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RESOLUTION COPPER PROJECT
CLEAN WATER ACT SECTION 404 CONCEPTUAL MITIGATION PLAN

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1. INTRODUCTION

Resolution Copper Mining, LLC (Resolution, or the Applicant) proposes to develop and operate an underground copper and molybdenum mine near Superior, Arizona. As proposed, the tailings storage facility (TSF), pipelines, and associated facilities require the discharge of fill to surface water features that the U.S. Army Corps of Engineers (Corps) is anticipated to determine to be potentially jurisdictional waters of the United States (waters of the U.S.) pursuant to a preliminary jurisdictional determination (PJD). Based on the presumption that potentially jurisdictional waters of the U.S. will be impacted by discharges of dredged or fill material resulting from portions of Resolution's planned mine development, Resolution will need to make an application for a Clean Water Act (CWA) Section 404 permit for these discharges.

In order to secure a CWA Section 404 permit, the Applicant is bound by the requirements of the Corps' and the U.S. Environmental Protection Agency's (EPA) "Final Rule for Compensatory Mitigation for Losses of Aquatic Resources" (33 C.F.R. Parts 325 and 332 and 40 C.F.R. Part 320; published in 73 Fed. Reg. 19594-19705) (Corps & EPA 2008), hereinafter referred to as the 2008 Mitigation Rule. The fundamental objective of the 2008 Mitigation Rule is to establish standardized compensatory mitigation criteria for all mitigation types to offset unavoidable impacts to waters of the U.S. authorized through the issuance of a CWA Section 404 permit. This Conceptual Mitigation Plan introduces the suite of potential mitigation elements that Resolution will use to comply with the 2008 Mitigation Rule. A final Habitat Mitigation and Monitoring Plan, in conformance with the 2008 Mitigation Rule, will be developed and approved by the Corps prior to permit issuance. These mitigation measures will also apply in the context of the National Environmental Policy Act (NEPA) evaluation being led by the U.S. Forest Service (USFS) with the Corps as a cooperating agency.

2. PROJECT DESCRIPTION

Resolution's planned mine development is located near Superior in Pinal County, Arizona (**Figure 1**) in an area called the Copper Triangle and specifically within the Pioneer Mining District. Mine exploration and operations have been conducted in the area since the early 1860's, when the discovery of silver led to the development of the Silver King Mine. Magma Copper Company (Magma) took over the Silver King Mine and operated it as the Magma Mine from 1912 until the concentrator was finally shut down in 1996. After Magma's shutdown, the Resolution ore deposit was discovered 1.2 miles south of the existing Magma Mine and 7,000 feet below the ground surface.

Resolution was formed as a limited liability company in 2004 by Rio Tinto and BHP Billiton. Rio Tinto is the managing entity and possesses a 55-percent ownership stake in Resolution, while BHP Billiton maintains 45-percent ownership. Since 2004, Resolution has steadily worked to investigate and delineate the Resolution ore body, develop a mine design, prepare environmental and engineering studies to support the mine permitting and approvals effort, and conduct multiple community outreach efforts and public meetings to inform and involve the public as plans were developed. These efforts led to the submittal of a General Plan of Operations (GPO) to the USFS in November 2013, and the subsequent NEPA evaluation by the Corps and the USFS.

Resolution proposes the development of the Resolution ore body using panel caving, a type of block cave mining. The copper and molybdenum ore will be mined, undergo primary crushing underground, and then be sent to a newly constructed concentrator facility to be located at the existing WPS north of Superior. Concentrate produced here will be transported offsite for additional processing, while the resulting tailings will be transported via a tailings pipeline to the proposed TSF location. Under the current proposed operating conditions and Life of Mine (LOM) planning parameters, the Resolution ore body is sufficient to support the concentrator operations for approximately 41 years. As currently configured, operations are anticipated to result in the mining of approximately 1.4 billion tons of copper and molybdenum ore and the production of approximately 1.37 billion tons of tailings.

Through the alternatives analysis process under NEPA, the U.S. Forest Service (USFS) evaluated numerous geographic locations for tailings storage within an approximately 200-mile radius around the mine. The USFS evaluated both singular TSFs, where pyrite and scavenger tailings were stored together, and separate scavenger and pyrite TSFs, depending on the geophysical and hydrogeological setting. Additional factors included favorable topography and sufficient storage capacity. This information is detailed in Section 2 and Appendix B of the *Resolution Copper Project and Land Exchange Draft Environmental Impact Statement* (USFS 2019). The final alternatives selected for detailed analysis were those TSF designs that addressed the widest range of issues identified during public scoping and had the potential to be selected as the least environmentally damaging practicable alternative (LEDPA). This conceptual mitigation plan has been developed based on the assumption that the Corps would identify the Skunk Camp TSF alternative as the LEDPA for the Resolution Project (WestLand 2019). However, the mitigation elements described herein would be applicable to all the alternatives carried forward for consideration in the DEIS (USFS 2019) and the 404(b)(1) alternatives analysis (WestLand 2019).

3. AVOIDANCE AND MINIMIZATION

The development of the Resolution Project's TSF design included a significant effort to avoid and minimize impacts to potential waters of the U.S. As indicated above, an exhaustive evaluation of TSF alternatives was completed by the USFS and the Corps, including other mine (brownfields) sites in Arizona (USFS 2019). While the use of one of these brownfields sites would likely have avoided impacts to waters of the U.S., the agencies determined that none of the brownfields alternatives were feasible.

The Skunk Camp TSF design avoids impacts to identified spring features, resulting in only impacts to ephemeral washes. The design minimizes impacts to downstream waters by diverting upstream stormwater flows around the facility. The TSF has been located relatively high in the watershed of Dripping Springs Wash, minimizing the size of the upgradient watershed for which stormwater must be managed. While engineering designs will continue to advance, the stormwater diversions will be designed to maintain downstream stormwater flows in Dripping Springs Wash to the maximum extent practicable. In addition, engineering controls will be used to minimize the risk of contaminant discharge to downstream surface water features.

4. PROJECT IMPACTS TO WOTUS

The proposed Skunk Camp TSF is located in the Dripping Springs Mountains approximately 12 miles southeast of Superior, Arizona in Pinal and Gila counties (**Figure 1**). Land ownership, or surface management, for the TSF and associated infrastructure includes private lands and lands administered by the Arizona State Land Department (ASLD). The TSF will entail approximately 4,002 acres of surface disturbance and will impact approximately 112.8 acres of potential waters of the U.S. comprised solely of ephemeral drainages, including Dripping Spring Wash, Skunk Camp Wash, Stone Cabin Wash and a number of unnamed drainages.

As proposed, only the development of the TSF and associated infrastructure (including pipelines) may require a discharge of dredged or fill material into waters of the U.S. Discharge of fill for the development of these features, particularly the TSF, consists mostly of the levelling of existing topography through cut and fill of the natural ground surface. Materials to be discharged would consist of native soil and rock taken from the footprint of the constructed features during the grading process.

The proposed pipeline corridor would cross Queen Creek, Devils Canyon, Mineral Creek, and numerous unnamed tributaries. The construction of the pipeline bridge across Queen Creek may temporarily impact some intermittent flows within the river during construction; however, no piers would be placed directly within the ordinary high-water mark of Queen Creek. The crossings of both Devils Canyon and Mineral Creek are still being evaluated, but it is anticipated that the Applicant will be able to span or otherwise avoid the discharge of fill to these features. Other impacts to waters of the U.S. from development of TSF associated infrastructure (including pipelines) are estimated to entail approximately 37.0 acres of ephemeral drainages.

The Project will not adversely impact any special aquatic sites (including wetlands, seeps, and springs) or any perennial or intermittent drainages (with the spanning of Queen Creek, Devils Canyon, and Mineral Creek). Indirect impacts to potential waters of the U.S. downstream of the Project may occur as a result of reducing, diverting, or eliminating upstream flows. The extent of these indirect impacts is still being evaluated.

To facilitate mitigation planning, impacted drainages were grouped into three drainage classes based on physical characteristics affecting their hydrologic, chemical, and biotic function. Each drainage class is described as follows.

- **Ephemeral Class A:** This class consists of low-gradient, braided (multi-thread) ephemeral drainages within broad, relatively unrestricted floodplains, generally lower in the Project area watershed. These drainages include the lower portions of Dripping Spring Wash, Stone Cabin Wash, Skunk Camp Wash, and an additional unnamed drainage (**Figure 2**). Xeroriparian vegetation is common and widespread along the banks and floodplain terraces of Class A drainages. Vegetation is generally absent in the low-flow channels. Sediment in the active channels of Class A drainages is typically unconsolidated and is characterized by a well-sorted mixture composed primarily of sand, silt, and gravel.

- **Ephemeral Class B:** This class consists of low- to moderate-gradient, typically single-thread ephemeral drainages that are located higher in the watershed. The active channels of Class B drainages are generally confined within well-defined, relatively narrow floodplains. Class B drainages are located throughout the Project area, and most are directly tributary to the Class A drainages (**Figure 2**). Vegetation along Class B drainages typically includes narrow bands of xeroriparian vegetation along the banks. Vegetation may be present within the low-flow channel as well. Sediment in the active channels of Class B drainages may be well-or poorly-sorted, and typically includes sand, gravel, and cobbles.
- **Ephemeral Class C:** This class consists of moderate- to high-gradient single-thread ephemeral drainages that are located in the headwaters of the watershed. The active channels of Class C drainages are typically confined within well-defined, narrow floodplains. Class C drainages comprise the upper-most headwater tributaries of the Project area (**Figure 2**). Vegetation along Class C drainages typically includes narrow bands of upland and xeroriparian vegetation along the bed and banks. Upland species may be present in the low-flow channel. The substrate in the active channels of Class C washes may be well-or poorly sorted, and typically includes gravel, cobbles, and boulders. Cut banks are common in these drainages, and the channel bed may be scoured to bedrock.

The estimated total impacts to probable waters of the U.S. associated with the Skunk Camp TSF, pipelines and associated facilities is 149.8 acres, all of which are ephemeral. Impacts by drainage class are provided in **Table 1**.

Table 1. Impacts to Probable WOTUS by Drainage Class

Impacted Drainage Class	Skunk Camp TSF Direct Impacts (acres)	Pipelines and Associated Facilities[1] (acres)	Total
Ephemeral Class A	36.0	11.8	47.8
Ephemeral Class B	41.9	13.7	55.6
Ephemeral Class C	34.9	11.4	46.3
TOTAL	**112.8**	**37.0**	**149.8**

[1] Drainage Class acres for pipelines and associated facilities are preliminary estimates and will be refined when the functional assessment of these features is complete.

WestLand conducted a qualitative functional assessment of a representative sample of drainages within the Skunk Camp TSF footprint (**Figure 2**), during which a set of eleven hydrologic, chemical, and biotic functions were evaluated (**Table 2**).

Table 2. Functions Evaluated for Skunk Camp TSF Impacted Drainages

Evaluated Functions
HYDROLOGIC FUNCTIONS
Hydrologic Connectivity
Subsurface Flow and Groundwater Recharge
Energy Dissipation
Sediment Transport/Regulation
CHEMICAL FUNCTIONS
Elements, Compounds, and Particulate Cycling
Organic Carbon Export/Sequestration
BIOTIC FUNCTIONS
Aquatic Invertebrate Fauna
Presence of Fish and Fish Habitat Structure
Riparian/Wetland Vegetation Structure
Age Class Distribution of Wooded Riparian or Wetland Vegetation
Native/Non-native Plant Species

Evaluation of these eleven functions was based on available data, published literature, aerial photography, general field observations, and field data collected following the *California Rapid Assessment Method Episodic Riverine Field Book, version 2.0* (CRAM) (CWMW 2018), which was specifically developed to assess the functionality of ephemeral drainages based on relationships between condition and function. The functions of each identified drainage class were scored qualitatively on a six-rank scale: none, low, low-moderate, moderate, moderate-high, and high. **Table 3** provides the functional scores attributed to each drainage class identified within the Skunk Camp TSF footprint that would be lost as a result of the Project, along with the scoring rationale.

Table 3. Functional Assessment Scoring of the Skunk Camp TSF Impacted Drainage Classes

Functions	Drainage Class	Score	Rationale
HYDROLOGIC FUNCTIONS			
Hydrologic Connectivity	Ephemeral Class A	Moderate	Class A features lack major impediments to flow and are capable of transporting high volumes of water, though transport capacity is dependent on rainfall.
	Ephemeral Class B	Low-Moderate	Class B features lack major impediments to flow and are capable of transporting low to moderate volumes of water, though transport capacity is dependent on rainfall.
	Ephemeral Class C	Low	Class C features transport low volumes of water, and only in response to heavy precipitation events.
Subsurface Flow/ Groundwater Recharge	Ephemeral Class A	Low-Moderate	Water flow through the loose and unconsolidated alluvial soils in Class A channels provides some subsurface flow and potential to replenish groundwater aquifers, with subsurface flows strongly dependent on precipitation events. Xeroriparian vegetation indicates that temporary lateral subsurface flow potential may exist.
	Ephemeral Class B	Low	Class B features likely provide a limited amount of subsurface flow and potential to replenish groundwater aquifers, though infiltration may be limited by impervious layers at shallow depths. Subsurface flows are strongly dependent on precipitation events. Limited xeroriparian vegetation indicates that temporary lateral subsurface flow potential may exist.
	Ephemeral Class C	Low	Class C features likely provide a very small amount of subsurface flow and a very limited potential to replenish groundwater aquifers. Deep infiltration is likely prohibited by shallow depth to bedrock. Subsurface flows are strongly dependent on precipitation events. Narrow bands of xeroriparian vegetation indicates that temporary lateral subsurface flow potential may exist.
Energy Dissipation	Ephemeral Class A	Moderate	Class A features exhibit braided channels, channel sinuosity, low-gradient, a relatively unrestricted floodplain, and a bed of unconsolidated alluvium capable of reducing flow intensities through evaporation, channel infiltration, and natural physical control features including vegetated islands and channel bars.
	Ephemeral Class B	Low-Moderate	Class B features typically contain single-thread, moderate-gradient channels. Energy dissipation occurs through infiltration and natural physical control features such as cut banks, channel sinuosity, boulder steps, and/or flood debris.
	Ephemeral Class C	Low	Class C features contain single-thread, high-gradient channels that are typically incised. Energy dissipation occurs primarily via natural physical control features such as cut banks, channel sinuosity, boulders, debris jams, and vegetation growing in the floodplain.

Table 3. Functional Assessment Scoring of the Skunk Camp TSF Impacted Drainage Classes

Functions	Drainage Class	Score	Rationale
Sediment Transport/ Regulation	Ephemeral Class A	Moderate-high	Class A features have braided channels with well-sorted bed material and primarily unrestricted floodplains and can retain and deposit large amounts of sediment during precipitation events. Lack of dense riparian vegetative structure may limit the ability of these features to regulate excessive sediment loads.
	Ephemeral Class B	Low-Moderate	Class B features have well or poorly-sorted bed material and can retain and deposit a moderate amount of sediment during precipitation events. These drainages can be incised with confined floodplains, which limits the extent of sediment regulation in these features.
	Ephemeral Class C	Low	Class C features have well or poorly-sorted bed material and deposit only small amounts of sediment during precipitation events. Incised channels within confined floodplains limits the extent and capacity of sediment deposition and transport in these features.
CHEMICAL FUNCTIONS			
Elements, Compounds, and Particulate Cycling	Ephemeral Class A	Moderate	Class A features have broad channels with unconsolidated alluvium bed material having the potential to store and mix nutrients and particles in subsurface soils and provide downstream pulses during flow events. These systems are ephemeral and are generally vegetated only with xeroriparian and upland species, which limits the potential nutrient cycling capacity.
	Ephemeral Class B	Low-Moderate	Class B features have a limited capacity to store and mix nutrients and particles in subsurface soils and provide downstream pulses during flow events. These systems are ephemeral and are generally vegetated with a narrow band of xeroriparian vegetation, which may limit nutrient cycling capacity.
	Ephemeral Class C	Low	Class C features have a shallow depth to bedrock, creating a very limited capacity for these features to store and mix nutrients and particles in subsurface soils and provide downstream pulses during flow events. These drainages are ephemeral and are generally vegetated with narrow bands of xeroriparian vegetation, which further limits the potential nutrient cycling capacity.

Table 3. Functional Assessment Scoring of the Skunk Camp TSF Impacted Drainage Classes

Functions	Drainage Class	Score	Rationale
Organic Carbon Export/ Sequestration	Ephemeral Class A	Low-Moderate	Class A features have the potential to store organic matter in subsurface soils and provide downstream pulses during flow events. The features, along with upstream and downstream adjacent waters, are ephemeral, limiting both the amount and timing of carbon sequestration and export through the system. These features also lack a substantial amount of in-channel vegetation and a dense riparian buffer, which limits the ability of these systems to generate or export high amounts of organic carbon.
	Ephemeral Class B	Low	Class B features have limited potential to store organic matter in subsurface soils and provide downstream pulses during flow events. The features, along with upstream and downstream adjacent waters, are ephemeral, limiting both the amount and timing of carbon sequestration and export through the system. These features lack a dense riparian buffer and may have shallow depths to bedrock, which limits the ability of these features to generate or export high amounts of organic carbon.
	Ephemeral Class C	Low	Class C features have limited potential to store organic matter in subsurface soils and provide downstream pulses during flow events. The features, along with upstream and downstream adjacent waters, are ephemeral, limiting both the amount and timing of carbon sequestration and export through the system. These features have confined floodplains, shallow depths to bedrock, and narrow xeroriparian buffers, which limits the ability of these features to generate or export high amounts of organic carbon.
BIOTIC FUNCTIONS			
Aquatic Invertebrate Fauna	Ephemeral Class A	None	Class A features do not support perennial or intermittent flows. Irruptive aquatic insects may be present in small pools or water collection areas during significant precipitation events, but these temporary populations are not indicative of a stable prey community for aquatic-feeding species.
	Ephemeral Class B	None	Class B features do not support perennial or intermittent flows. Irruptive aquatic insects may be present in small pools or water collection areas during significant precipitation events, but these temporary populations are not indicative of a stable prey community for aquatic-feeding species.
	Ephemeral Class C	None	Class C features do not support perennial or intermittent flows. Irruptive aquatic insects may be present in small pools or water collection areas during significant precipitation events, but these temporary populations are not indicative of a stable prey community for aquatic-feeding species.

Table 3. Functional Assessment Scoring of the Skunk Camp TSF Impacted Drainage Classes

Functions	Drainage Class	Score	Rationale
Presence of Fish and Fish Habitat Structure	Ephemeral Class A	None	Class A features do not contain any permanent or intermittent waters. Flow events within these ephemeral systems do not support fish species.
	Ephemeral Class B	None	Class B features do not contain any permanent or intermittent waters. Flow events within these ephemeral systems do not support fish species.
	Ephemeral Class C	None	Class C features do not contain any permanent or intermittent waters. Flow events within these ephemeral systems do not support fish species.
Riparian/ Wetland Vegetation Structure	Ephemeral Class A	Moderate	Class A features generally do not support riparian-obligate species. Xeroriparian vegetation is common and widespread along the banks and floodplain terraces of these features.
	Ephemeral Class B	Low-Moderate	Class B features generally do not support riparian-obligate species. Xeroriparian vegetation is common along the banks of these features.
	Ephemeral Class C	Low	Class C features do not support riparian-obligate species. Xeroriparian vegetation is present in narrow bands along the bed and banks of these features.
Age Class Distribution of Woody Riparian or Wetland Vegetation	Ephemeral Class A	Moderate	In Class A features, wetland vegetation is generally absent. Xeroriparian and upland vegetation is common and widespread. A self-sustaining community of woody trees and shrubs from a range of age classes are present.
	Ephemeral Class B	Moderate	In Class B features, wetland vegetation is generally absent. Xeroriparian and upland vegetation is common. A self-sustaining community of woody trees and shrubs from a range of age classes are present.
	Ephemeral Class C	Moderate	In Class C features, wetland vegetation is absent. Xeroriparian and upland vegetation is common along the bed and banks. Woody trees and shrubs from a range of age classes are present.
Native/ Non-native Plant Species	Ephemeral Class A	Moderate-High	Woody vegetation in Class A features is mostly native. Nonnative grasses and forbs are common but do not dominate the landscape. Tamarisk and Russian thistle are absent.
	Ephemeral Class B	Moderate-High	Woody vegetation in Class A features is mostly native. Nonnative grasses and forbs are common but do not dominate the landscape. Tamarisk and Russian thistle are absent.
	Ephemeral Class C	Moderate-High	Woody vegetation in Class A features is mostly native. Nonnative grasses and forbs are common but do not dominate the landscape. Tamarisk and Russian thistle are absent.

To compensate for these unavoidable impacts and functional losses, six offsite mitigation opportunities have been identified that provide the potential for functional gains through implementation of active management, enhancement, restoration, and preservation activities.

5. MITIGATION OPPORTUNITIES

The 2008 Mitigation Rule identifies general classes of compensatory mitigation and identifies clear preferences among these classes, specifically noting that mitigation banks[1] and then in-lieu fee (ILF) mitigation are preferred over permittee-responsible onsite or offsite mitigation. As a general matter, in-kind mitigation is preferred over out-of-kind mitigation.

In accordance with the Corps' *Final 2015 Regional Compensatory Mitigation and Monitoring Guidelines* (2015), Resolution evaluated mitigation opportunities, based on the above hierarchy, within the Project watershed (Middle Gila Watershed [USGS HUC 15050100]) and adjacent watersheds. WestLand is not aware of any watershed planning efforts for the HUC-6 or HUC-8 watersheds within which the Project is located that identify specific restoration goals for aquatic resources. No onsite mitigation opportunities were identified.

Six offsite mitigation opportunities (**Figure 3**) have been identified as Potential Mitigation Opportunities (**Section 4.1**). The relative mitigation benefits of each mitigation opportunity are discussed based on WestLand's recent experience working within the framework of the 2008 Mitigation Rule on similar mining projects (WestLand 2017, 2018) and following Corps guidelines (Corps 2015). The mitigation opportunities include both permittee-responsible and ILF mitigation. Fulfillment of mitigation under each opportunity would provide regional conservation benefits, though not all of the proposed mitigation measures will create xeroriparian habitat similar to the habitat that will be lost or impacted by the Project. Some of the opportunities entail preservation, enhancement, and restoration of high-value mesoriparian and hydroriparian habitats, which are rarer within the regional landscape and have higher productivity and wildlife values (Lowery, Stingelin, and Hofer 2016).

5.1. POTENTIAL MITIGATION OPPORTUNITIES

5.1.1. GRIC MAR-5 Recharge Project

The Gila River Indian Community (GRIC, the Community) MAR-5 Recharge Project is, to-date, a 3-year pilot study to evaluate the effectiveness of recharging a portion of the GRIC allotment of CAP water into the Gila River, on the Community's lands (**Appendix A**). Over the 3-year pilot study, CAP water was discharged at a single turnout near the Olberg Road Bridge in GRIC District 3. Water discharge at the site initiated in August 2015, and vegetation monitoring was conducted at the site each year from 2015 through 2017, including baseline data collection in June 2015. The pre-discharge vegetation of the area was described as a sparse collection of upland woody shrubs with desert forbs

[1] There are currently no mitigation banks established in Arizona.

and Bermudagrass (*Cynodon dactylon*), along with the nonnative, invasive tamarisk (*Tamarix* spp.). The 2017 data show a five-fold increase in total vegetation volume and a six-fold increase in total herbaceous cover, and at the end of the pilot study the site was populated with desirable riparian species including cattails (*Typha* spp.) and Goodding's willow (*Salix gooddingii*). Tamarisk density at the site also increased substantially, from 11 plants per hectare in June 2015 to 352 plants per hectare in 2017 (**Appendix A**).

The instream discharge created an approximately 123-acre wetted area at the GRIC MAR-5 site (**Figure 4**), and it is anticipated that continued discharges would allow for significant ecological lift as riparian habitat in this area continues to develop, though Corps guidance (2015) indicates that mitigation credited towards this lift may be negatively-impacted by the presence and density of tamarisk. The GRIC Department of Environmental Quality has recently conducted limited tamarisk removal and native plant reseeding at the GRIC MAR-5 site and has identified a large tamarisk thicket directly upstream that is likely a major seed source contributing to the tamarisk colonization and proliferation at the GRIC MAR-5 site. Tamarisk removal and native reseeding efforts at the upstream tamarisk seed source are described in the Olberg Road Restoration Site Project mitigation option (**Section 4.1.3**).

The Corps places a high value on restoration projects (33 CFR 332.3(a)(2)), and the GRIC MAR-5 recharge project represents a significant restoration effort on one of Arizona's largest river systems. The Corps prefers that mitigation take place within the same watershed as the impacted site (33 CFR 332.3(b)), and the GRIC MAR-5 site occurs within the same HUC 8 watershed, the Middle Gila, as the Project (**Figure 3**). Additionally, the Community has indicated that the GRIC MAR-5 recharge project would restore a cultural resource (surface flows in the Gila River), which has significant traditional value to the Community.

While mitigation ratios for the Project have not yet been established, the 123-acre wetted area at the GRIC MAR-5 site is proposed mitigation to offset impacts to 120 acres of probable waters of the U.S. resulting from the Project.

5.1.2. Lower San Pedro River Wildlife Area In-lieu Fee Project

The ILF mitigation programs allow impacts to surface water features to be mitigated through funds paid to a governmental or non-profit natural resources management entity as a means to satisfy compensatory mitigation requirements (Corps & EPA 2008). These programs are a form of compensatory mitigation that can aid in larger restoration efforts, making ILF projects (along with mitigation banks) the Corps' preferred method of compensatory mitigation (Corps 2015).

The Arizona Game and Fish Department (AGFD), in collaboration with Arizona Land and Water Trust and Intel Corporation, has developed an ILF mitigation project, the Lower San Pedro River Wildlife Area (LSPRWA) along the San Pedro River near Winkelman, Arizona. Although the LSPRWA ILF project is located within the Lower San Pedro (HUC 8) watershed adjacent to the Project area's watershed (**Figure 3**), the ILF project itself is located near the watershed boundary and has been used as mitigation for other projects located in the Middle Gila River HUC 8 watershed (WestLand 2018). The LSPRWA ILF project consists of converting over 100-acres of agricultural fields to native pasture grasses to reduce groundwater consumption and help restore base flows and riparian habitat (BFWS 2019). Additionally, the restoration project will involve substantial exotic species removal and subsequent plantings to establish native woody vegetation within the 2,116 acre site (Lowery, Stingelin, and Hofer 2016).

The AGFD has indicated in a letter to Resolution Copper (**Appendix B**) that all advanced credits available for purchase through the LSPRWA ILF project have been sold or obligated for sale. However, AGFD will expand the LSPRWA ILF project to make an additional 650 credits available for purchase through five future phases of development. Resolution may purchase as many LSPRWA ILF credits as necessary to meet the mitigation requirements needed to offset impacts resulting from the Project regardless of the outcome of mitigation negotiations involving the GRIC MAR-5 Recharge Project.

The LSPRWA ILF project has previously been used as mitigation by Asarco in support of the proposed Ripsey Wash TSF project (Ripsey) (WestLand 2018). Ripsey is similar to the Project in that for both projects, all proposed impacted drainages are ephemeral. Mitigation ratios established using the LSPRWA ILF to offset impacts from Ripsey were set at 1:1 for both newly-established wetland habitat and restored riparian habitat (WestLand 2018). Due to the similar nature and functional value of the proposed impacted drainages between Ripsey and the Project, WestLand assumes that a mitigation ratio of 1:1 or similar would be used for the Project.

5.1.3. Olberg Road Restoration Site Project

The proposed 23-acre Olberg Road Restoration Site (ORRS) is located along the south bank of the Gila River just east of the Olberg Bridge in GRIC District 3, immediately upstream of the GRIC MAR-5 site (**Figure 4**). The conceptual mitigation strategy for the ORRS project consists of exotic tree species (principally tamarisk) removal and control, combined with native plant species reseeding. Nonnative, invasive tamarisk has shown substantial increase in cover at the GRIC MAR-5 site during the 3-year pilot study (**Appendix A**), prompting identification of the 23-acre ORRS as a major tamarisk seed source for the GRIC MAR-5 site. Exotic tree species removal and control combined with seeding of native plant species at the ORRS site would allow for the establishment and maintenance of a riparian habitat dominated by native tree species, and eliminate a large, local source of exotic tree species seed from that section of the Gila River.

The ORRS project is not expected to generate the same ecological lift and mitigation credit value as the GRIC MAR-5 site, as it provides fewer ecological benefits relative to restoring surface flows and high-value riparian vegetation. The mitigation actions associated with tamarisk removal and reseeding would be considered as restoration.

5.1.4. Queen Creek Project

Conceptual mitigation elements for the Queen Creek project consists of actions to improve the ecological condition of a stretch of Queen Creek near Superior, Arizona (**Figure 3**). The actions include the removal of tamarisk to allow riparian vegetation to return to its historic composition and structure and promote more natural stream functions. Additionally, a conservation easement would be established, covering approximately 150 acres along 1.8 miles of Queen Creek to restrict future development of the site and provide protected riparian and wildlife habitat. The 150-acre Queen Creek project area includes lands owned by Resolution and BHP Mineral Resources, Inc. (BHP).The Corps would likely categorize the Queen Creek project as an enhancement (lift of one or a few selected functions) project. However, important to note is that the Queen Creek project would be accessible and highly-visible from Superior (**Figure 3**), allowing a local community affected by the Project to be a major beneficiary of the mitigation.

5.1.5. Arlington Wildlife Area In-lieu Fee Project

The Arlington Wildlife Area (AWA), another AGFD ILF mitigation project, is a 1,500-acre wetland and riparian habitat restoration project along the west bank of the Gila River in Maricopa County, Arizona. The AWA is located within the Lower Gila (HUC 8) watershed, adjacent to the Project area's Middle Gila watershed (**Figure 3**). The AWA consists of agricultural lands, constructed wetlands, and riparian areas dominated by tamarisk and mixed native and non-native vegetation (AGFD 2019). Restoration actions at the AWA consist of streambank shaping, erosion control, and native revegetation. As an ILF project, the Corps places high value on this opportunity due to its potential to have a substantial impact on broader restoration efforts.

5.1.6. Lower San Pedro River BHP Parcel Preservation Project

The Lower San Pedro River BHP Parcels (Parcels) are land parcels currently owned and managed by BHP that encompass the San Pedro River riparian corridor and adjacent bosque habitat along an approximately 5-mile stretch of the San Pedro River east of San Manuel, Arizona (**Figure 3**). The Parcels are located in the Lower San Pedro Watershed, adjacent to the Project's Middle Gila Watershed. Based on a review of current and historic aerial imagery on Google Earth, stretches of the San Pedro River within the Parcels appear to be intermittent to perennial and support riparian-deciduous galley forest habitat dominated by large Fremont cottonwood (*Populous fremontii*) and Goodding's willow (*Salix gooddingii*) trees, as well the Parcels contain an approximately 2-acre pond that appears to be perennial.

The Parcels overlap with a portion of the Lower San Pedro River Important Bird Area (IBA) which is part of the Arizona IBA Program. The Arizona IBA Program is co-administered by Audubon Arizona and the Tucson Audubon Society, and works in partnership with AGFD, Arizona State Parks, the U.S. Fish and Wildlife Service (USFWS) and other entities to identify sites that maintain the long-term viability of wild-bird populations while engaging the public to conserve those areas of critical habitat (Arizona IBA Program 2011a). According to the Arizona IBA Program, the Parcels along with adjacent lands, including approximately 3,000 acres along the Lower San Pedro River owned by Resolution called the 7B Ranch, contain the largest intact mesquite bosques in Arizona and contain the highest documented numbers of nesting Southwestern willow flycatchers (*Empidonax traillii extimus*) on the San Pedro River (Arizona IBA Program 2011b). Southwestern willow flycatcher is listed by the USFWS as endangered under the Endangered Species Act (USFWS 1995).

The Corps would consider this mitigation option as preservation. A conservation easement would be established to restrict future development of the site to protect the existing riparian habitat. Perimeter fencing would be erected and maintained where necessary to prevent trespass by vehicles and livestock to further protect the ecological integrity of the site.

6. LONG-TERM SITE PROTECTION INSTRUMENTS

All of the permittee-sponsored mitigation opportunities (GRIC MAR-5 Recharge Project, ORRS project, Queen Creek project, and the BHP Parcels project) to the extent necessary will have a suitable site-protection instrument recorded in their respective counties or tribal government to provide long-term protection of the conservation objectives outlined here and to comply with the 2008 Mitigation Rule. The details of the site-protection instruments to be recorded at these mitigation sites have not been finalized at this time. The site-protection instruments will include prohibitions on any forms of grazing or other land uses, such as fuel wood harvesting, that are not compatible with maintaining the desired ecological functions of the mitigation sites. Some low-impact public uses such as hiking and bird watching may be allowed in certain areas. The permittee would provide funds for the long-term management by of the sites pursuant to the respective site-protection instrument.

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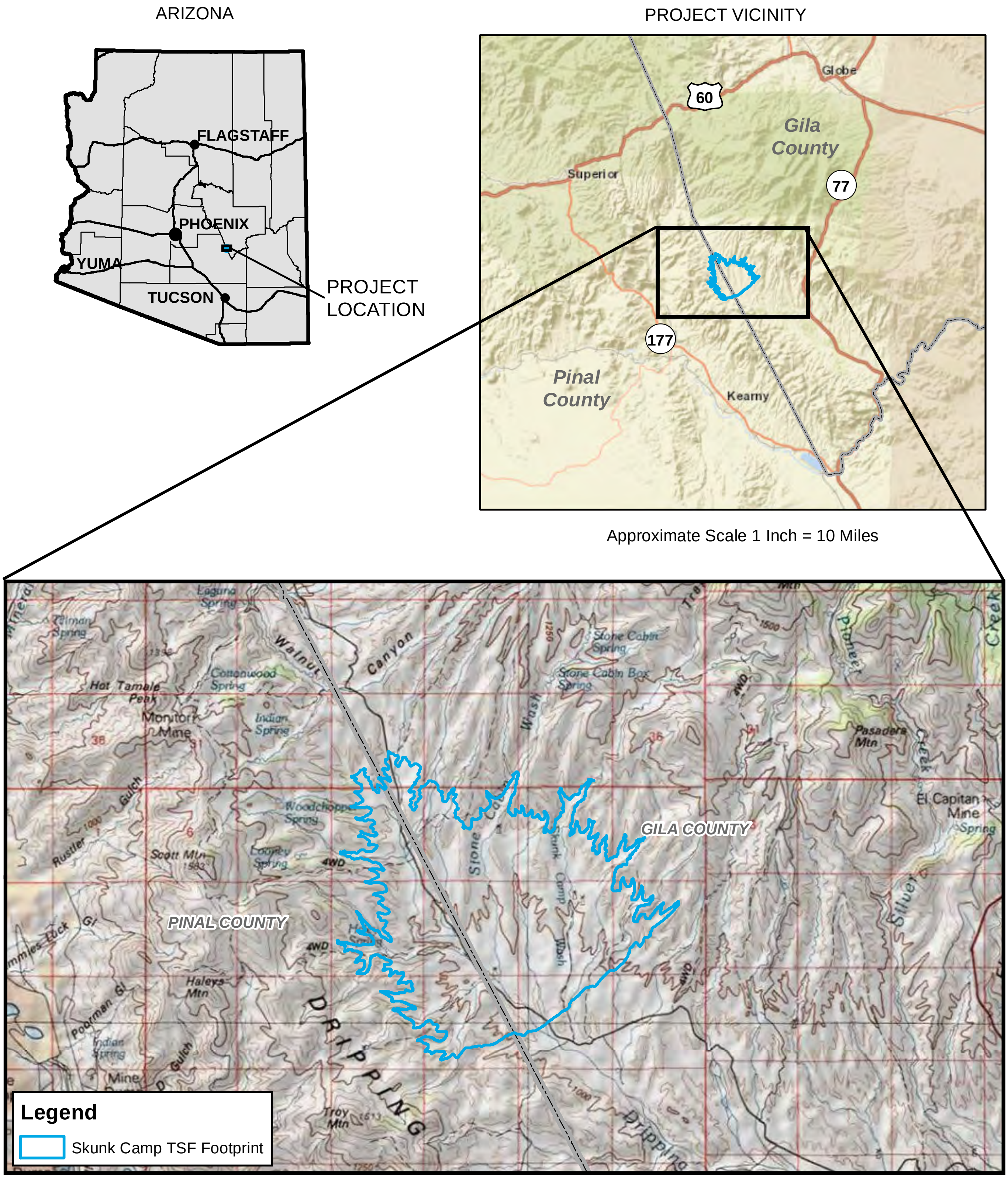
FIGURES



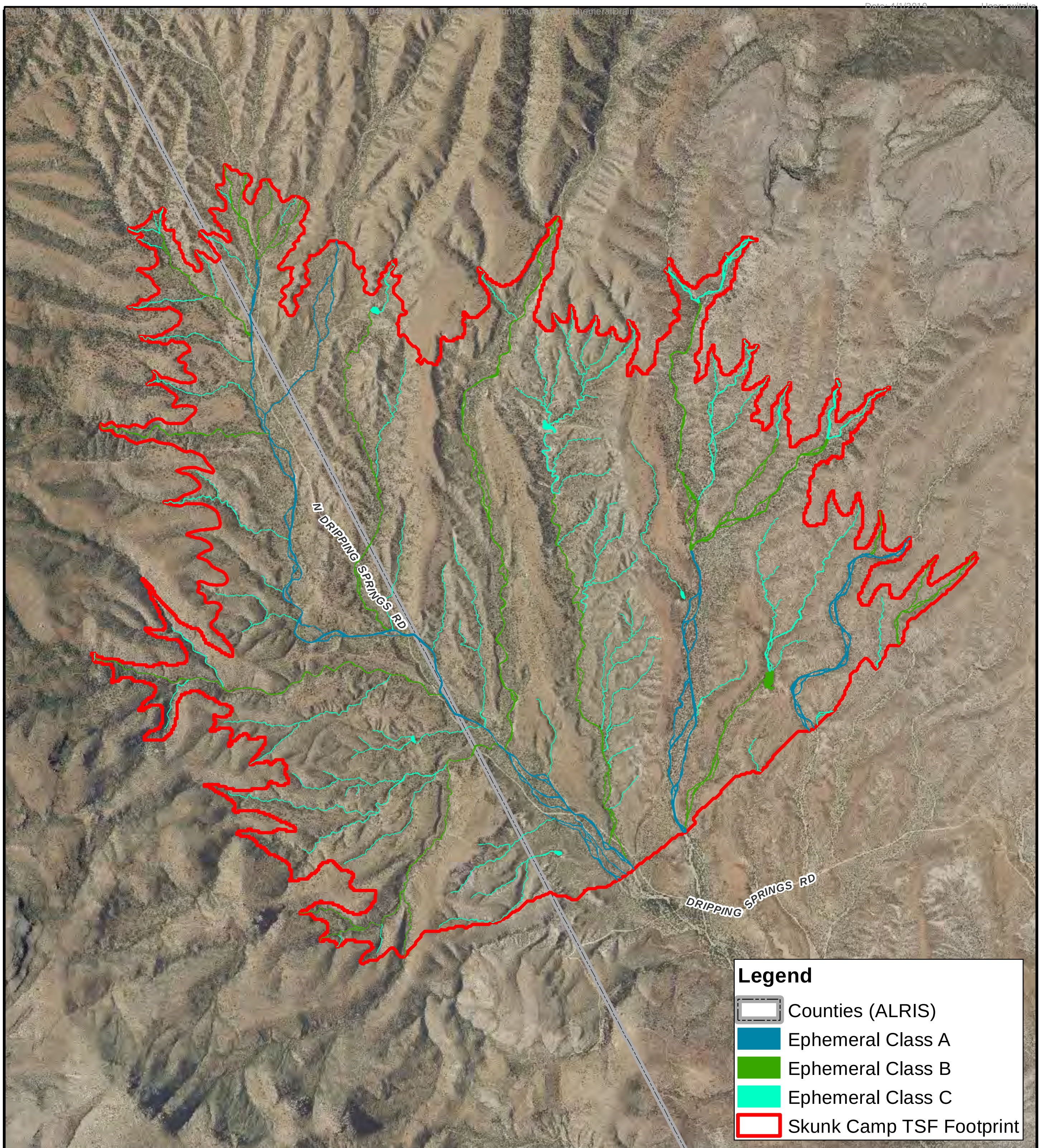
T2S, R14E, Portions of Sections 33-35
T3S, R14E, Portions of Sections 1-4, 9-12, and 14-16
Gila and Pinal Counties, Arizona,
Globe USGS 100,000 Quadrangle
Image Source: ArcGIS Online World Street Map

RESOLUTION COPPER
Resolution Copper Project Clean Water Act
Section 404 Conceptual Mitigation Plan

VICINITY MAP
Figure 1

N
0 1 2 Miles
0 2 4 Kilometers

WestLand Resources



T2S, R14E, Portions of Sections 33-35,
T3S, R14E, Portions of Sections 1-4, 9-12, and 14-16,
Gila and Pinal Counties, Arizona,
Image Source: 2017 USDA NAIP Orthophoto

WestLand Resources

N

0 1,500 3,000 Feet

0 600 1,200 Meters

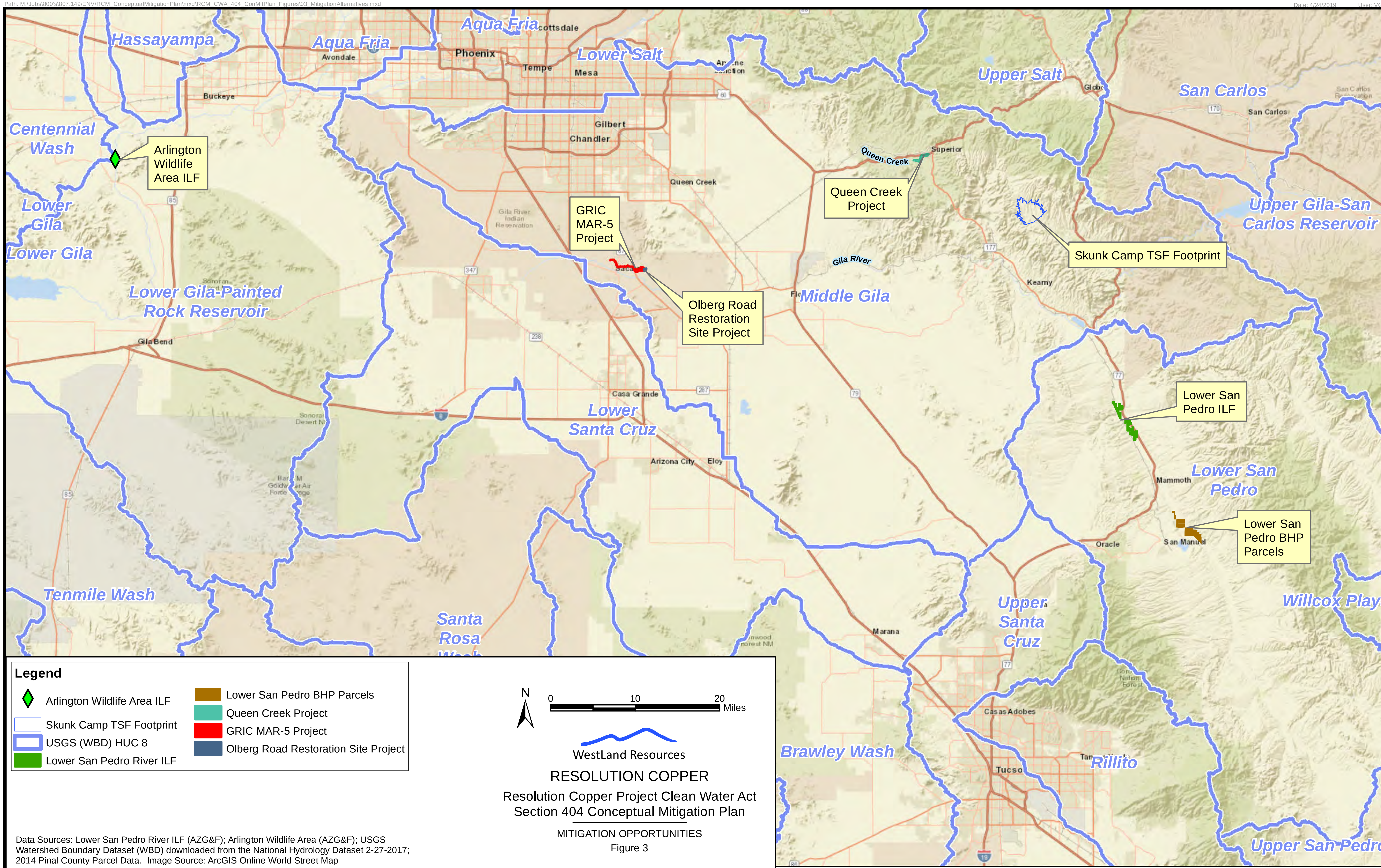
RESOLUTION COPPER

Resolution Copper Project Clean Water Act
Section 404 Conceptual Mitigation Plan

SKUNK CAMP TSF
DRAINAGE CLASSIFICATIONS

Figure 2

Path: M:\Jobs\800's\807.149\ENV\RCM_ConceptualMitigationPlan\mxd\RCM_CWA_404_ConMitPlan_Figures\03_MitigationAlternatives.mxd Date: 4/24/2019 User: VGENTILE



Legend

- Arlington Wildlife Area ILF
- Skunk Camp TSF Footprint
- USGS (WBD) HUC 8
- Lower San Pedro River ILF
- Lower San Pedro BHP Parcels
- Queen Creek Project
- GRIC MAR-5 Project
- Olberg Road Restoration Site Project

N

0 10 20 Miles

WestLand Resources

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Resolution Copper Project Clean Water Act Section 404 Conceptual Mitigation Plan

MITIGATION OPPORTUNITIES

Figure 3

Data Sources: Lower San Pedro River ILF (AZG&F); Arlington Wildlife Area (AZG&F); USGS Watershed Boundary Dataset (WBD) downloaded from the National Hydrology Dataset 2-27-2017; 2014 Pinal County Parcel Data. Image Source: ArcGIS Online World Street Map

Path: M:\Jobs\800's\807.149\ENV\RCM_ConceptualMitigationPlan\mxd\RCM_CWA_404_ConMitPlan_Figures\04_GRIC_MAR_5_Project.mxd   Date: 4/24/2019   User: VGENTILE

T4S, R6E, Portions of Sections 8 - 14,
Pinal County, Arizona.
Gila Butte SE and Sacaton USGS 7.5' Quadrangles
Image Source: Pleiades Satellite Imagery 10/28/2017

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0 800 1,600 Feet
0 250 500 Meters

N

Legend

- Olberg Road Restoration Site Project
- MAR-5 Wetted Area

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Resolution Copper Project Clean Water Act
Section 404 Conceptual Mitigation Plan

GRIC MAR-5 PROJECT
Figure 4

APPENDIX A

Gila River Indian Community MAR-5 2017 Vegetation Monitoring Report

GILA RIVER INDIAN COMMUNITY MAR-5
2017 VEGETATION MONITORING REPORT
Resolution Copper

Prepared for:

RESOLUTION COPPER

102 Magma Heights – Superior, Arizona 85173
Project Number: 807.131 03 02
May 2019

WestLand Resources

WestLand Resources, Inc. • 4001 E. Paradise Falls Drive • Tucson, Arizona 85712 • 520•206•9585

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APPENDICES

1. INTRODUCTION AND BACKGROUND

WestLand Resources, Inc. (WestLand), was retained by Resolution to conduct vegetation monitoring of restoration efforts in partnership with the Gila River Indian Community (GRIC) through the discharge of Central Arizona Project (CAP) water to the Gila River as part of a Managed Aquifer Recharge (MAR) and riparian restoration pilot program.. Instream discharge of the GRIC CAP water allocation into the Gila River is currently conducted at a single turnout near the Olberg Road Bridge, referred to as MAR-5. The GRIC MAR-5 recharge study site is situated along the southern side of the Gila River, approximately 1 mile north of the town of Sacaton in Township 4 South, Range 30 East, Sections 9 through 11, 13, and 14 (the Project Area; **Figure 1**).

A 3-year pilot study to evaluate the effectiveness of the discharge at MAR-5 was initiated in 2015. Baseline vegetation data was collected in June 2015 before the initial discharge of water in July 2015. Additional vegetation data was collected in November and December 2015, November and December 2016, and November 2017.

This report presents the baseline vegetation data collected in June 2015 and provides a comparative analysis to the vegetation data collected in November-December 2015, November-December 2016, and November 2017 after instream discharge commenced at MAR-5. The report is presented in five sections: **Section 1**: Introduction, **Section 2**: Methods, **Section 3**: Results, **Section 4**: Discussion, and **Section 5**: References.

2. METHODS

Although the Corps has no approved wetlands functional assessment model for determining ecological restoration benefits in Arizona, WestLand used the Planning-based Wetland Functional Assessment Model developed by the Corps (Webb and Burks-Copes 2009) to establish an index of hydrological function of the MAR-5 recharge pilot study site, called its Functional Capacity Index (FCI). The FCI is a value ranging from 0 to 1 which reflects the quality of the evaluated wetland area relative to a hypothetical properly-functioning wetland. An index of "1" indicates that the wetland functions at a level equivalent to a wetland under reference standard conditions (Webb and Burks-Copes 2009), and an index at or above 0.50 indicates that the wetland has a moderate to high functional capacity (Burks-Copes and Webb 2003). The FCI is calculated by evaluating ten functions (e.g., channel dynamics, nutrient cycling, habitat structure), which in turn are calculated by formulas involving a total of 27 variables. Most of the variables are measured at the field sites; a few are evaluated using GIS. The Model converts measured variable values into a Variable Subindex (VSI) score for each variable, which ranges from 0 to 1. The VSI values comprise the variables within the formulas that calculate an FCI for each of the ten wetland functions. The FCI values of the 10 functions are averaged to produce an overall FCI for each sampled site. An overall average among all sites provides a single FCI for the entire study area. The FCI of the site is multiplied by the acreage of the represented area to calculate Functional Capacity Units (FCU). The value of the FCU reflects the quality and quantity of the wetland area, and can be compared among sites and over time for purposes of monitoring and mitigation.

2.1. Field Methods

The Model recognizes five types of wetlands (termed Partial Wetland Assessment Areas [PWAA]) in southern Arizona. All the study transects were in the Scrub-Shrubland PWAA, characterized by the presence of shrubs (defined as woody vegetation less than 3 inches in diameter at breast height), but lacking trees (>3 inches diameter at breast height). Also in the floodplain of the Gila River but outside of the channel wetted by discharge from MAR-5 are extensive areas of the Dry Riverbottom PWAA, characterized by a lack of woody vegetation (Webb and Burks-Copes 2009).

Prior to fieldwork, 38 study transects were selected by inspection of aerial imagery within the area predicted to be wetted from the discharges. Study transects were located perpendicular to the channel at intervals of approximately 200 meters (m). The lengths of the proposed transects varied in accordance with the width of the predicted wetted area (**Figure 2**). Throughout the four data collection periods, some transects were shortened, others were omitted, to better represent the wetted discharge channel and to omit non-wetted areas. Data was collected from 27 transects in June 2015, from 24 transects in November-December 2015, from 18 transects in November-December 2016, and from 24 transects in November 2017 (**Figure 3**). For transects that were shortened in November-December 2015 to include only wetted areas, the June data reported in **Section 3** was adjusted to correspond to the shortened transects, by deleting data points that were recorded in omitted sections of the transects.

At each transect, the following data were collected:

- Total Vegetation Volume (TVV)
- Percent Cover
- Belt Density of Woody Species
- Hydrological Variables
- Photographs

2.1.1. Total Vegetation Volume

The total vegetation volume (TVV) index is used to characterize community structure and composition of the vegetation and to provide an indication of overall productivity. This technique samples a series of one-decimeter (dm)-high by one-dm-radius cylinders (3.14 dm^3) from the ground surface through the top of the vegetation canopy at regular intervals along established transects. At each of the sample points per transect, a straight rod was held vertically; any live woody vegetation that occurred within a 10-centimeter (cm) radius cylinder centered on the vertical rod was recorded by species as "hits". Data was separated into 1-m vertical increments (ground-1 m, 1-2 m, 2-3 m, 3-4 m, 4-5 m, 5-6 m, 6-7 m, 7-8 m, and >8 m). Each vertical meter increment could have a maximum of 10 hits, corresponding to the number of 10-dm high x 10-cm radius cylinders occupied by live vegetation, within each vertical 1-m increment. For vegetation that occurred higher than 8 m, one hit was scored per species in the >8-m category.

The calculation procedure for computing vegetation volume data is provided below:

h_i = total number of hits (dm layers containing vegetation) at the i^{th} sample point

n = the total number of sample points within the transect

$\sum_{i=1}^{n} h_i$ = the sum of all hits within the transect

The sum of the hits can be used to calculate the volume of vegetation per dm^2 area for the transect:

$$\text{Vegetation volume per area (in decimeters)} = \frac{\sum_{i=1}^{n} h_i * 3.14dm^3}{n * 3.14dm^2}$$

The vegetation volume as cubic meters of vegetation per square meter, then, is calculated as:

$$\text{Vegetation volume per area (in meters)} = \frac{\sum_{i=1}^{n} h_i * 3.14dm^3}{n * 3.14dm^2} * \frac{1m^3}{1{,}000dm^3} * \frac{100dm^2}{1m^2}$$

This total vegetation volume per area can then be simplified and stated as an index value, TVV:

$$\text{TVV} = \frac{\sum_{i=1}^{n} h_i}{10n}$$

2.1.2. Percent Cover

Percent cover is defined as the proportion of the ground area that is covered by plant canopy, algae, water, or dead plant matter; the balance is bare ground. Plant canopy cover can be visualized as the outline projected to the ground resulting from draping a form-fitting sheet over the individual plant, i.e. ignoring small gaps in the canopy.

Percent cover was evaluated in June 2015, November-December 2016, and November 2017 with the line-intercept method, using the same transect lines established for TVV. Line-intercept essentially maps the transect in terms of the plants, litter, or bare ground that lie in a vertical plane defined by the transect. The observer begins at the 0-m mark on the transect tape and records the start and stop measures for each feature encountered along the line. For example, bare ground from 0 m to 13.75 m, mesquite canopy from 13.75 m to 20.30 m, etc., until the end of the transect is reached. Percent cover is calculated for each plant species and for litter and bare ground by summing the lengths for each feature and dividing by the total transect length. Adjustment of June data to the shortened November-December 2015 transects was accomplished by deleting any data points that occurred in portions of the transect that were later omitted. For example, Transect 3 was shortened from 250 m to 200 m; therefore, the June cover data that occurred in the last 50 m of the transect was deleted for comparison to later data.

In November-December 2015, plant cover was evaluated with the line-point method. Percent cover of a plant species or ground cover type is calculated as the percent of sample points in which the species occurred. The transect was sampled by identifying the plant species and ground cover that occurred at a series of points located at regular intervals. At each sample point, a vertical line was projected. The plant species and any dead plant matter that the vertical line intercepted was recorded. If more than one live plant species was intercepted, both species were recorded, as well as any dead plant matter. The cover of algae, algal remnants, or standing water was recorded. If there was neither live plant nor dead plant matter at the point, bare ground was recorded. Dead plant matter was recorded in one of these categories:

- LITTER (non-woody)
- FWD (Fine woody debris) ≤ 2.5 inches diameter
- CWD (Coarse woody debris) ≥ 2.5 inches diameter

2.1.3. Belt Density

Density is defined as the number of individual plants or plants of a given species per unit of area. Plant density monitoring occurred in June 2015 before the initiation of instream discharges to establish the baseline, and in November-December 2015, November-December 2016, and November 2017.

Plant density data was collected in 5-m-wide belt transects, which varied in length depending on the width of the channel (**Figure 3**). The belt transects were divided into 10-m by 5-m segments, and the number of individual perennial plants of each woody species that were more than 0.5 m in height was recorded within each segment. The ground rule for distinguishing conspecific individuals was a separation of at least 1 m between rooted stems. The division of the belt transects into segments enabled inter-year comparisons for transects that were shortened, by omitting the June 2015 data for any 10 m segments not later sampled. To document recruitment and establishment of seedlings, in November-December 2016 and November 2017, the woody plants were counted in these height classes: <20 cm, 21-50 cm, 51-100 cm, 101-200 cm and > 200 cm.

2.1.4. Photopoints

Photographs were taken from the endpoints of each of the transects, with views along the transects towards the other endpoint (**Appendix A**). Prints of the earlier photographs were taken into the field to ensure that the photos were matched (**Appendix A**).

2.1.5. Hydrological Variables

The following variables were evaluated in the field in November-December 2015, November-December 2017, and November 2017, using scores presented in the Model document (Webb and Burks-Copes 2009). Use of the Model was not implemented in time to collect data prior to discharge, thus there are no pre-discharge scores for these variables.

- DECAY: Presence of coarse woody debris in various stages of decomposition.
- FREQ: Frequency of inundation. This variable is intended to reflect the frequency of flood events necessary to inundate the site with perennial flow scored highest and 100-year flood return interval scored lowest.
- PORE: Soil pore space available for storing sub-surface water; depends on soil permeability. This variable was scored from 1 to 5, with a score of 1 indicating no restrictive layer and a score of 5 indicating a non-porous substrate.
- Q: This variable scores alterations of hydroregime by human activities, with no alterations scored highest and alterations with substantial changes to channel morphology scored lowest.
- SED: This variable scores the extent of sediment delivery to the wetland from human activity, with no human activity affecting sediment delivery scored highest, and site entirely filled with sediment from human sources scored lowest.
- SPECRICH: Species richness. A complete species list was made at each site on the same stream terrace and within 50 m upstream and downstream of each transect.
- SUBIN: Subsurface flow. This variable scores subsurface flow into the wetland either from adjacent lands or upstream sources, with subsurface flow evident scored highest and subsurface flow not evident scored lowest. Evidence of subsurface flow, in the absence of surface water, was marsh vegetation (cattails, bulrushes, reeds).
- SURFIN: Surface inflow from sheetflow. This variable was evaluated relative to an imaginary well-functioning reference area of the same PWAA in a similar hydrogeomorphic position. The variable scores surface inflow present and similar to pristine area highest, and no surface inflow with channelization scored lowest.
- TOPO: Macro- and microtopographic relief. Roughness and relief increase wetland function, by slowing and retaining water flow across the surface. Macrotopography refers to large-scale features such as bars and swales. Microtopography refers to small-scale features such as

pit-and-mound and hummock-and-hollow. This variable was scored from 1 to 5, with a score of 1 indicating complex macro and micro topographic relief and a score of 5 indicating steep banks and channelization, variable not recoverable.

- VEGSTRATA: Number of vegetation layers present. This variable has 14 categories from broad leaved tree to biotic soil crust. The more categories present, the higher the score.
- WIS: Wetland indicator score. This variable was evaluated after data entry, and was based on the plant species present. The Corps publishes an online list of species for the state of Arizona (Lichvar et al. 2016), with scores reflecting the degree to which a moist wetland habitat is necessary for the species. The lowest score (i.e. most indicative of wetland conditions) among the species present at each transect was used for the variable WIS.

  Scores are:

  1. Obligate
  2. Facultative wetland
  3. Facultative upland
  4. Upland

2.2. GIS Methods

The following variables were evaluated by inspection of Google Earth imagery:

- BUFFWIDTH (distance in meters to nearest human disturbance)
- CONTIG (cover of contiguous vegetation between wetlands and uplands)
- FPA (flood prone area)
- LANDBUFF (calculated from LANDUSE and BUFFWIDTH)
- LANDUSE (type of adjacent land use)
- TRIB (presence of connected tributaries)

2.3. Data Entry and Analysis

The field data was entered into an Excel™ workbook, and the Variable Subindex Score (VSI, a number between 0 and 1) for each variable was calculated. The VSI values populated the formulas that calculated the FCI values for the ten wetland functions:

- CHANNELDYN: maintenance of characteristic channel dynamics
- WATSTORENR: dynamic surface water storage/energy dissipation
- WATSTORLNG: long-term surface water storage
- WATSTORSUB: dynamic subsurface water storage
- NUTRIENT: nutrient cycling

- ELEMENTS: detention of imported elements and compounds
- DETPARTICL: detention of particles
- PLANTS: maintain characteristic plant communities
- HABSTRUCT: maintain spatial structure of habitat
- INTERSPERS: maintain interspersion and connectivity

More detailed descriptions of these functions are included in the Corps report (Webb and Burks-Copes 2009) and provided in **Appendix B**.

The Model requires a breakdown of plant canopy cover into herbaceous, shrub, and tree species, but only defines trees as greater than 3 inches in diameter at breast height (Webb and Burks-Copes 2009). Shrubs were classified as perennial woody plants with persistent single or multiple stems less than 3 inches in diameter at breast height, and herbaceous species as perennial or annual non-woody plants with single or multiple stems that do not persist.

A spreadsheet was created that lists every species found in all sites, with an indication for each species whether it is an herb, shrub, tree, invasive, and its WIS, if available. Species were counted as invasive and included in the variable INVAS if they appeared on the lists of:

1. Plant species listed as noxious weeds by the state of Arizona (Arizona Department of Agriculture 2005), and
2. Other non-native plant species considered invasive in Arizona (Northam et al. 2016).

While TVV data was collected in the field by recording each species' contribution separately in 1-m by 20-dm cylinders; the data required by the Model is a single number, so all hits on all species were summed for entry into the data spreadsheets.

3. RESULTS AND DISCUSSION

3.1. Total Vegetation Volume

Comparisons of TVV index values by transect for the four sample periods are presented in **Table 1**, showing baseline data from June 2015 and post-discharge data from November-December 2015, November-December 2016, and November 2017.

Table 1. Total Vegetation Volume Index Summarized by Transect

Transect Number	Total Vegetation Volume Index, m^3/m^2			
	June 2015	November - December 2015	November - December 2016	November 2017
1	0	*	*	0.27
2	0.025	0.071	0.23	0.035
3	0.016	0	0.18	0.01
4	0.025	0.100	0.65	0.09
5	0.005	0.020	*	0.215
6	0.02	0.013	*	0.01
7	0.05	0.165	*	0.15
8	0.01	0.035	*	0.005
9	0.012	0.150	*	0.225
12	0.012	0	*	0.015
13	0.014	0.004	0.04	0.01
14	0.040	0.004	0.11	0
15	0.024	0	0.23	0.035
17	0.020	0	0.03	0.025
19	0.004	0	0.08	0.12
22	0.020	0	0.07	0.03
24	0.032	0	0.05	0.085
25	0.008	0.010	0.01	*
27	0.024	*	0.26	0.29
28	0.016	0	0.15	0.16
31	0.004	0	0.24	0.19
33	0.020	0.020	0.17	0.13
35	0	0	0	0.01
36	0.020	0	0.05	0
37	0.010	0.015	0.22	0.025
Average	0.017	0.0264	0.154	0.089

* Denotes transects that were not sampled during data collection.

The TVV values by transect of the most common woody species for each sampling period are presented in **Table 2**. All the woody species increased in volume over the study period; the greatest increase was in saltcedar (*Tamarix chinensis*).

Table 2. Total Vegetation Volume by Transect of Most Common Woody Species, June 2015, November-December 2015, November-December 2016, and November 2017

Transect	1	2	3	4	5	6	7	8	9	12	13	14	15	17	19	22	24	25	27	28	31	33	35	36	37
June 2015																									
Atriplex canescens	0	0.015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baccharis sarothroides	0	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isocoma pluriflora	0	0	0.008	0.005	0	0	0	0	0	0	0.06	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Prosopis velutina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.01	0	0	0
Tamarix chinensis	0	0	0.008	0.005	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.005	0
November-December 2015																									
Atriplex canescens	0	0.009	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baccharis sarothroides	0	0.011	0	0.070	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isocoma pluriflora	0	0.011	0	0	0	0	0	0	0	0	0	0.004	0	0	0	0	0	0	0	0	0	0	0	0	0
Prosopis velutina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.020	0	0	0.015
Tamarix chinensis	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
November-December 2016																									
Atriplex canescens	0	0.035	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baccharis sarothroides	0	0.005	0	0.03	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Isocoma pluriflora	0	0.065	0.065	0.125	0	0	0	0	0	0	0.015	0	0	0	0	0	0.015	0	0	0.065	0	0	0	0	0
Prosopis velutina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.065	0	0	0.1
Tamarix chinensis	0	0.01	0.025	0.17	0	0	0	0	0	0	0	0	0.115	0.015	0.04	0.035	0.01	0.005	0.13	0.01	0.12	0.02	0	0.025	0.01
November 2017																									
Atriplex canescens	0.155	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Baccharis sarothroides	0.01	0	0	0.07	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.03	0	0	0	0
Isocoma pluriflora	0	0.025	0.01	0	0.145	0.01	0.015	0.005	0	0	0	0	0.005	0	0	0	0.04	0	0	0.085	0	0	0	0	0
Prosopis velutina	0.04	0	0	0	0	0	0	0	0.21	0	0	0	0	0	0	0	0	0	0	0	0.03	0.095	0	0	0.005
Tamarix chinensis	0.065	0.01	0	0.02	0.07	0	0.105	0	0.015	0.015	0	0	0.03	0.025	0.12	0.03	0.045	0	0.27	0.075	0.13	0.035	0.01	0	0.02

3.2. Percent Cover

Comparisons of percent cover values of ground and plant cover categories averaged among transects during the four sample periods are presented in **Table 3**. There has been a decrease in bare ground, from 81.2 percent in June 2015 to 33.7 percent in November 2017. Herbaceous canopy cover has increased from 8.3 percent in June 2015 to 59.0 percent in November 2017, and shrub cover has increased from 3.3 percent to 10.5 percent.

Table 3. Percent Cover of All Categories of Ground Cover Averaged Across All Sampled Transects; June 2015, November-December 2015, November-December 2016, and November 2017

Ground Cover Categories	Average Percent Cover			
	June 2015	November - December 2015	November - December 2016	November 2017
Bare soil or rock	81.2	84.7	50.3	33.7
Litter	5.7	14.9	8.7	2.0
Herbaceous canopy	8.3	17.4	48.0	59.0
Shrub canopy	3.3	4.0	8.2	10.5

Comparisons of percent cover values of all plant species are presented in **Table 4**. The most notable changes, between June and November 2017 following the discharge of water in August 2015, were increases in herbaceous vegetation, mostly due to Bermudagrass (*Cynodon dactylon*), barnyard grass (*Echinochloa crus-galli),* and cattail (*Typha latifolia*). Cover of Bermudagrass averaged across all transects increased almost ten-fold, from 2.1 percent to 19.5 percent, and cover of barnyard grass increased from 0 to 17 percent (**Table 4**). The increase in cover of Bermudagrass and barnyard grass followed the discharge of water from MAR-5 and the summer rains. The increase in cattail cover, from 0 to 10 percent, can be directly attributed to the discharge from MAR-5, as it is an obligate wetland species (Lichvar et al. 2016) and is absent from the Gila River floodplain outside the discharge channel.

Table 4. Percent Cover of Live Vegetation; June 2015, November-December 2015, November-December 2016, and November 2017; Summarized by Species and Averaged Across All Sampled Transects

Species	Average Percent Cover			
	June 2015	November - December 2015	November - December 2016	November 2017
Ambrosia salsola	0	0.3	0.2	0.2
Amsinckia sp.	0	0.1	0	0
Atriplex canescens	0.3	0.2	0.2	0.4
Atriplex polycarpa	0.1	0.0	0.1	0
Atriplex rosea	4.3	0.0	11.0	0.9
Baccharis sarothroides	0.2	0.9	0.4	0.3
Bouteloua barbata	0	0.1	0.2	0
Brassica tournefortii	0	0.2	0	0
Camissonia sp.	0	0.3	0	0
Cynodon dactylon	2.1	11.4	13.4	19.5
Echinochloa crus-galli	0	0.3	5.2	16.9
Eclipta prostrata	0	0	0	4.2
Erodium cicutarium	0	0.3	0	0
Eriogonum sp.	0.1	0.0	2.5	0
Helianthus annuum	0	0	0	0.1
Heliotropium curassavicum	0	0	0.2	0
Isocoma pluriflora	1.1	1.2	2.8	2.3
Lactuca seriola	0	0	0	0.1
Leptochloa fulca	0	0	2.2	4.5
Pennisetum ciliaris	0	0.6	0.5	0.2
Prosopis velutina	0.6	1.0	0.3	1.6
Rumex sp.	0	0.0	1.7	0
Salsola tragus	1.6	1.3	7.0	1.5
Sonchus sp.	0	0.1	0	0
Sporobolus cryptandrus	0	0.1	0.3	0.1
Sphaeralcea sp.	0.1	0.1	0	0.1
Tamarix aphylla	0	0	0	0.1
Tamarix chinensis	1	0.3	4.2	5.6
Tidestromia lanuginosa	0	0.1	0	0.5
Tiquilia plicata	0.1	0.4	0.4	0.1
Typha latifolia	0	0	3.2	10.3
Unknown annual forb	0	0.2	0.1	0
Unknown annual grass	0	1.8	0	0

3.3. Belt Density

Comparisons of belt density of woody species by transect are presented in **Table 5**. To enable comparison across sampling periods, **Table 5** does not include shrubs less than 0.5 m high, as this data was only collected in November 2016 and 2017. Comparisons of belt density of woody species by species are presented in **Table 6**. Height class data for the seven most common woody species, averaged across all transects sampled in November 2017, is presented in **Table 7**.

Table 5. Total Woody Plant Density (Number of Plants >50 cm High Per Hectare) by Transect, June 2015, November-December 2015, November 2016, and November 2017

Transect	June 2015 *	Nov 2015	Nov 2016	Nov 2017
1	365	not sampled	not sampled	1050
2	1053	1093	3200	653
3	800	640	1490	750
4	914	900	1120	557
5	325	100	not sampled	1300
6	1286	1200	not sampled	457
7	320	1240	not sampled	1240
8	367	467	not sampled	267
9	100	250	not sampled	1200
10	100	0	not sampled	not sampled
11	0	0	not sampled	not sampled
12	171	114	not sampled	286
13	120	360	1160	40
14	0	280	not sampled	not sampled
15	0	0	6467	400
17	0	0	1333	267
19	0	0	1840	320
22	0	0	1750	700
24	0	100	7400	1000
25	0	200	1800	not sampled
27	0	0	6200	1600
28	100	0	1320	800
31	80	160	2560	640
33	0	0	800	700
35	400	0	400	533
36	100	100	1300	500
37	0	0	0	300

* June data was adjusted for any shortening of transects in November-December 2015 and November 2017.

Table 6. Woody Plant Density (Plants >50 cm Height Per Hectare) of Most Common Species Averaged Across All Sampled Transects, June 2015, November-December 2015, November-December 2016, and November 2017

Species	Belt Density (no. of plants per hectare)			
	June 2015 * (Baseline)	November - December 2015 (Post-discharge)	November - December 2016	November 2017
Ambrosia salsola	7	19	12	237
Atriplex canescens	18	20	20	95
Baccharis sarothroides	19	28	128	40
Isocoma pluriflora	158	207	524	149
Prosopis velutina	7	15	1	59
Salix gooddingii	0	0	87	12
Tamarix chinensis	11	6	1514	352
All woody species	244	300	2230	677

* June data was adjusted for any shortening of transects in November-December 2015 and November 2017.

From June 2015, before the initiation of MAR-5 discharge, to November-December 2015, all woody species increased in density, except for four-wing saltbush (*Atriplex canescens*) and saltcedar. In the period November 2015 to November 2016 desert broom (*Baccharis sarothroides*), jimmyweed (*Isocoma pluriflora*), Goodding's willow (*Salix gooddingii*), and saltcedar showed sharp increases in density, while mesquite showed a sharp decrease. The anomalously high-density data in 2016 may have been due to a mistaken sampling procedure: the rule of thumb for counting nearby plants as individuals was that each should be at least 1 m from a conspecific. This rule may not have been observed by the field crew in 2016, resulting in an overcount. The anomalous data for mesquite can be explained by the lack of data from transects that were not sampled in 2016 (transects 1, 5, 6, 7, 8, 9, and 12) in four of which mesquite had been present in 2015. Its large increase in 2017 was real, as it appeared for the first time in nine transects.

Table 7. Woody Plant Density (plants per hectare) by Height Class of Most Common Species Averaged across All Transects Sampled in November 2017

Species	Belt Density (no. of plants per hectare) by Height Class				
	< 20 cm	21-50 cm	51-100 cm	101-200 cm	>200 cm
Ambrosia salsola	0	2	18	13	1
Atriplex canescens	0	0	2	12	3
Baccharis sarothroides	0	3	14	19	3
Isocoma pluriflora	6	75	90	49	1
Prosopis velutina	9	24	10	5	11
Salix gooddingii	0	0	0	4	8
Tamarix chinensis	0	16	115	170	94

In the height class distribution shown in **Table 7**, a large proportion of plants of a given species in the smaller height classes (presumably younger individuals) indicates a growing population. Among these species, jimmyweed and mesquite show the most potential for population growth, with 37 percent and 57 percent respectively of their populations in the smaller two height classes. Goodding's willow, probably the most desirable tree species to become established in the wetted area (Webb and Burks-Copes 2009), has a low potential for increase given the small number of saplings present and the high cover of Bermuda grass in the wetter portions of the site as bare ground is required for willow recruitment (Stromberg 1993). Numerous willow saplings that had recently died were observed, probably a result of the fluctuations in ground water levels. Moist soils throughout the growing season are necessary for the establishment of willow recruits (Lite and Stromberg 2005, Stromberg 1993), and water stress effects are often most pronounced in the juveniles of a species (Lite and Stromberg 2005, Stromberg 1997).

3.4. INVASIVE SPECIES

Several species classified as non-native invasive plant to Arizona (Northam et al. 2016) occur in the GRIC MAR-5 study area, including buffelgrass (*Pennisetum ciliaris*), Sahara mustard (*Brassica tournefortii*), filaree (*Erodium cicutarium*), Bermudagrass, saltcedar, Athel tamarisk (*Tamarix aphylla*), Russian thistle, *Sonchus* sp., Mediterranean grass (*Schismus barbatus*), and barnyard grass. Bermudagrass, barnyard grass, and saltcedar have shown substantial increases in cover since the initiation of discharge in 2015 (**Table 5**).

3.5. HYDROLOGICAL VARIABLES

The field variables used in the Model were evaluated during fieldwork in November-December 2015, November-December 2016, and November 2017. The field and GIS variable values were converted to VSI scores and used to calculate the FCI scores for the three years. The overall averages of the FCI scores are presented in **Table 8**, as well as the FCU values (FCI multiplied by acreage). The slight increase in FCI score from 2015 to 2017 indicates that the site is approaching a moderate functional capacity (Burks-Copes and Webb 2003). Note that modifications to the MAR-5 discharge facility in 2017 resulted in an increased wetted area, which diverted water away from the established transects.

Table 8. Functional Capacity Index (FCI) Scores Averaged across All Sites and Functions, and FCU Values for the Entire Wetted Areas, Compared across All Sampling Periods

Category	November - December 2015	November - December 2016	November 2017
Overall Average FCI	0.44	0.61	0.47
Wetted acreage	53.9	53.9	123.4
FCU	23.7	32.9	58.0

The FCI scores for the hydrological functions evaluated at the transects in November-December 2015, November-December 2016, and November 2017 are provided in **Appendix C**. FCIs are scored from 0 to 1, with "1" considered a well-functioning wetland (riparian) site (Webb and Burks-Copes 2009). A comparison among years of FCI values for wetland functions averaged among all sample transects is provided in **Table 9**.

Table 9. Comparison Between Years of FCI Values Averaged across All Transects

Code	Name	2015	2016	2017
CHANNELDYN	Function 1: Maintenance of Characteristic Channel Dynamics	0.64	0.84	0.42
WATSTORENR	Function 2: Dynamic Surface Water Storage/Energy Dissipation	0.81	0.94	0.80
WATSTORLNG	Function 3: Long Term Surface Water Storage	0.51	0.92	0.66
WATSTORSUB	Function 4: Dynamic Subsurface Water Storage	0.50	0.50	0.50
NUTRIENT	Function 5: Nutrient Cycling	0.09	0.18	0.12
ELEMENTS	Function 6: Detention of Imported Elements and Compounds	0.32	0.51	0.41
DETPARTICL	Function 7: Detention of Particles	0.52	0.72	0.51
PLANTS	Function 8: Maintain Characteristic Plant Communities	0.17	0.50	0.47
HABSTRUCT	Function 9: Maintain Spatial Structure of Habitat	0.38	0.44	0.38
INTERSPERS	Function 10: Maintain Interspersion and Connectivity	0.40	0.51	0.40
	Average	**0.44**	**0.61**	**0.47**

The low FCI scores (less than 0.50) for most of the functions in **Table 9** indicate that, according to the Model, the GRIC MAR-5 site is presently not considered a well-functioning wetland (riparian) site. However, the site had just been recently tested with only 1 to 2 growing seasons, as such, it is expected that there would be significant potential for improvement. The water storage functions (Functions 2 - 4) will continue to improve with continued discharge from MAR-5. The CHANNELDYN, HABSTRUCT and INTERSPERS FCI scores will increase as more heterogenous habitats and contiguous areas of food and cover for wildlife develop with continued discharge of water into the channel. Likewise, the ELEMENT and NUTRIENT FCI scores will increase as plants colonize the wetted area and associated floodplain, and produce litter, fine and coarse woody debris, and increase the canopy and volume of vegetation.

The preponderance of invasive plants (see **Section 3.4**) will continue to depress FCI scores for the function PLANTS (maintenance of characteristic plant communities). However, with the implementation of an invasive species management plan the score would be likely to improve. Several functions involve the variable Flood Prone Area (FPA), which measures the degree to which the stream is confined within a man-made channel or gully. Eleven of the 24 study transects sampled in 2017 were scored as 4, defined as "FPA is confined and <1.5 bankfull width", indicating that the stream reach was confined in a gully. Discharge from MAR-5 has evidently scoured the channel in numerous areas, and continues to aggravate the gullying problem. However, the construction of a three-way flow splitter box in 2017 and subsequent distribution of water into a secondary channel and tertiary pond has markedly improved the channeling problem and distributed the flow over a larger area.

4. SUMMARY

The initiation of water discharge from MAR-5 into the Gila River in August 2015 created a strip of wetland, called the "wetted area", that varied in width and degree of saturation with the amount of discharge and distance from the source. The pre-discharge vegetation of the area was a sparse collection of upland woody shrubs (four-wing saltbush, mesquite, jimmyweed, desert broom) with desert forbs (*Atriplex rosea, Tiquilia plicata,* and Russian thistle) and Bermudagrass. Saltcedar and Athel Tamarix were present at low cover. There were no cattails. After a few months of discharge, the water was turned off and the area was re-sampled in late November-early December 2015, by which time the cover of Bermudagrass had increased almost ten-fold, barnyard grass had become common, and the woody shrubs had increased in cover and density.

The area was re-sampled a year later in November-December 2016. Bermudagrass and barnyard grass continued to increase in cover, while cattails and the grass Mexican sprangletop (*Leptochloa fusca*) became common. Russian thistle was very common, and had increased in cover from 1.6 percent before discharge to 7.0 percent. Jimmyweed and the invasive saltcedar increased in cover, density, and volume. Thousands of saltcedar recruits had appeared since the previous year.

The data recorded in November 2017 showed a continuation of these trends. The grasses Bermudagrass, barnyard grass, and Mexican sprangletop together with cattails contributed over 50-percent cover, as contrasted to the total herbaceous cover of 8.3 percent in June 2015. Shrub cover for most species was steady or had declined slightly, except for saltcedar. The density of saltcedars had increased from 11 to 352 per hectare over the period June 2015 to November 2017.

Vegetation cover decreases with distance downstream from the MAR-5 discharge site, from an average cover of 86 percent in the six transects closest to MAR-5 to 33 percent in the farthest six. The most distant transect (Transect 37) had only 11-percent vegetation cover in November 2017.

The modification to the MAR-5 discharge facility in 2017 resulted in an increase in the wetted area from 53.9 to 123.4 acres; however, the amount of discharge was not increased.

Future discharge of water will probably result in increased production of vegetation in the wetted area, especially of cattails, Bermudagrass, barnyard grass, saltcedar, and mesquite. Upland woody species, including jimmyweed, desert broom, and saltbush, may decline in the wetted area because they cannot tolerate frequent inundation (Stromberg 1993). More desirable species, such as Goodding's willow, may require a shorter dry period to become established and persist (Lite and Stromberg 2005, Stromberg 1997).

5. REFERENCES

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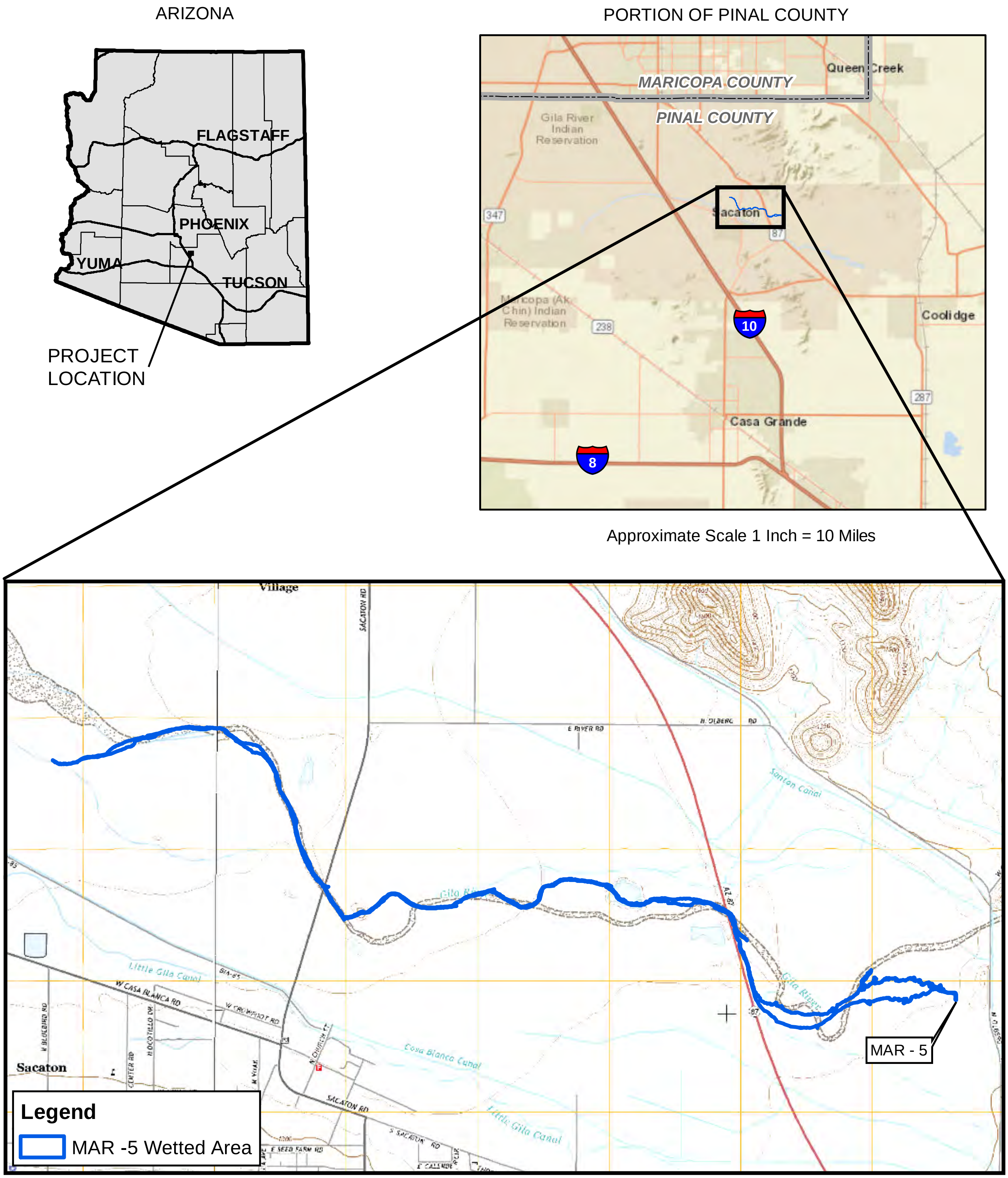
FIGURES



MAR-5 Wetted Area in
T4S, R6E, Portions of Sections 8-11, 13, and 14,
Pinal County, Arizona,
Sacaton and Gila Butte SE USGS 7.5' Quadrangles (2014)
Image Source: ArcGIS Online, World Street Map

RESOLUTION COPPER GRIC MAR-5

2017 Vegetation Monitoring Memo

VICINITY MAP

Figure 1

N

0 1,800 3,600 Feet

0 600 1,200 Meters

WestLand Resources

Path: M:\Jobs\800's\807.131\ENV\GRIC\Gric_MAR5_2017VegMonitoringMemo\MXD\FIG2_GRIC_MAR5_VegMon2015.mxd Date: 3/21/2018 User: rwitzke

WestLand Resources

T4S, R6E, Portions of Sections 9-11, 13, and 14,
Pinal County, Arizona,
Gila Butte and Sacaton USGS 7.5' Quadrangles
Projection: UTM NAD83, Zone 12
Photo Source: ArcGIS Online

0 600 1,200 Feet
0 200 400 Meters

N

Legend

- Stake Locations
- Transect Locations
- MAR 5 100cfs Predicted Wetted Area

RESOLUTION COPPER GRIC MAR - 5
2017 Vegetation Monitoring Memo

VEGETATION MONITORING TRANSECTS - JUNE 2015
Figure 2

WestLand Resources

Wetted Area found within:
T4S, R6E, Portions of Sections 8-11, 13, and 14,
Pinal County, Arizona.
Image Source: 2015 USDA NAIP Orthophoto
Data Sources: BLM PLSS section data, GRIC BIA
Allotment data provided by Paul Shorthair, Land Use Ordinance Officer.
Department of Land Use Planning and Zoning, Gila River Indian Community.
We received 4 scanned images from Paul Shorhair. They were rectified to the NAIP 2015 imagery and the red lines on these maps were delineated as BIA Allotment Lines

N

0 800 1,600 Feet

0 0.25 0.5 Miles

Legend

- Access Point
- Transect Point 2016
- AccessRoute
- Transect Line 2016
- Approximate BIA Allotment Lines
- MAR -5 Wetted Area
- PLSSFirstDivision (Sections)

RESOLUTION COPPER GRIC MAR - 5
2017 Vegetation Monitoring Memo

VEGETATION MONITORING TRANSECTS - NOVEMBER 2016
Figure 3

Path: M:\Jobs\800's\807.131\ENV\GRIC\Gric_MAR5_2017VegMonitoringMemo\MXD\Fig04_GRIC_MAR_5_Vegetation_Monitoring.mxd Date: 3/21/2018 User: rwitzke

T4S, R6E, Portions of Sections 8 - 14,
Pinal County, Arizona.
Gila Butte SE and Sacaton USGS 7.5' Quadrangles
Image Source: Pleiades Satellite Imagery 10/28/2017

Legend

- Transect Line
- MAR-5 Wetted Area

RESOLUTION COPPER GRIC MAR-5
2017 Vegetation Monitoring Memo

VEGETATION MONITORING TRANSECTS - NOVEMBER 2017
Figure 4

WestLand Resources

0 750 1,500 Feet
0 250 500 Meters

N

APPENDIX A

Repeat Photographic Documentation of Vegetation Monitoring Transects

Photo 1. Transect 1a, 10 degrees. June 2015

Photo 2. Transect 1a, 90 degrees. November 2015

Photo 3. Transect 1a, 90 degrees. November/December 2016

Photo 4. Transect 1a, 10 degrees. November 2017

Photo 5. Transect 2a, 23 degrees. June 2015

Photo 7. Transect 2a, 340 degrees. November 2016

Photo 6. Transect 2a, 23 degrees. November 2015

Photo 8. Transect 2a, 345 degrees. November 2017

Photo 9. Transect 3a, 10 degrees. June 2015

Photo 11. Transect 3a, 10 degrees. November 2016

Photo 10. Transect 3a, 10 degrees. November 2015

Photo 12. Transect 3a, 10 degrees. November 2017

Photo 13. Transect 4a, 342 degrees. June 2015

Photo 14. Transect 4a, 315 degrees. November 2015

Photo 15. Transect 4a, 340 degrees. November 2016

Photo 16. Transect 4a, 315 degrees. November 2017

Photo 17. Transect 5a, 0 degrees. June 2015

Photo 19. Transect 5a, 0 degrees. November 2016

Photo 18. Transect 5a, 0 degrees. November 2015

Photo 20. Transect 5a, 330 degrees. November 2017

Photo 21. Transect 6a, 340 degrees. June 2015

Photo 23. Transect 6a, 340 degrees. November 2016

Photo 22. Transect 6a, 340 degrees. November 2016

Photo 24. Transect 6a, 340 degrees. November 2017

Photo 25. Transect 7a, 158 degrees. June 2015

Photo 26. Transect 7a, 158 degrees. November 2015

Photo 27. Transect 7a, 158 degrees. November 2016

Photo 28. Transect 7a, 158 degrees. November 2017

Photo 29. Transect 8a, 80 degrees. June 2015

Photo 30. Transect 8a, 80 degrees. November 2015

Photo 31. Transect 8a, 80 degrees. November 2016

Photo 32. Transect 8a, 30 degrees. November 2017

WestLand Resources

Photo 33. Transect 9a, 72 degrees. June 2015

Photo 34. Transect 9a, 72 degrees. November 2015

Photo 35. Transect 9a, 72 degrees. November 2016

Photo 36. Transect 9a, 60 degrees. November 2017

Photo 37. Transect 10a, 86 degrees. June 2015

Photo 38. Transect 10a, 90 degrees. November 2015

Photo 39. Transect 10a, 90 degrees. November 2016

Photo 40. Transect 11a, 82 degrees. June 2015

Photo 41. Transect 11a, 90 degrees. November 2015

Photo 42. Transect 11a, 90 degrees. November 2016

Photo 43. Transect 12a, 67 degrees. June 2015

Photo 44. Transect 12a, 67 degrees. November 2015

Photo 45. Transect 12a, 67 degrees. November 2016

Photo 46. Transect 12a, 67 degrees. November 2017

Photo 47. Transect 13a, 5 degrees. June 2015

Photo 48. Transect 13a, 5 degrees. November 2015

Photo 49. Transect 13a, 5 degrees. November 2016

Photo 50. Transect 13a, 5 degrees. November 2017

Photo 51. Transect 14a, 0 degrees. June 2015

Photo 52. Transect 14a, 0 degrees. November 2015

Photo 53. Transect 14a, 0 degrees. November 2016

Photo 54. Transect 14a, 340 degrees. November 2016

Photo 55. Transect 15a, 350 degrees. June 2015

Photo 56. Transect 15a, 350 degrees. November 2015

Photo 57. Transect 15a, 350 degrees. November 2016

Photo 58. Transect 15a, 340 degrees. November 2017

Photo 59. Transect 17a, 40 degrees. June 2015

Photo 61. Transect 17a, 40 degrees. November 2016

Photo 60. Transect 17a, 40 degrees. November 2015

Photo 62. Transect 17a, 10 degrees. November 2017

Photo 63. Transect 19a, 320 degrees. June 2015

Photo 65. Transect 19a, 320 degrees. November 2016

Photo 64. Transect 19a, 320 degrees. November 2015

Photo 66. Transect 19a, 305 degrees. November 2017

Photo 67. Transect 22a, 335 degrees. June 2015

Photo 68. Transect 22a, 335 degrees. November 2015

Photo 69. Transect 22a, 335 degrees. November 2016

Photo 70. Transect 22a, 310 degrees. November 2017

Photo 71. Transect 24a, 350 degrees. June 2015

Photo 72. Transect 24a, 350 degrees. November 2015

Photo 73. Transect 24a, 350 degrees. November 2016

Photo 74. Transect 24a, 340 degrees. November 2017

Photo 75. Transect 25a, 10 degrees. June 2015

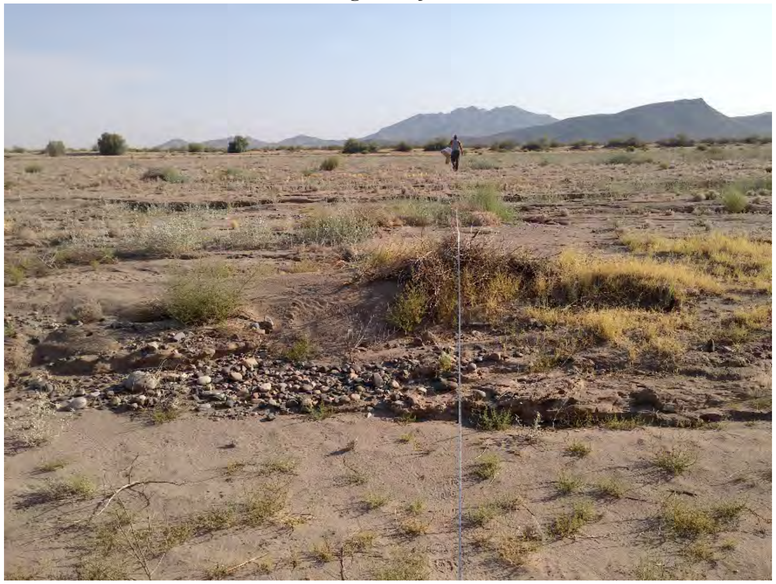


Photo 76. Transect 25a, 10 degrees. November 2015

Photo 77. Transect 25a, 10 degrees. November 2016

Photo 78. Transect 27a, 328 degrees. June 2015

Photo 79. Transect 27a, 328 degrees. November 2015

Photo 80. Transect 27a, 328 degrees. November 2016

Photo 81. Transect 27a, 320 degrees. November 2017

Photo 82. Transect 28a, 333 degrees. June 2015

Photo 83. Transect 28a, 333 degrees. November 2015

Photo 84. Transect 28a, 333 degrees. November 2016

Photo 85. Transect 28a, 340 degrees. November 2017

Photo 86. Transect 31a, 50 degrees. June 2015

Photo 87. Transect 31a, 50 degrees. November 2015

Photo 88. Transect 31a, 50 degrees. November 2016

Photo 89. Transect 31a, 60 degrees. November 2017

Photo 90. Transect 33a, 54 degrees. June 2015

Photo 91. Transect 33a, 54 degrees. November 2015

Photo 92. Transect 33a, 54 degrees. November 2016

Photo 93. Transect 33a, 60 degrees. November 2017

Photo 94. Transect 35a, 48 degrees. June 2015

Photo 95. Transect 35a, 48 degrees. November 2015

Photo 96. Transect 35a, 48 degrees. November 2016

Photo 97. Transect 35a, 40 degrees. November 2017

Photo 98. Transect 36a, 324 degrees, June 2015

Photo 99. Transect 36a, 324 degrees. November 2015

Photo 100. Transect 36a, 20 degrees. November 2016

Photo 101. Transect 36a, 20 degrees. November 2017

Photo 102. Transect 37a, 0 degrees. June 2015

Photo 104. Transect 37a, 0 degrees. November 2016

Photo 103. 37a, 0 degrees. November 2015

Photo 105. Transect 37a, 10 degrees. November 2017

APPENDIX B

Table 2 from Tres Rios del Norte (Pima County, Arizona) Ecosystem Restoration Functional Assessment Using HGM, December 2003, Analyses, Results, and Documentation Draft Report

Table 2. Functions in the Arizona Riverine HGM Model

Code	Name	Description
CHANNELDYN	Function 1: Maintenance of Characteristic Channel Dynamics	Physical processes and structural attributes that maintain characteristic channel dynamics. These include flow characteristics, bedload, in-channel coarse woody debris, and potential coarse woody debris inputs, channel dimensions, and other physical features (e.g. bank vegetation, slope).
WATSTORENR	Function 2: Dynamic Surface Water Storage/Energy Dissipation	Dynamic water storage and dissipation of energy at bankfull and greater discharges. These are a function of channel width, depth, bedload, bank roughness (coarse woody debris, vegetation, etc.), presence and number of in-channel coarse woody debris jams, and connectivity to off-channel pits, ponds, and secondary channels.
WATSTORLNG	Function 3: Long Term Surface Water Storage	The capability of a wetland to temporarily store (retain) surface water for long durations; associated with standing water not moving over the surface. Water sources may be overbank flow, overland flow, and/or channelized flow from uplands, or direct precipitation.
WATSTORSUB	Function 4: Dynamic Subsurface Water Storage	Availability of water storage beneath the wetland surface. Storage capacity becomes available due to periodic drawdown of water table.
NUTRIENT	Function 5: Nutrient Cycling	Abiotic and biotic processes that convert elements from one form to another; primarily recycling processes.
ELEMENTS	Function 6: Detention of Imported Elements and Compounds	The detention of imported nutrients, contaminants, and other elements or compounds.
DETPARTICL	Function 7: Detention of Particles	Deposition and detention of inorganic and organic particulates (>0.45 um) from the water column, primarily through physical processes.
PLANTS	Function 8: Maintain Characteristic Plant Communities	Species composition and physical characteristics of living plant biomass. The emphasis is on the dynamics and structure of the plant community as revealed by the species of TVVs, shrubs, seedlings, saplings, and herbs and by the physical characteristics of the vegetation.
HABSTRUCT	Function 9: Maintain Spatial Structure of Habitat	The capacity of a wetland to support animal populations and guilds by providing heterogeneous habitats.
INTERSPERS	Function 10: Maintain Interspersion and Connectivity	The capacity of the wetland to permit aquatic organisms to enter and leave the wetland via permanent of ephemeral surface channels, overbank flow, or unconfined hyporheic gravel aquifers. The capacity of the wetland to permit access of terrestrial or aerial organisms to contiguous areas of food and cover.

APPENDIX C

Functional Capacity Index (FCI) Scores of Functions Evaluated, for all Sampling Periods

Appendix C. Functional Capacity Index (FCI) Scores[1] of Functions Evaluated for all Sampling Periods[2]

Transect	CHANNELDYN	WATSTORENR	WATSTORLNG	WATSTORSUB	NUTRIENT	ELEMENTS	DETPARTICL	PLANTS	HABSTRUCT	INTERSPERS	Average
November-December 2015											
1	-	-	-	-	-	-	-	-	-	-	-
2	0.25	0.57	0.50	0.50	0.13	0.35	0.28	0.23	0.23	0.23	0.33
3	0.25	0.57	0.50	0.50	0.08	0.30	0.28	0.20	0.20	0.23	0.31
4	0.50	1.000	0.50	0.50	0.37	0.41	0.67	0.62	0.63	0.52	0.57
5	0.25	0.55	0.50	0.50	0.07	0.31	0.28	0.14	0.20	0.23	0.30
6	0.58	0.55	0.50	0.50	0.07	0.31	0.32	0.22	0.21	0.23	0.35
7	0.50	0.59	0.50	0.50	0.28	0.40	0.34	0.22	0.24	0.23	0.38
8	0.50	0.56	0.50	0.50	0.08	0.32	0.31	0.27	0.23	0.23	0.35
9	0.50	0.65	0.60	0.50	0.19	0.39	0.45	0.13	0.23	0.25	0.39
12	0.50	0.61	0.69	0.50	0.04	0.25	0.44	0.10	0.23	0.25	0.36
13	0.50	0.55	0.50	0.50	0.02	0.30	0.30	0.12	0.22	0.23	0.32
14	0.67	0.73	0.50	0.50	0.04	0.31	0.42	0.21	0.23	0.23	0.38
15	0.83	0.99	0.50	0.50	0.03	0.30	0.67	0.33	0.64	0.71	0.55
17	0.83	0.99	0.50	0.50	0.03	0.31	0.67	0.00	0.55	0.71	0.51
19	0.67	1.000	0.50	0.50	0.04	0.30	0.68	0.00	0.66	0.71	0.51
22	0.83	0.99	0.50	0.50	0.05	0.32	0.68	0.31	0.57	0.71	0.55
24	0.83	0.99	0.50	0.50	0.05	0.31	0.68	0.20	0.67	0.71	0.55
27	-	-	-	-	-	-	-	-	-	-	-
28	0.83	0.99	0.50	0.50	0.06	0.33	0.68	0.00	0.18	0.25	0.43
31	0.83	0.99	0.50	0.50	0.04	0.27	0.67	0.07	0.23	0.23	0.43
33	0.83	0.99	0.50	0.50	0.06	0.32	0.67	0.10	0.23	0.23	0.44
35	0.83	0.99	0.50	0.50	0.08	0.31	0.67	0.00	0.65	0.64	0.52
36	0.83	0.99	0.50	0.50	0.04	0.30	0.67	0.16	0.60	0.60	0.52
37	0.83	0.99	0.50	0.50	0.06	0.33	0.67	0.20	0.62	0.52	0.52
Average	**0.64**	**0.81**	**0.51**	**0.50**	**0.09**	**0.32**	**0.52**	**0.17**	**0.38**	**0.40**	**0.44**
November-December 2016											
1	-	-	-	-	-	-	-	-	-	-	-
2	0.58	0.66	0.84	0.50	0.30	0.53	0.45	0.30	0.23	0.25	0.46
3	0.58	0.65	0.84	0.50	0.22	0.46	0.44	0.29	0.23	0.25	0.45
4	0.58	0.72	0.84	0.50	0.57	0.68	0.48	0.32	0.23	0.25	0.52

Appendix C. Functional Capacity Index (FCI) Scores[1] of Functions Evaluated for all Sampling Periods[2]

Transect	CHANNELDYN	WATSTORENR	WATSTORLNG	WATSTORSUB	NUTRIENT	ELEMENTS	DETPARTICL	PLANTS	HABSTRUCT	INTERSPERS	Average
13	0.58	0.62	0.97	0.50	0.05	0.46	0.43	0.26	0.22	0.25	0.44
14	0.67	0.79	0.97	0.50	0.13	0.50	0.56	0.27	0.23	0.25	0.49
15	1.00	1.00	0.97	0.50	0.24	0.58	0.84	0.65	0.64	0.78	0.73
17	1.00	1.00	0.97	0.50	0.04	0.46	0.82	0.89	0.64	0.78	0.71
19	1.00	1.00	0.97	0.50	0.08	0.48	0.82	0.55	0.63	0.78	0.68
22	1.00	1.00	0.97	0.50	0.07	0.48	0.82	0.88	0.63	0.78	0.72
24	1.00	1.00	0.97	0.50	0.09	0.46	0.83	0.75	0.65	0.78	0.71
27	1.00	1.00	0.97	0.50	0.24	0.60	0.84	0.76	0.63	0.78	0.74
28	0.83	1.00	0.91	0.50	0.16	0.50	0.83	0.22	0.23	0.28	0.55
31	0.83	1.00	0.91	0.50	0.28	0.56	0.83	0.23	0.22	0.25	0.57
33	1.00	1.00	0.97	0.50	0.25	0.54	0.84	0.25	0.23	0.25	0.59
35	1.00	1.00	0.91	0.50	0.05	0.41	0.83	0.72	0.66	0.71	0.68
36	0.83	1.00	0.84	0.50	0.06	0.41	0.80	0.58	0.59	0.67	0.63
37	0.83	1.00	0.84	0.50	0.22	0.52	0.82	0.54	0.59	0.60	0.65
Average	**0.84**	**0.94**	**0.92**	**0.50**	**0.18**	**0.51**	**0.72**	**0.50**	**0.44**	**0.51**	**0.61**
November 2017											
1	0.25	0.67	0.77	0.50	0.31	0.52	0.45	0.31	0.24	0.25	0.43
2	0.25	0.56	0.65	0.50	0.15	0.37	0.29	0.29	0.24	0.23	0.35
3	0.25	0.55	0.65	0.50	0.05	0.36	0.28	0.31	0.23	0.23	0.34
4	0.25	0.57	0.65	0.50	0.15	0.41	0.30	0.30	0.24	0.23	0.36
5	0.42	0.60	0.77	0.50	0.22	0.54	0.32	0.31	0.22	0.23	0.41
6	0.50	0.55	0.65	0.50	0.04	0.36	0.30	0.31	0.23	0.23	0.37
7	0.50	0.58	0.65	0.50	0.21	0.45	0.32	0.31	0.23	0.23	0.40
8	0.50	0.55	0.65	0.50	0.08	0.35	0.31	0.27	0.23	0.23	0.37
9	0.25	0.60	0.65	0.50	0.22	0.49	0.29	0.29	0.22	0.23	0.38
12	0.25	0.55	0.65	0.50	0.01	0.36	0.27	0.31	0.22	0.23	0.34
13	0.25	0.55	0.65	0.50	0.05	0.36	0.28	0.29	0.23	0.23	0.34
14	0.50	0.72	0.65	0.50	0.00	0.35	0.39	0.27	0.22	0.23	0.38
15	0.50	0.99	0.65	0.50	0.07	0.37	0.65	0.89	0.65	0.71	0.60
17	0.50	0.99	0.65	0.50	0.04	0.37	0.65	0.85	0.64	0.71	0.59
19	0.50	1.00	0.65	0.50	0.14	0.43	0.66	0.75	0.64	0.71	0.60

Appendix C. Functional Capacity Index (FCI) Scores[1] of Functions Evaluated for all Sampling Periods[2]

Transect	CHANNELDYN	WATSTORENR	WATSTORLNG	WATSTORSUB	NUTRIENT	ELEMENTS	DETPARTICL	PLANTS	HABSTRUCT	INTERSPERS	Average
22	0.50	0.99	0.65	0.50	0.07	0.37	0.66	0.84	0.66	0.71	0.59
24	0.50	1.00	0.65	0.50	0.15	0.41	0.68	0.80	0.69	0.71	0.61
27	0.50	1.00	0.65	0.50	0.31	0.54	0.68	0.82	0.65	0.71	0.64
28	0.50	1.00	0.65	0.50	0.23	0.45	0.71	0.27	0.25	0.25	0.48
31	0.50	1.00	0.65	0.50	0.22	0.47	0.67	0.25	0.23	0.23	0.47
33	0.50	1.00	0.77	0.50	0.12	0.43	0.78	0.23	0.22	0.25	0.48
35	0.50	0.99	0.58	0.50	0.02	0.33	0.64	0.81	0.63	0.64	0.56
36	0.50	1.00	0.69	0.50	0.04	0.33	0.77	0.67	0.61	0.67	0.58
37	0.50	1.00	0.69	0.50	0.06	0.34	0.77	0.50	0.60	0.60	0.56
Average	**0.42**	**0.80**	**0.66**	**0.50**	**0.12**	**0.41**	**0.51**	**0.47**	**0.38**	**0.40**	**0.47**

1 Scores range from 0 to 1, based on similarity to well-functioning reference sites; see **Appendix B** for description of functions.

2 Rows with no scores were not sampled during that period.

APPENDIX B

AGFD Letter to Resolution Copper on the Lower San Pedro River Wildlife Area In-Lieu Fee Program

(Dated April 15, 2019)

April 15, 2019

Vicki Peacey
Senior Manager Permits & Approvals
Resolution Copper
102 Magma Heights
Superior, AZ 85173

Ms. Peacey,

The Department maintains an In-Lieu-Fee (ILF) program for Army Corps of Engineers (ACOE) 404 permit mitigation in an effort to facilitate economic development while ensuring conservation of Arizona's natural resources. One of the ILF programs maintained by the Department is located on the Lower San Pedro River Wildlife Area (LSPRWA). Your organization has expressed interest in purchasing mitigation credits within this ILF site. As we have discussed, all Advanced Credits at our LSPRWA ILF site have been sold or obligated for sale.

That said, the first set of Project Specific Credits will become available after the site has met established performance standards for the first 50 Advanced Credits and full approval of the Development Plan is obtained from the ACOE. At this time, we anticipate full sale of the Advanced Credits will be completed by the end of calendar 2019 with the Development Plan submitted the ACOE in calendar 2020. The full conservation of the LSPRWA site will be implemented in phases to ensure ecological performance standards are being met and ACOE approvals obtained for each phase. The Department's LSPRWA has five phases of 130 credits each accounting for a total of 650 credits. These credit releases will be available for purchase over time and will be available to anyone requiring mitigation credits.

I want to thank you and your staff for taking the time to make the Department's staff aware of your program development and look forward to a continued excellent relationship with Resolution. Further, as the Department's obligation for prior credit commitments are fully met, the Department will consider making future credits available to Resolution Copper and other entities in need of mitigation credits. Additionally, the Department would like to offer assistance in working with Resolution Copper to investigate other mitigation opportunities as a result of project implementation of your mining plan of development,

Again, thanks for your organization's positive working approach with the Department.

Sincerely,

Jim deVos
Assistant Director Wildlife Management Division

Cc:

Craig McMullen, Assistant Director Field Operations Division
Jay Cook, Regional Supervisor Mesa
Keith Knutson, Chief Wildlife Contracts
Clayton Crowder, Chief Habitat Branch

AGFD #M19-04014607