VegSpec soil texture groups and corresponding soil texture classes.

VegSpec soil texture group [A]	Corresponding soil texture classes from the Soil Texture Triangle [B]		
Coarse	Sand	Coarse sand	Fine sand
	Loamy course sand	Loamy fine sand	Loamy very fine sand
	Very fine sand	Loamy sand	
Medium	Silt	Sandy clay loam	Very find sandy loam
	Silty clay loam	Silt loam	Loam
	Fine sandy loam	Sandy loam	Coarse sandy loam
	Clay loam		
Fine	Sandy clay	Silty clay	Clay

Table footnotes:

[A] Source: The soil texture classes are from the Soil Science Society of America, http://www.soils.org/. An NRCS team partitioned the soil textures into the 3 groups.

[B] The United States Department of Agriculture (USDA) defines particle sizes as: sand 2.0–0.05 mm; silt 0.05–0.002 mm; and clay <0.002 mm in diameter.

Nitrogen Fixation: What is the amount of nitrogen fixed by this plant relative to other species? (None, Low, Moderate, High, Unknown (blank))

Fertility Requirement: What is the level of nutrients (N, P, K) required for normal growth and development relative to other species? (Low, Medium, High)

CaCO3 Tolerance: Want is the plant's tolerance to calcareous soil relative to other species. We define calcareous soil as soil containing sufficient free $CaCO_3$ and other carbonates to effervesce visibly or audibly when treated with cold 0.1M HCl. These soils usually contain from 10 to almost 1000g/kg $CaCO_3$ equivalent. (Low, Medium, High, None, Unknown (blank))

Minimum/Maximum pH: The minimum/maximum soil pH within the plant's known geographical range. For cultivars, the geographical range is defined as the area to which the cultivar is well adapted rather than marginally adapted.

Salinity Tolerance: What is the plant's tolerance to soil salinity? Tolerance to a soil salinity level is defined as only a slight reduction (not greater than 10%) in plant growth. None = tolerant to a soil salinity of 0–2 mmhos/cm; Low = tolerant to a soil salinity of 2.1-4.0 mmho/cm; Medium = tolerant to a soil salinity of 4.1–8.0 mmhos/cm; High = tolerant to a soil salinity greater than 8.0 mmhos/cm.

2.4 Other Environmental Factors

Shade Tolerance: What is the tolerance for this plant, relative to other species, to grow in shade conditions? Refer to Table E-3. (Intolerant, Intermediate, Tolerant)

Table E-3. Comparison of shade tolerance classes.

Silvics of North America classes	Corresponding VegSpec classes
Very Intolerant and Intolerant	Intolerant
Intermediate	Intermediate
Very Tolerant and Tolerant	Tolerant

Hedge Tolerance: What is the tolerance of the woody perennial to hedging (close cropping) by livestock or wildlife. Forbs, grasses and non-woody vines are classified as "None." (Low, Medium, High, None, Unknown (blank))

Minimum Temperature: The 2 in 10 year average minimum temperature (F°) across years, of the coldest climate station within the known geographical range of the plant. For cultivars, the geographical range is defined as the area to which the cultivar is well adapted rather than marginally adapted.

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Appendix F

Western Yellow-Billed Cuckoo Breeding Habitat Prediction Modeling Methods

1 PURPOSE

This appendix presents a summary of the methods used to predict breeding habitat potential for the threatened Western Yellow-Billed Cuckoo (*Coccyzus americanus*) in the El Rio planning area. Graphical results of the modeling are presented in Section 2.9.2 of the main document. The purpose of the analysis was to apply a predictive habitat model for the cuckoo, which is a listed under the Federal Endangered Species Act (USFWS 2014a), to assist the District with development of the El Rio Vegetation Management Plan. The modeling work was performed by James Hatten, Research Biogeographer with the USGS's Columbia River Research Laboratory.

2 METHODS

An analytical model was used to create a map of potential cuckoo breeding habitat along the lower Gila River in Maricopa County. The study area included the approximately 27-mile reach of the river corridor between 1-mile upstream of the confluence with the Salt River and 1-mile downstream of the confluence with the Hassayampa River. Additionally, the study area included the lower 1-mile of the Salt River. This extent covered the entirety of the 17-mile El Rio planning area as well as that portion of the river corridor recently proposed for critical habitat status for the cuckoo (USFWS 2014b). The GIS-based model evaluated habitat suitability using Landsat Thematic Mapper (TM) imagery and a 30-meter resolution digital elevation model (DEM). For the present study, the GIS-based model (hereafter called "satellite model") utilized Landsat 8 imagery from April 23, 2016.

The original cuckoo satellite model was developed as part of a study in the lower Colorado River basin in support of the Bureau of Reclamation's Lower Colorado River Multi-Species Conservation Program (Johnson et al. 2012). The study authors developed a conceptual model of breeding-habitat selection based on hypotheses tested with multivariate logistic regression (Figure F-1). The model assumes that selection of breeding habitat is influenced by riparian patch size, vegetation density, structure and community, habitat fragmentation, and patch location in relation to land use/cover (e.g., agriculture, urban development, water). The original model underwent a 6-step development and review process, as described in Johnson et al. (2012): (1) creation of a cuckoo use/non-use map for a given year; (2) development of a spatial database of vegetation and floodplain features extracted from the Landsat TM imagery; (3) use of logistic regression to test a set of hypotheses, identify significant associations between cuckoos and biophysical variables, and build and test predictive models; (4) creation of a probability map that depicts the likelihood of cuckoo habitat based upon a specific logistic-regression equation; (5) validation of the spatial model with a set of field-observed cuckoo locations within the lower Colorado River study area; and (6) extrapolation of the model to reaches of the Verde and San Pedro rivers.

Two satellite models were employed for the El Rio study, both of which characterize vegetation from Landsat TM imagery having a 30x30-meter pixel-to-ground resolution. Vegetation density (i.e., lushness) is characterized in each 30x30-meter cell with the Normalized Difference Vegetation Index (NDVI) with values ranging from -1 to 1. Satellite model 1 contained three predictor variables, all of which are positive coefficients: (1) terrain ruggedness (TRI) discretized into four classes of ruggedness (flat, low, moderate, high); (2) heterogeneity in vegetation density in 480-meter radius; and (3) amount of dense vegetation (NDVI>0.41) inside a 120-meter radius. Satellite model 2 contains the same two vegetation-density variables as model 1, but no the TRI

variable. The numerical criteria used in the models were based on published breeding habitat requirements. Specifically, efforts to conserve and/or restore high quality cuckoo breeding habitat should include habitat patches that are at least 480-meters in radius (72 hectares) with a core area of at least 120-meter radius (4.5 hectares).

Each of the two satellite models has greater value depending on their particular application. Within the El Rio planning area, Satellite model 1 was deemed most applicable because of the understanding of how vegetation and habitat are influenced by topographic variation throughout the river and riparian corridor.

The analysis using Satellite model 1 produced a habitat suitability map, which was presented in Figure 14 in the main document. Because the habitat suitability data presented in the map are based on a probability model, the results are not 100% certain nor is it likely that a cuckoo will use a location in the planning area. Therefore, the results are intended to provide a relative perspective, where it is more likely that cuckoos will occur in higher probability-class areas than in lower classes. Further investigation of actual habitat use and validation of the modeling results in the planning reach are recommended.

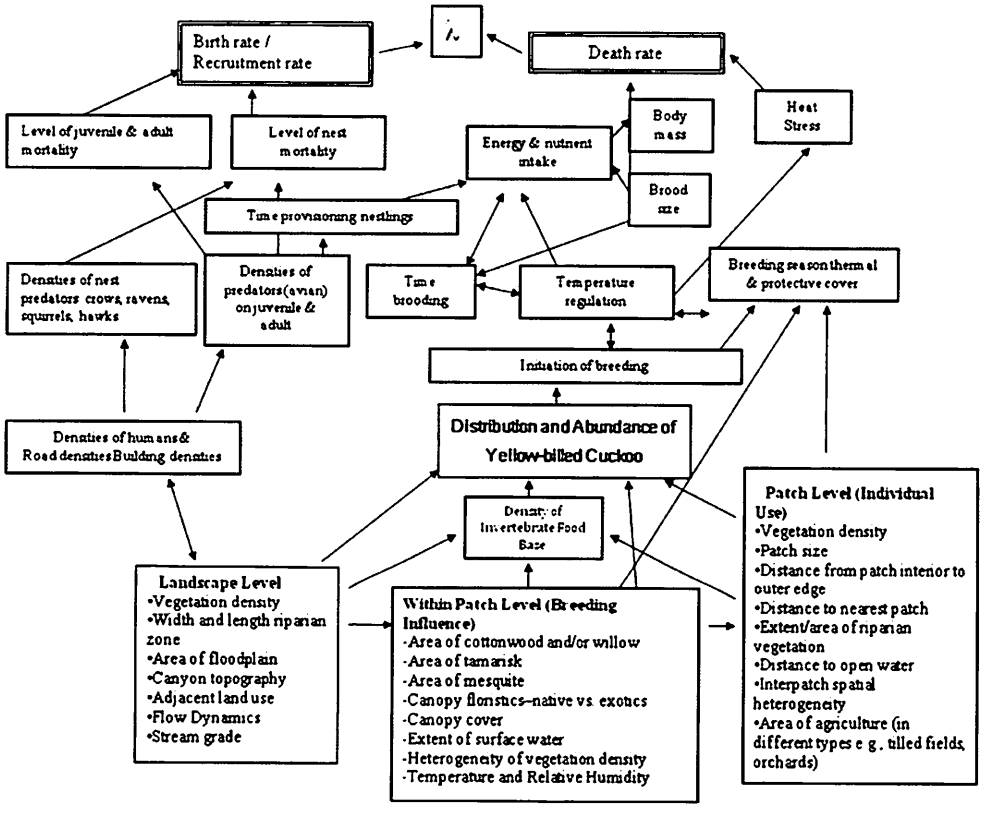

Figure F-1. Conceptual model of factors that affect yellow-billed cuckoo habitat selection along the lower Colorado River, Verde River watershed, and San Pedro River (source: Johnson et al. 2012).

3 REFERENCES

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