



Final Report

Santa Cruz River Restoration Master Plan: Oso Wash to Green Valley

Prepared for
SONORAN INSTITUTE

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Expect More. Experience Better.



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1 EXECUTIVE SUMMARY

The Santa Cruz River Restoration Master Plan establishes a long-term framework for evaluating, prioritizing, and implementing restoration and rehabilitation opportunities along approximately 40 stream miles of the Upper Santa Cruz River corridor from Oso Wash and the International Border north to Green Valley at Continental Road. The plan was prepared for Sonoran Institute to support coordinated decision-making by land and water managers, public agencies, landowners, and community stakeholders as future wastewater treatment improvements, changing effluent conditions, and ongoing watershed pressures influence the river system.

The river corridor is defined by a complex combination of perennial effluent-supported reaches, intermittent and ephemeral reaches, highly variable groundwater conditions, and a long history of geomorphic adjustment. Upgrades to the Nogales International Wastewater Treatment Plant have improved water quality and supported riparian recovery in portions of the corridor; however, the river remains affected by channel incision, floodplain disconnection, groundwater stress, sediment imbalance, invasive vegetation, trash accumulation, and recurring water quality concerns such as *E. coli* contamination during storm-related system breaches.

The existing conditions assessment documents that river function varies substantially by reach. The most resilient riparian conditions occur where perennial baseflow, groundwater accessibility, and geomorphic stability support vegetation and habitat complexity, particularly through portions of the Tumacácori and Tubac reaches. In contrast, more degraded reaches exhibit incision, widening, limited floodplain connectivity, reduced groundwater interaction, and constrained recovery potential due to infrastructure, land use, and altered sediment and hydrologic regimes.

Stakeholder engagement was central to development of the plan. A Stakeholder Advisory Group met three times between December 2025 and April 2026 and provided input on existing conditions, restoration priorities, conceptual approaches, and implementation considerations. The highest-ranked restoration outcomes were increased surface water quantity, improved groundwater recharge and availability, additional habitat and green space connectivity, improved water quality, and enhancement of native vegetation.

The restoration approach is grounded in a functional-based stream restoration framework that prioritizes hydrology, hydraulics, geomorphology, water quality, and biology as interconnected system functions. The plan emphasizes restoring or amplifying natural river processes where feasible, improving floodplain connectivity, guiding the river toward a more stable dynamic equilibrium, protecting critical infrastructure and land uses, and integrating public access, trails, interpretation, and community connection without constraining river function.

Restoration concepts include a range of approaches, from preservation and low-tech process-based restoration to larger-scale floodplain reconnection, channel and floodplain re-establishment, confined channel stabilization, wetland creation or enhancement, vegetation restoration, trash capture and removal, and public realm improvements. These concepts are intended to serve as a flexible menu of options that can be applied selectively based on reach-specific geomorphic condition, hydrologic setting, constraints, risk tolerance, landowner coordination, and available funding.

Three pilot project areas—Amado, Palo Parado, and Oso Wash—are identified to test varying levels of intervention and generate transferable lessons for future implementation. These pilot projects are intended to function as a learning laboratory for evaluating hydraulic, geomorphic, ecological, and maintenance responses before broader corridor-scale implementation.



Planning-level cost estimates indicate that restoration costs vary widely depending on the level of intervention, with low-tech process-based concepts having substantially lower unit costs than more intensive earthwork-based approaches. Because many restoration areas overlap conceptually and are not intended to be cumulative, future prioritization will need to refine project limits, select preferred alternatives, evaluate constructability, and develop phasing strategies that align with funding availability and implementation readiness.

Implementation is expected to occur over multiple decades and will require continued coordination among Sonoran Institute, county flood control districts, local jurisdictions, landowners, regulatory agencies, conservation partners, and funding entities. Future phases should include detailed topographic survey, hydraulic and geomorphic modeling, surface water and groundwater coordination, environmental and cultural resource review, landowner outreach, permitting, design development, adaptive monitoring, and phased implementation of priority projects.



2 BACKGROUND

Kimley-Horn (KH or Consultant) was retained by Sonoran Institute (SI) to provide planning, stakeholder involvement, and conceptual design services for the analysis of restoration and rehabilitation opportunities along the Santa Cruz River (SCR or River) from Oso Wash to Green Valley. More specifically, the project limits along the SCR are from the International Border north to Continental Road. The project limits also include Potrero Creek/Nogales Wash, and the Oso Wash south into Sonora, Mexico to the two Wastewater Treatment Plants (WWTP), Lomas de Anza and Puerta de Anza. The project length is just over 40 miles of the River (see **Figure 1**), flowing through Santa Cruz County (SCC) into Pima County (PC). The SCR and Oso Wash are effluent dependent watercourses. Oso Wash and the upper SCR have perennial flow from the Lomas de Anza and Puerta de Anza Wastewater Treatment Plants which extends ~2-3 stream miles downstream of the confluence of the Oso Wash and Santa Cruz River. The central reach within the project is also perennial as a result of effluent discharged from the Nogales International Wastewater Treatment Plant (NIWTP) with perennial flow extending from the NIWTP outfall to the Tubac area, ~15-16 stream miles. The project limits also include two long reaches of ephemeral watercourse.

In 2009, SCC reached a significant restoration milestone when the International Boundary and Water Commission (IBWC) began releasing higher-quality treated effluent into the SCR. Upgrades to the NIWTP infrastructure in Rio Rico made this improvement to water quality and available surface flow possible. Since the improvements, the relative health and recovery of riparian vegetation and growth has increased, promoting the return of wildlife and aquatic species, including several threatened and endangered species, while also renewing the public's interest and advocacy for the River's health.

With additional upgrades to the NIWTP proposed in the future, the plant is expected to accommodate increased influent volumes and corresponding effluent releases, a comprehensive stream restoration management strategy is necessary to optimize the restoration opportunities and future outcomes through planned and intentional utilization of treated effluent as an economic and ecological regional resource.

This report is intended to provide a framework for land and water managers, federal, state and local agencies, and other stakeholders to assess the health of the river and consider restoration opportunities based on the current and projected future flows in the river. The report also documents the goals and objectives of the Stakeholder Advisory Group (SAG), documents historic conditions of the River, defines reference reaches that have high stream function, evaluates the current condition and geomorphic function of the River, and provides a professional opinion of stream rehabilitation approaches for the varying conditions found along the River corridor. Lastly, this report documents the data collection that informed the approaches presented by master planning technical team.

This project includes active stretches of Juan Bautista De Anza National Historical Trail and other recreational trails and parks, areas of the Tumacácori National Historical Park, and intersects many other private and public owned parcels.

This Master Plan was funded by a Grant from the Water Infrastructure Finance Authority (WIFA) of Arizona.





3 PROJECT DESCRIPTION

The project was broken into three primary tasks; Data Collection and Conservation Opportunity Study, Restoration Concept Development, and Implementation and Cost Estimating. Under separate cover, AECOM is also completing an Economic Analysis to aid in understanding the value of the river corridor, effluent discharges, and potential stream restoration.

Data collection consisted of capitalizing upon the extensive research and management that has been completed along the project corridor by organizations including Sonoran Institute (SI), Arizona Department of Water Resources (ADWR), Arizona Department of Environmental Quality (ADEQ), the University of Arizona, SCC and PC, and the U.S. Environmental Protection Agency's US-Mexico Border Water Infrastructure Program.

Data Collection consisted of both literature review and collection of spatial datasets. Sonoran Institute's Living River Reports were key annual summaries that provide an understanding of attributes being monitored for the River's health, as well as understanding the change it goes through during a Water Year. Supplemental analysis was completed by the team to gauge the geomorphic conditions of the River, and how these processes have shaped the river over time, keying into its historical tendencies. Sources regarding geology, hydrology and hydraulics, effluent recharge, and vegetation were also collected to help support the understanding of the River system as a whole and larger regional resource. While conducting the data collection, measures for stakeholder engagement were taken to ensure input from voices within the project limits who experience the River on a daily basis were considered. Valuable information was gathered from the Stakeholder Advisory Group (SAG) put together to better inform river rehabilitation and restoration approaches. From there, attribute mapping in ArcGIS Pro began, creating visuals of geospatial data, providing a basis for how the information was to be relayed to SI and the SAG.

To guide the detailed river rehabilitation approaches, the project was divided into multiple technical evaluations to establish an existing-condition functional assessment and identify opportunities for interventions that provide functional lift and enhance the river as a resource. These analyses include stream function and geomorphic condition, vegetation function, recreational opportunities, and trash management. The team evaluated the conditions of degraded reaches as well as reference reaches. This effort was followed by restoration and rehabilitation approaches and concept sections, which outline approaches to achieve functional improvements within the river corridor on a reach-by-reach basis.

Restoration concepts were applied across the full project corridor, creating a menu of options for SI and other stakeholders to evaluate when considering feasibility and prioritizing rehabilitation strategies as funding becomes available. Advancement of these concepts will require additional feasibility analyses and design development beyond the scope of this study, including cultural and historic resource assessments, threatened and endangered species review, permitting, utility investigations, and more rigorous hydraulic and geomorphic analysis.



4 HISTORICAL BACKGROUND

The Upper Santa Cruz River is a structurally, climatically, and anthropogenically driven fluvial system whose geomorphology, hydrology, groundwater behavior, vegetation patterns, and ecological communities respond dynamically to both natural climatic oscillations and human intervention. A shift in the river's function began with European settlement into the region and the river continues to function in various stages of instability as humans continue to impact the watershed. The river's overall condition reflects the interplay between fault-controlled basin geometry, episodic flood regimes, long-term groundwater overdraft, effluent-dependent perennial flow, and shifting riparian habitat viability. Key findings show persistent geomorphic instability, continued groundwater stress in downstream reaches, documented improvements in water quality following upgrades to the NIWTP, and the emergence of Tubac as the most resilient riparian corridor.

Historically, the River was a broad, slow flowing braided river that was intrinsically and hydraulically connected to its floodplain. The groundwater was shallow, supporting large marshy cienegas and a wide variety of healthy riparian vegetation, as well as other wildlife that lived with and on the river.

The Santa Cruz River valley is one of the longest continuously inhabited regions in North America, with human presence dating back over 11,000 years. Early indigenous groups, most notably the Hohokam, developed extensive irrigation systems that enabled agriculture and represent some of the earliest large-scale human modifications to the River system. These interventions, while sophisticated, generally maintained a functional balance with the River's natural processes (The Lessening Stream, Logan 34). With the arrival of Spanish settlers in the late 1600s, land use shifted toward livestock grazing and expanded agriculture. European and later American settlers in the late eighteenth and nineteenth centuries intensified cultivation and land alteration, increasing pressure on the River system.

Incision and bank erosion began to occur in the late 1800's, with major entrenching happening in the northern reaches. Agriculture and human interference paired with overgrazing were the main catalysts of these drastic changes, amplifying the natural geomorphic processes. Large flood events like those during the late 1800s caused large head cuts to move further upstream, lowering groundwater levels in the surrounding areas. By the 1940s perennial surface flow had vanished in many reaches, replaced by dry channels and declining riparian health. The River continued to reshape itself with storm events of all sizes, leading to engineered bank stabilization projects through the Tucson reach (outside of project limits), in Sahuarita/Green Valley (near the northern project limits), and at isolated locations within the project area (Webb, et al, 2014).

Since 1951, wastewater being produced in Nogales, Sonora has been captured and piped to the U.S. through the International Outfall Interceptor (IOI) to be treated in the United States. With its construction in 1951, the NIWTP began releasing treated effluent into the River, and continued when it was relocated to its current location in 1972. At the time the plant was releasing approximately 1.6 million gallons of effluent a day into the River's system. (Peterson-Perlman, 2019).

Prior to the 2009 upgrades of the NIWTP, the effluent being released was lower quality. This caused a thick layer of algae to build-up on the riverbed and introduced high levels of nitrogen into the system. During this time, levels of ammonia, phosphorous, and cadmium were high while dissolved oxygen was extremely low, causing nearly collapsed native fish populations and poor infiltration rates. The surface flow observed at the time extended 17 miles, regularly to Amado

In 2009, major infrastructure improvements and upgrades were completed at the NIWTP, leading to what is now the current effluent-driven stretch of the River. The upgrades gave the plant the capacity to treat a



total of 14.7 million gallons per day (MGD), of which 9.9 MGD is received from Nogales, Sonora. The total amount of wastewater reaching the plant can vary on an annual and seasonal basis. During the wet seasons, the NIWTP can receive quantities of water that exceeds the limit of the plant, breaching the lagoons. This is due to Nogales, Sonora having one system for both stormwater and wastewater, causing untreated wastewater to discharge into the River contaminating the water with E. Coli and other unwanted dissolved materials. (Peterson-Perlman, 2019).

Infrastructure improvements to the NIWTP and the IOI are currently in the planning process. These improvements would increase the capacity and reliability of the conveyance system bringing influent to the NIWTP and increase the treatment capacity of the plant. These improvements should result in fewer breaches of the system thus improve overall water quality. The increased capacity of the system will also allow for increases in influent in the future, with an anticipated increase in effluent discharge of up to 15 MGD (100% increase).

Following the upgrades and the release of an A-grade effluent, water quality has generally improved. Ammonia, phosphorus, and cadmium concentrations declined, while dissolved oxygen increased. The cleaner effluent reduced sludge and algal buildup, supporting improved infiltration, and native fish species, including Gila Topminnow and Longfin Dace, recolonized the system. Overall, the new treated effluent created more stable biologic and physiochemical conditions for the river, encouraging healthier riparian habitat growth since the WTP improvements were completed.

In 2013, the Los Alisos Wastewater Treatment and Conveyance Project was constructed in Nogales, Sonora to help alleviate the volumes of wastewater entering the NIWTP. This project consisted of a new wastewater treatment plant in the Los Alisos River Basin which is located south of Nogales and outside the SCR watershed. The project also included the construction of a lift station in Nogales, Sonora (within the SCR watershed / NIWTP sewershed), force main, and gravity outfall to collect waste generated within the NIWTP sewershed and convey it to the new Los Alisos plant. The Los Alisos plant was designed to treat up to 5 MGD with current inflows measuring between 3.1 and 3.5 MGD, releasing the treated effluent into Los Alisos River Basin, outside of the SCR watershed. The lift station that diverts wastewater from the NIWTP sewershed to the Los Alisos plant occasionally fails, increasing the amount of wastewater being treated at the NIWTP. The *Organismo Operador Municipal de Agua Potable, Alcantarillado y Saneamiento* (OOMAPAS) of Mexico operate and manage the Los Alisos Wastewater Treatment and Conveyance System.

In the early 2010's development within eastern Nogales, Sonora began to push into the Oso Wash/Brickwood Canyon watershed. This development spurred the need for new wastewater treatment facilities. In 2012 the Lomas de Anza WWTP was constructed, designed to have a max capacity of 0.7 MGD. Shortly thereafter, the Puerta de Anza WWTP was constructed near the Lomas de Anza WWTP, with a maximum capacity of 1.5 MGD. Both of these smaller plants on the Oso Wash discharge lower-class treated effluent into the wash. This flow crosses the International Border and joins the flow in the SCR, just north of the International Border.



5 EXISTING CONDITIONS

5.1 WATERSHED AND HYDROLOGY

The Santa Cruz River watershed is in south-central Arizona and northern Sonora, Mexico and is tributary to the Gila River. Within the United States (U.S.), the River's headwaters start in the San Rafael Valley, flowing south into Sonora, Mexico before making a 20-mile horseshoe-bend back to the northwest where the River re-enters the U.S. to the east of Nogales, Arizona. The River continues to travel northward, through Tucson before merging with the Gila River north of the community of Maricopa, Arizona. **Table 1** highlights the significant increase in overall watershed size from the upstream extent of the project (International Border) to the downstream (Green Valley @ Continental Road). The Watersheds can be seen on **Figure 2**.

Table 1 – Santa Cruz River Watershed

Santa Cruz River @	Watershed Area (sq. mile)
International Border	532
Green Valley (Continental Road)	1654

Table 2 – FEMA FIS Discharges

Location on SCR	Drainage Area (sq. mi)	Peak Discharges (cfs)			
		10%-Annual Chance	2%-Annual Chance	1%-Annual Chance	0.2%-Annual Chance
Pima/SCR County Line	1448	15750	32400	45000	108000
Amado-Montosa Road	1279	15050	30960	43000	103200
Bridge Road in Tubac	1209	14700	30240	42000	100800
Confluence with Josephine Canyon Wash	1163	14490	29810	41400	99360
Confluence with Peck Canyon Wash	1097	14180	29160	40500	97200
Confluence with Agua Fria Canyon Wash	1045	13900	28580	39700	95280
Ro Rico Drive near Guy Tobin Trailhead	1000	13650	28080	39000	93600
Highway 82 Bridge	574	11380	23400	32500	78000
International Border	532	11200	23040	32000	76800

Within the project limits, multiple tributaries contribute to the SCR, with large tributaries such as Sopori Wash and Sonoita Creek. The tributaries begin in adjacent 'Sky Island' mountain ranges including the Patagonia and Santa Rita Mountains to the east and Atascosa and Tumacácori Mountains to the west. The tributaries are vital to the function of the SCR contributing surface runoff to the River, and due to the



variability in watershed sizes, elevations, and climatic conditions, the tributaries often contribute runoff at rates and timing completely independent to the SCR. The tributaries not only contribute runoff, but they are also important sources of sediment deposition into the River. The sediment deposits include nutrients and pollutants; seeds, both native and invasive; along with woody debris, and trash. Kimley-Horn's field and desktop review of the project limits show a potential correlation between large tributaries and the hydraulic and geomorphic conditions within the SCR. The tributaries could be providing a natural surface (and possibly sub-surface) grade control which may be reducing the slope of the river upstream of the confluence, possibly resulting in higher groundwater levels. This hypothesis was not documented in the literature or further researched with this project, but could be worth additional evaluation to better understand the impacts of the tributaries on the SCR. **Table 3** shows prominent tributaries of the SCR and their contributing watershed area (See **Figure 3**).

Table 3 – Tributary Watershed FEMA FIS Discharges

Tributary	Watershed Area (sq. mile)	Peak Discharges (cfs)			
		10%-Annual Chance	2%-Annual Chance	1%-Annual Chance	0.2%-Annual Chance
Oso Wash	10.3	N/A	N/A	N/A	N/A
Potrero Creek	93.4	7430	17420	24200	58080
Sonoita Creek	258.3	6705	15389	20514	34477
Agua Fria Canyon	44.6	6538	7958	9861	14192
Peck Canyon	47.5	9632	15700	18315	25570
Josephine Canyon	49.1	8211	15919	19594	28657
Mavis Wash	12.7	N/A	N/A	N/A	N/A
Cottonwood Canyon	12.5	N/A	N/A	N/A	N/A
Sopori Wash	167	4965	9779	12338	19044
Madera Canyon	23.3	N/A	N/A	N/A	N/A

The US Geological Survey (USGS) defines the section of the SCR in eastern Santa Cruz and Pima Counties as an interrupted stream (PCRWRD 2002, NV5 2021). This means that the River has reaches that are ephemeral, intermittent, and perennial with variability based on location, season, and annual precipitation (NV5, 2021). The River is perennial from the NIWTP through Tubac, with stretches south of the plant and north of Tubac being intermittent or ephemeral. The effluent-driven section of the SCR has healthier riparian vegetation and wildlife-filled habitats. As documented in **Section 4**, the conditions of the SCR have varied over time, largely due to the changes in hydrology, groundwater, and availability of perennial baseflow. Future improvements to the NIWTP and the associated increase in effluent discharge have the potential to increase groundwater availability, provide better groundwater and surface water connectivity, and increase the lengths of intermittent and perennial reaches within the project limits.

Figure 2 - Santa Cruz River Watershed Map

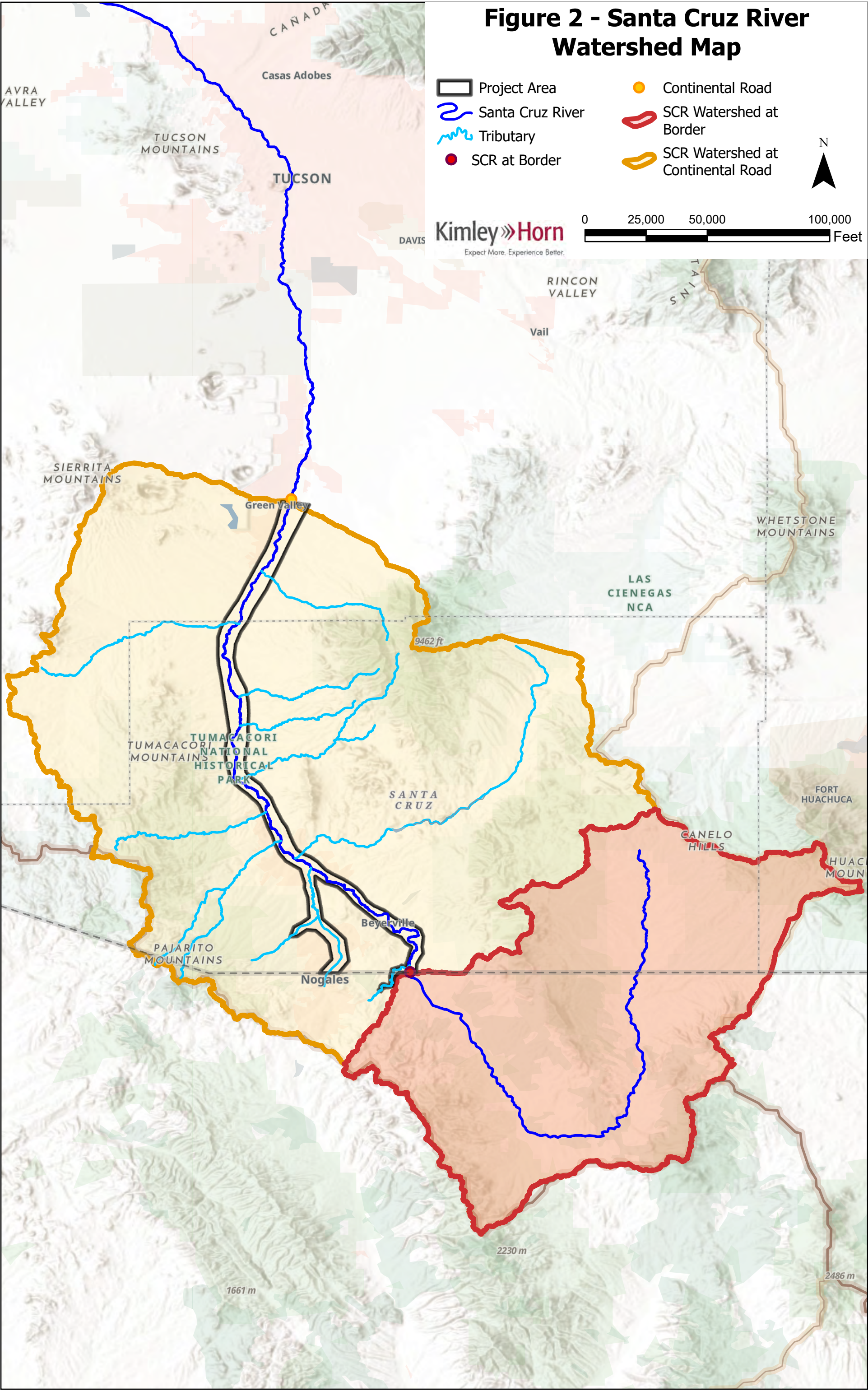
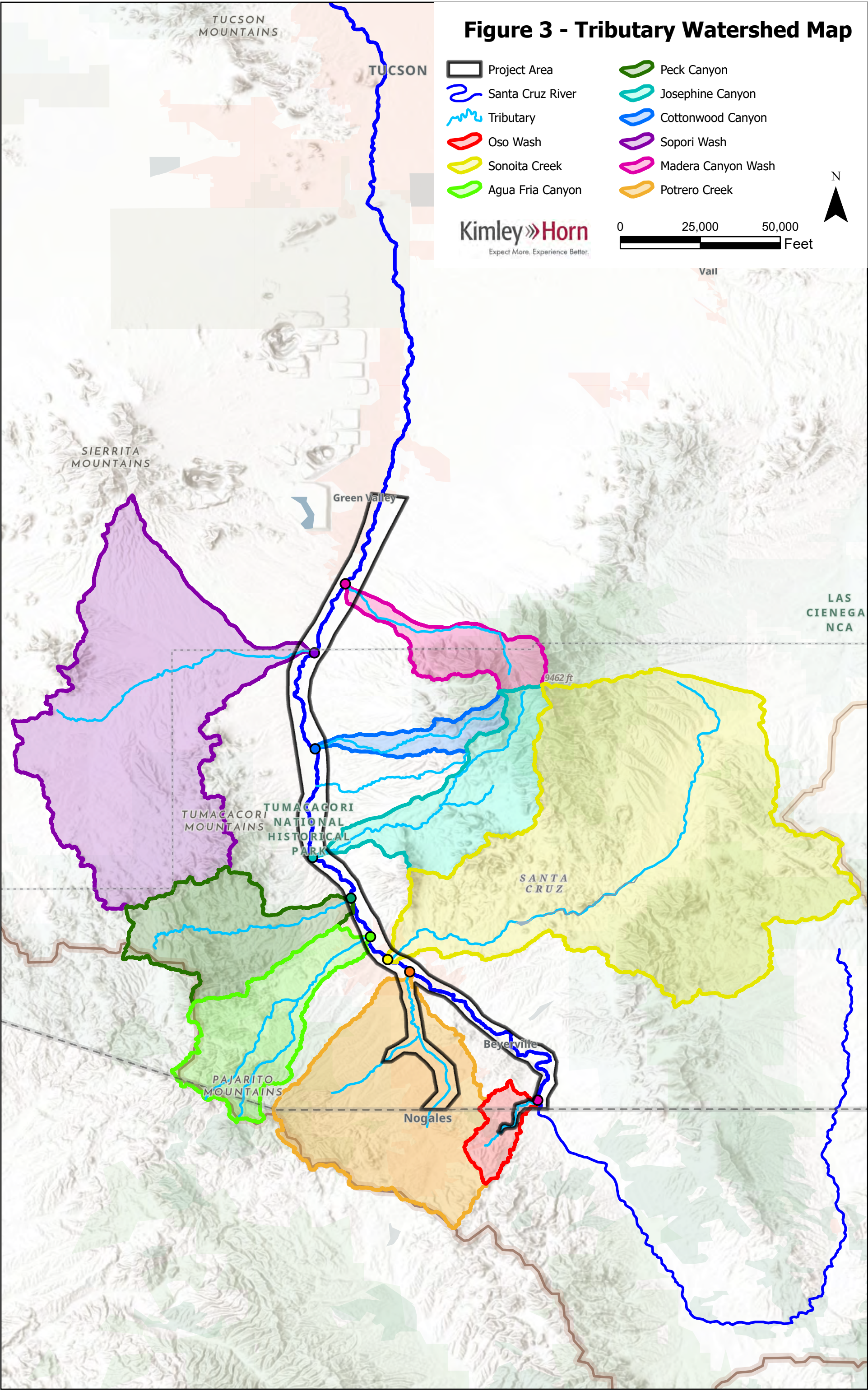


Figure 3 - Tributary Watershed Map





Starting on the most upstream (southern) end of the river, Oso Wash carries lesser-treated effluent from the two wastewater treatment plants from Sonora, Mexico making this tributary a perennial stretch that flows into the Santa Cruz River. This effluent discharge generates a perennial surface flow extending northward 2-3 stream miles as a losing reach of the river, where flow progressively infiltrates and diminishes below the surface. Downstream of this reach, the system transitions to an ephemeral condition, with flows occurring only in response to precipitation events. The river remains ephemeral until it reaches the NIWTP, where A-class effluent discharge reintroduces perennial flow to the channel. From this point, the river exhibits perennial flow conditions through Tubac (15-16 stream miles), with base flow progressively lost to infiltration within the alluvial sands approximately one mile south of Amado Montosa Road. Elevated groundwater levels between Tumacácori and Tubac may sustain intermittent surface flow over a longer extent. Downstream, the system reverts to ephemeral conditions, with channel flow primarily driven by storm events as it continues north through Green Valley toward Tucson.

The connectivity between surface flow and groundwater of the river is highly variable along the project limits. SI's Living River Reports detail well data for given regions within project limits. The criteria for determining if depths are "good" is based on how deep cottonwood roots extend to reach groundwater which ranges from 2.5 to 5.1 meters, or 8 to 16 feet. The northern ends of the Rio Rico and Tubac reaches most often meet depths for the health of cottonwoods. The southern areas of the Rio Rico reach and the northern areas of the Amado reach do not meet depth requirements for cottonwood health.

According to Groundwater Flow Model of the Santa Cruz Active Management Area Microbasins International Boundary to Nogales International Wastewater Treatment Plant Santa Cruz County, Arizona by Gretchen Erwin, gradients below ground are unpredictable due to the overdraft of groundwater throughout the area (46). Hydraulic conductivity of soils depends on the geologic formation the River runs through and the age of the alluvium. Wells in the Rio Rico area have the highest levels of groundwater reported, with studies indicating high hydraulic conductivity and infiltration rates, with both properties decreasing while moving northward through Tubac and Amado. (Groundwater Flow Model of the Santa Cruz Active Management Area Along the Effluent-Dominated Santa Cruz River Santa Cruz and Pima Counties, Arizona by Keith Nelson).

A detailed hydrologic study of surface and subsurface conditions is necessary to fully understand the connectivity between surface water and groundwater. Such model could aid in predicting the impacts that stream restoration would have on the overall surface water / groundwater system as well as the impacts to increases in effluent discharge. The Lacher hydrological study initially prescribed to model and understand the complex nature and properties of surface and groundwater connectivity and interaction within and along the SCR. An overview of the model was provided to the project team and preliminary findings appeared promising for use in this Masterplan or other planning projects along the SCR. The primary findings impacting this Masterplan are that perennial baseflow and groundwater conditions are highly correlated, and that with a future increase in effluent discharge, the surface baseflow rates are expected to increase and the baseflow is expected to reach further downstream. Quantitative results along with the final findings of this model and study were not made available to the project team. Additional coordination and/or expansion of the Lacher study are recommended with the advancement of this Masterplan. Due to the lack of availability of these model results, projections and planning for future increases in effluent discharges is speculative in nature. Oversimplifying a complex system of groundwater and surface water conditions could be detrimental to the findings and recommendations presented in this Masterplan.

5.2 FLOODPLAINS AND HYDRAULICS

Throughout the entirety of the project corridor, the SCR is mapped as a FEMA Zone AE Floodplain, with a Floodway. Zone AE floodplains are defined as areas of special flood hazard subject to inundation by the



1% annual chance (100-year) flood, with base flood elevations determined. The Floodway is the channel of a stream plus any adjacent floodplain areas that must be kept free of encroachment so that the 1% annual chance (100-year) flood can be carried without substantial increases in flood heights. FEMA has also mapped the 0.2% annual chance (500-year) flood along the SCR.

Many of the major tributaries within the project corridor are also mapped as FEMA Floodplains. Potrero Creek and Nogales Wash are both also mapped as FEMA Zone AE Floodplains with a Floodway, and both also have the 0.2% annual chance flood hazard mapped. The FEMA Floodplains are shown on the attached **Exhibit A**.

Restoration activities along the project corridor will be required to meet FEMA policies as well as the Floodplain Ordinance of the local jurisdiction (SCC or PC). Any rise in Base Flood Elevation (BFE) will require remapping of the FEMA Floodplains/Floodways and may not be permitted depending on impacts to adjacent properties. At a planning stage, any restoration activity that raises the stream bed or reduces conveyance area (grade control, in-stream structures, etc.) should be offset with added conveyance area (new primary or secondary channels, benching, laying back channel banks, etc.).

Historically the hydraulic conditions of the SCR were quite tranquil. Natural base flow occupied multiple braided thalwegs across the valley. Small frequent storms rose onto low terraces and occupied additional secondary thalwegs. Larger, less frequent flood flows spread across the floodplain, occupied upper benches, but were still very slow moving, with high variability in flow depths and velocities across the floodplain. During flood events, the floodplain stored a tremendous volume of runoff, resulting in attenuation of the peak discharge as it moved downstream as well as significant groundwater recharge as the flood receded.

The predominant degraded condition of the SCR is incision of the main channel. This results in very different hydraulic conditions than the historic conditions described above. The incised main channel has a much higher conveyance capacity than the historic/natural conditions. This higher conveyance capacity results in base flows, small frequent storms, and even some flood flows remaining contained in the primary channel. The flow depths, velocities, and shear stress during these flow events are much higher, and concentrated within the main channel, increasing bed and bank erosion, and further exacerbating the channel incision. Throughout much of the project corridor, a large flood event is required to occupy the natural floodplain. In these incised conditions, very little storage of the flood volume occurs and the flood wave largely passes through the reach with minimal attenuation. As such, groundwater recharge during a flood is minimal.

5.3 GEOMORPHOLOGY AND TRANSPORT OF MATERIALS

The Santa Cruz River alternates between aggraded floodplain states with slightly incised meandering and braided channels to more entrenched channels the further north it creeps. The aggradation and incision processes are driven by climactic oscillations and anthropogenic disturbance as outlined in *The Lessening Stream* by Michael Logan and *Requiem for the Santa Cruz; An Environmental History of an Arizona River* by Robert Webb.

Manmade alterations to the River and surrounding areas have led to channel incision. Encroachments into the floodplain have resulted in more turbulent hydraulic conditions and more erosive forces, as described in **Section 5.2**. Pumping has lowered the groundwater level, especially in the northern reaches of this project. The overdraft of groundwater induces subsidence, compacts and artificially ages sediments, and reduces recharge capacity. Tributary watercourses naturally provide a significant sediment load into the SCR. Development within the tributary watersheds, infrastructure such as roads and railroads crossing the tributaries, and sand and gravel mining operations in the tributaries have all reduced the sediment supply



to the SCR, throwing off the sediment balance in the River. This results in the River being 'hungry' to achieve its sediment balance, thus needing to capture more sediment from the River bed and banks.

Sections observed in the Amado reach and north into PC are where this deeper incision is most prevalent. The soil is dry, cottonwoods are frail, and the greenery on the overbanks is virtually non-existent. Eye-witness accounts of the River near Amado dictate that the river used to have two primary channels side-by-side that eventually eroded away the middle section, combining the two channels creating one wide primary channel, disconnected from its floodplain.

The SCR is a highly dynamic geomorphic system with varying levels of stability along the corridor. This dynamic system evolves with the perennial baseflow, small frequent storms events, and large floods.

Channel Evolution Stages

The 40-mile river corridor spans Stages 0 through 5 of the Cluer and Thorne (2014) Channel Evolution Model (Figure 4). Relatively stable reaches, including those near the Peck Canyon outfall and through Tubac, align with Stage 0 and Stage 1 conditions. In contrast, areas near the Sopori Wash outfall reflect Stage 3 conditions and ongoing channel degradation. Additional descriptions of each stage observed along the corridor are provided below, in **Table 4** and in **Exhibit B**.

Stage 0

Stage 0 represents a stream/river system before disturbance; a dynamic, self-formed alluvial system meaning a connected valley-bottom system. These systems have high floodplain connectivity, a key defining trait of Stage 0 Evolution. Floodplains foster wetlands, allowing water to frequently spread across the valley bottom rather than confined banks. Channels are often braided and wandering, with no clear defined flow path in some cases. These characteristics contribute to saturated soils with high groundwater tables, sediment storage in the floodplain, and variable flow depths and velocities in the primary and secondary channels, creating habitat variability for variety of vegetation and aquatic communities and species. Stage 0 has the highest levels of hydrologic connectivity, habitat diversity, and ecosystem function. This stage is the most stable of stages.

Stage 1

Stage 1 captures the transition to more concentrated flow rather than low and slow flowing braided channels. Banks become more defined and primary flows and small storm flows become more confined to a primary channel. The floodplain largely retains its elevation, and the system remains relatively connected to the geomorphic floodplain. Overbank flows become less frequent and more dependent on larger storm events. These changes typically occur from changes in land use due to agriculture, grazing/clearing, or urbanization, loss of woody structures including debris jams or increased runoff. Stage 1 channels may appear stable but are often without natural grade control or stable sediment supply may not yet be adjusted to the altered flows and sediment regime, setting the channel up for potential incision that occurs in stage 2.

Stage 2

Stage 2 of geomorphic evolution consists of incision or downcutting of the primary channel, deeper into its bed. Vertical instability is the main defining characteristic of this stage, increased by stream power or reduced resistance of flows. Channel bed degradation rapidly increases depth, initiating headcuts and disconnecting the stream even further from its floodplain. What was the former floodplain becomes an elevated terrace and overbank flooding becomes rare, defining a critical shift in lateral connectivity. This



incision causes riparian vegetation to fall or be swept away by faster flows, exposing soil banks rather than vegetation-dense stabilized banks. Thus, cottonwood recruitment is likely lost. This incision causes groundwater tables to drop, leading to floodplain soils to dry and vegetation to become stressed.

Stage 3

Stage 3 consists of channel widening and bank failure, with the lateral instability beginning to dominate the stream/river area. After stage 2 deepening, banks become over-steepened, exceeding critical stability thresholds. Banks begin failing en-masse, triggered from steep bank heights and the removal of toe support due to continued scour. This channel widening occurs via episodic bank collapse rather than gradual erosion over time. This bank failure becomes a major sediment source for the system, either being stored at toes or transported further downstream. The sediment supply of the system then becomes bank-derived as opposed to the primary sediment coming from tributaries of the system. The original floodplain becomes a high terrace, vertically separated from the historic floodplain as the stream/river system widens.

Some reaches exhibit Stage 3 conditions characterized by active incision, while others reflect Stage 3s conditions where vertical degradation has begun to stabilize but floodplain connectivity and overall system function remain limited and impaired.

In turn, the widening decreases flow depth, slowing velocities and decreasing shear stress, setting up the transition to stage 4. Stage 3 represents geomorphic instability, crowning it the most destructive (active degradation and erosion) phase of the evolutionary process.

Stage 4

Stage 4 marks the onset of recovery, where sediment begins to deposit building up the channel bed initiating a new floodplain. Vertical build-up comes with bed aggradation when sediment from stage 3 begins to deposit downstream, gradually moving upstream. This sediment deposition creates low benches or inset floodplain surfaces. While these surfaces are still below the original floodplain, it begins to reconnect the system with moderate flows which is the first step to floodplain re-establishment. In stage 4 bank erosion and channel widening still occurs, but at a much slower rate, allowing banks to flatten and stabilize.

Stage 5

Stage 5 continues the recovery process that stage 4 began, representing the re-establishment of a dynamically stable channel-floodplain system. Equilibrium is forming, with sediment supply approximately equaling transport capacity, allowing the channel geometry to adjust to prevailing flows. This stage is often referred to as quasi-equilibrium or dynamic equilibrium. The system becomes self-maintaining no longer experiencing rapid incision and active widening. During this stage, a new inset floodplain is developed, regularly inundated at bankfull or near-bankfull flows. The historic floodplain still remains, but now as a terrace at higher elevation above the new floodplain and channel(s). The sediment regime of the system is balanced, no longer experiencing excessive transport (stages 2 and 3) or storage (stage 4). Stable sand bars and regular sediment sorting is observed, allowing the system to re-establish meanders, riffle-pools, and bar-bank interactions, allowing riparian vegetation to become well-established, providing more structural stability to the channel(s). This stage may also experience a reconnection of groundwater and surface water, supporting riparian vegetation recovery. This stage *is not a return to the original system*, but rather a new equilibrium at lower elevations. **Table 4** compares stages 1 through 5 of the geomorphic evolution cycle.



Stages 6 through 8

Stages 6 through 8 do not accurately describe the reach of River from Nogales to Green Valley. Most channel evolution models stop at stage 5, with stage 6 being further recovery of the system, while stages 7 and 8 are not universally defined and vary. Stages 6 through 8 are extensions of the already existing stages mentioned, describing longer-term recovery, legacy effects, and even alternative pathways. These stages can represent the maturing of a fully recovered system.

However, most rivers do not naturally recover to advanced stages (e.g., Stages 6–8 or fully reconnected, self-sustaining conditions) once they have progressed into incision, widening, and degradation. Structural controls, altered hydrology, sediment imbalance, encroachment, and land use constraints often prevent the natural recovery trajectory. As a result, many systems become effectively “locked” in mid- to late-stage degradation, lacking the processes necessary to rebuild floodplain connectivity and geomorphic complexity. In these cases, restoration or rehabilitation interventions are required to reset channel and floodplain processes, reestablish hydrologic and sediment regimes, and accelerate recovery toward more stable, functionally resilient conditions.

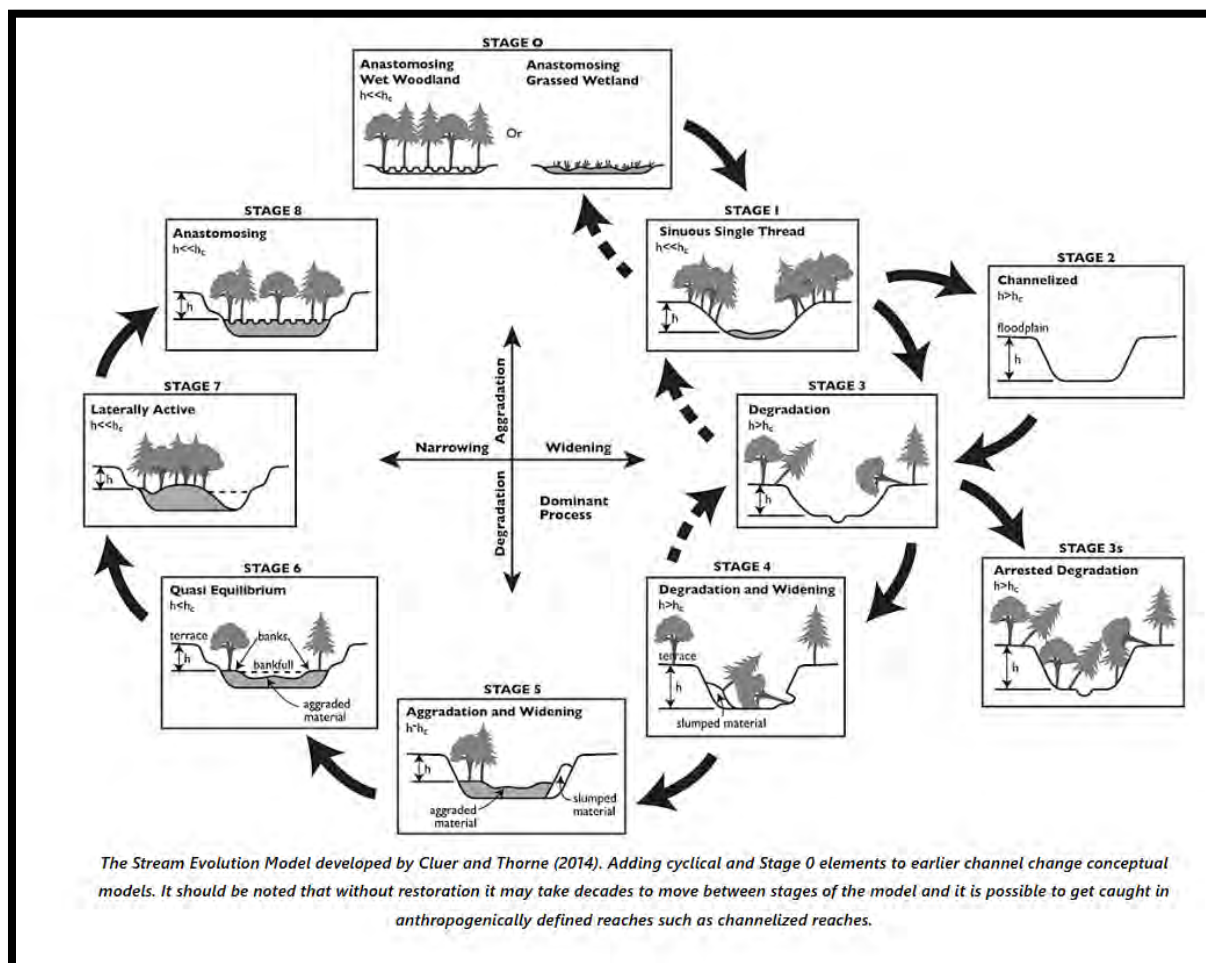


Figure 4 – Stream Evolution Model



Table 4 – Geomorphology Stages

Attribute	Stage 0	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5
Core condition	Connected valley-bottom system	Channel initiation	Incision (downcutting)	Widening (bank failure)	Aggradation / deposition	Quasi-equilibrium
Dominant process	Floodplain inundation, deposition	Flow concentration	Vertical erosion	Lateral erosion (mass wasting)	Sediment deposition	Dynamic balance
Channel form	Multi-thread / diffused	Emerging single-thread	Deepening single-thread	Rapidly widening channel	Adjusting channel with bars / benches	Stable single-thread
Width–depth ratio	Very high (shallow, wide)	Moderate	Low (narrow, deep)	Increasing rapidly	Moderating	Stable
Bed elevation trend	Stable (high valley floor)	Slightly adjusting	Rapid lowering	Low (post-incision)	Rising (aggradation)	Stable (new elevation)
Floodplain connectivity	Fully connected	Slightly reduced	Largely disconnected	Disconnected	Partially reconnecting (inset forming)	Connected to inset floodplain
Floodplain type	Extensive valley-bottom wetland/ floodplain	Same but less active	Abandoned (becomes terrace)	Terrace-dominated	Inset floodplain forming	Inset floodplain established
Sediment dynamics	Storage-dominated	Transitioning	Export-dominated	Major sediment source (banks)	Storage (bars / floodplain)	Balanced transport / storage
Sediment source**	Distributed (valley + channel)	Increasing channel focus	Bed erosion	Bank failure dominates	Deposited upstream / downstream	Balanced sources / sinks
Bank condition	Low, vegetated, stable	Defined but stable	Tall, steep, unstable	Failing / mass wasting	Stabilizing	Stable, vegetated
Groundwater interaction	High connectivity (shallow water table)	Slight decline	Water table drops	Disconnected from floodplain	Recovering	Partially reconnected
Hydrologic behavior	Attenuated, slow, diffuse flow	Increasing concentration	Confined, high-energy flows	Still energetic but dispersing	Energy decreasing	Adjusted to regime
Planform complexity	High (anabranching, wetlands)	Reduced	Low (simple thread)	Low–moderate	Increasing (bars, benches)	Moderate (meanders, bars)
System stability	Stable (reference condition)	Transitional	Highly unstable	Maximum instability	Recovering	Stable (dynamic equilibrium)
Geomorphic role	Reference / natural template	Departure initiation	Vertical adjustment phase	Lateral adjustment phase	Recovery phase	New equilibrium condition

**For the SCR, sediment and debris dynamics also provide an important indicator of expected trash behavior. For example, Stage 0 reaches are typically “storage-dominated,” where trash is retained within the system due to low energy conditions and frequent interaction with vegetation and floodplain surfaces. In contrast, Stage 3 reaches tend to function as transport-dominated systems, exporting trash downstream due to higher flow energies and active channel incision. As a result, relatively little trash is expected to accumulate in these reaches unless it is locally captured by vegetation, large wood, or debris features.

An increase in effluent discharge, and the anticipated increase in flow rates during base flow conditions is likely to accelerate the evolutionary stages described above, including both the degradation and stabilization processes. Increased flow rates would be anticipated to transport more sediment and debris, possibly accelerating the downcutting and incision of Stages 1 and 2. The erosion of sediment from one



reach typically results in deposition in another reach, which is likely to accelerate those areas beginning to recover in stage 4 and provide for more dynamic deposition and discussed in stage 5.

5.4 PHYSIOCHEMICAL PROPERTIES

Over the past eighteen years, Sonoran Institute has been conducting Living River Studies on the flowing sections of the River and surrounding areas between, giving clarity of the contributing factors to the SCR's health. Baseline requirements for the different dissolved chemicals in the system can be seen in **Table 5**. SI recently added Nogales Wash to their studies in the year 2019, recognizing the tributary is highly influenced by human interaction, collecting much debris and pollutants before its outfall to the River.

Dissolved Oxygen

Dissolved oxygen is an indicator of aerobic aquatic habitat quality and is controlled by temperature, flow, organic materials loading, and water nutrient levels. In most years since 2008, the observed level for oxygen has consistently met standard. Nogales Wash experiences occasionally reduced attainment of dissolved oxygen due to excess of nitrogen and phosphorous in the system. Dissolved oxygen is not a limiting factor for most of the SCR system, and all levels have improved since the 2009 improvements to the NIWTP resulted in a higher quality of effluent.

Ammonia and Total Phosphorous

Nutrients like Ammonia and total phosphorous are mostly associated with the wastewater inputs. The toxic form of nitrogen can be extremely dangerous depending on pH and temperature levels, with the first samples recorded in 2008 showing there was 0% attainment indicating severe impairment of the system. Once the NIWTP began releasing higher treated effluent, there was mixed attainment in each area they sampled, ranging from 40-100%. From the year 2010 and onward, nearly universal compliance of standards were met in the river due to the upgrades fully taking effect. Ammonia being one of the most improved parameters of the River post NIWTP upgrades.

Total phosphorous represents algal growth and eutrophication from other natural or artificial processes. Total phosphorous levels follow similar trends as previously mentioned, with very poor attainment in 2008 before NIWTP upgrades, with rapid improvements observed directly after. Overall, the long-term trend has shown declines in total phosphorous levels. An excess in phosphorous can significantly decrease dissolved oxygen, suffocating aquatic life and even releasing toxins that harm both human and animal life. The decrease of both ammonia and total phosphorous in the River system indicates a major turning point for the health of the River and surrounding areas, exhibiting increased infiltration rates and dissolved oxygen levels, and healthier riparian habitats.

E. Coli

A physiochemical property that continues to be a problem in the River is E. Coli contamination, and though the NIWTP upgrades helped with levels in the effluent, breaches of the system still occur each year. These breaches come with larger storm flows that not only collect ruminant fecal matter in runoff, but also compromise the NIWTP system with influxes of water. The complex intricacies that come with treating binational water/wastewater play roles in the management of the NIWTP, and also the health of the River. As outlined in **Section 4** of this report, stormwater flows mixed with wastewater from Nogales, Sonora enter the system, overtopping the facilities into the River. This contamination primarily consists of E. Coli derived from human and ruminant fecal matter, carrying the lengths of the River at times. E. Coli levels have strong seasonal signaling, peaking during monsoonal flooding in the summer wet seasons. Aging infrastructure such as the IOI contribute to poor management of wastewater flows entering the U.S. and River as well.



The perpetual E. Coli contamination clues that long-term water quality improvements need to be made to keep this impairment from recurring. Unlike the other nutrients, there is no sustained improvement trend for E. Coli contamination levels.

E. Coli reduction in surface water is typically most successful through source reduction (point sources and non-point sources) mitigation strategies.

Metals and Trace Elements

When levels of metals and other trace elements are high enough in water systems they can become extremely toxic contaminants, affecting reproduction, growth, and survival of plant and animal life in and around the river. Sources of excess metals can be from runoff coming from adjacent mines, as well as industrial and wastewater inputs to the river. Most of the metals monitored are consistently below standard, including arsenic, copper, lead, selenium, and zinc, with only cadmium being a recurring issue. The River experiences occasional lead exceedances, and in recent years there has been a potential nickel presence. Further removal of these metals would require control at the source(s).

Table 5 – Compounds Found in SCR

Compound	Standard
Dissolved Oxygen	≥ 1mg/L
Total Phosphorous	≤ 5 mg/L
Ammonia	Varies w/ pH & Temp
E. Coli	≤ 235 CFU/100ml
Metals	
Arsenic	150 µg/L ^b
Cadmium	0.8 – 3.7 µg/L ^e
Copper	16 µg/L
Lead	5.2 µg/L
Nickel	91 µg/L
Zinc	211 µg/L

*** Sonoran Institutes Living River Reports provided the data for this section of the report. This table was recreated from the reports, with superscripts as follows*

^b Not an average. Standard for arsenic does not vary with water hardness.

^e Average standard for 2009 more stringent standard or average standard for 2016 less stringent standard.



5.5 VEGETATION

Riparian vegetation plays a fundamental role in maintaining the physical and ecological health of river systems. Vegetation along the river corridor intercepts precipitation, enhances infiltration, uptakes nutrients, and dissipates stream energy. Healthy vegetation in high functioning river floodplain improves resiliency, water quality, and habitat diversity. Dense vegetation communities also improve soil structure by increasing permeability and organic content, which supports groundwater recharge and stabilizes channel conditions. In contrast, reductions in vegetation cover can lead to bank instability, increasing susceptibility to erosion during storm events and long-term channel degradation.

Effluent-supported reaches of the Santa Cruz River often sustain riparian vegetation which helps to stabilize channels and promotes sediment accumulation. However, widespread vegetation regeneration remains suppressed by low water tables and repeated channel widening. An extensive mapping of the existing vegetation function class is provided in **Exhibit C**. A summary of the most common plant species associated with hydro-mesoriparian vegetation areas and xeroriparian areas are provided in **Table 6** and **Table 7**, respectively. The most commonly encountered non-native and/or invasive vegetation species are provided in **Table 8**.

Table 6 – Hydro-Mesoriparian Vegetation

COMMON NAME	BOTANICAL NAME
TREES	
Arizona Alder	<i>Alnus oblongifolia</i>
Netleaf Hackberry*	<i>Celtis laevigata</i> var. <i>reticulata</i>
Velvet Ash*	<i>Fraxinus velutina</i>
Redberry Juniper	<i>Juniperus coahuilensis</i>
Arizona Walnut*	<i>Juglans major</i>
Arizona Mulberry	<i>Morus microphylla</i>
Arizona Sycamore*	<i>Platanus wrightii</i>
Fremont Cottonwood*	<i>Populus fremontii</i>
Blue Elderberry*	<i>Sambucus nigra</i>
Goodding's Willow*	<i>Salix gooddingii</i>
Black Willow	<i>Salix nigra</i>
Western Soapberry	<i>Sapindus saponaria</i> var. <i>drummondii</i>
Yewleaf Willow	<i>Salix taxifolia</i>
Emory Oak	<i>Quercus emoryi</i>
UNDERSTORY	
Weakeaf Bur Ragweed	<i>Ambrosia confertiflora</i>
Seepwillow*	<i>Baccharis salicifolia</i>
Desertbroom	<i>Baccharis sarothroides</i>
Fewflower Beggarticks	<i>Bidens leptcephala</i>
Western White Clematis	<i>Clematis ligusticifolia</i>
Pennywort	<i>Hydrocotyle ranunculoides</i>
Green Sprangletop	<i>Leptochloa dubia</i>
Big Sacaton*	<i>Sporobolus wrightii</i>



Canyon Grape*	<i>Vitis arizonica</i>
Rough Cocklebur	<i>Xanthium strumarium</i>

* Indicates species observed during field visits

Table 7 – Xeroriparian Vegetation

COMMON NAME	BOTANICAL NAME
TREES	
Whitethorn Acacia*	<i>Acacia constricta</i>
Catclaw Acacia*	<i>Acacia greggii</i>
Desert Hackberry*	<i>Celtis ehrenbergiana</i>
Desert Willow*	<i>Chilopsis linearis</i>
Blue Paloverde*	<i>Parkinsonia florida</i>
Velvet Mesquite*	<i>Prosopis velutina</i>
UNDERSTORY	
Thurber's Desert Honeysuckle	<i>Anisacanthus thurberi</i>
Fourwing Saltbush*	<i>Atriplex canescens</i>
Cane Bluestem	<i>Bothriochloa barbinodis</i>
Sideoats Grama*	<i>Bouteloua curtipendula</i>
Rothrock's Grama	<i>Bouteloua rothrockii</i>
Desert Ceanothus	<i>Ceanothus greggii</i>
Feather Fingergrass	<i>Chloris virgata</i>
Snakewood	<i>Condalia species</i>
Warnock's Snakewood	<i>Condalia warnockii</i>
Arizona Cottontop*	<i>Digitaria californica</i>
Buckwheat*	<i>Eriogonum species</i>
Snakeweed	<i>Gutierrezia species</i>
Hymenoclea	<i>Hymenoclea monogyra</i>
Morning Glory	<i>Ipomoea species</i>
Burroweed	<i>Isocoma tenuisecta</i>
Bladderpod*	<i>Lesquerella spp.</i>
Wolfberry*	<i>Lycium andersonii</i>
Catclaw Mimosa	<i>Mimosa aculeaticarpa var. biuncifera</i>
Muhly	<i>Muhlenbergia species</i>
Primrose	<i>Oenothera species</i>
Devil's Claw	<i>Proboscidea species</i>
Globe Mallow*	<i>Sphaeralcea species</i>
Spike Dropseed	<i>Sporobolus contractus</i>
Graythorn*	<i>Ziziphus obtusifolia</i>

* Indicates species observed during field visits



Table 8 – Non-Native / Invasive Vegetation

COMMON NAME	BOTANICAL NAME
TREES	
Tree Of Heaven*	<i>Ailanthus altissima</i>
Chinaberry Tree	<i>Melia azedarach</i>
Mexican Paloverde*	<i>Parkinsonia aculeata</i>
Athel Tamarisk	<i>Tamarix aphylla</i>
Saltcedar	<i>Tamarix ramosissima</i>
Siberian Elm	<i>Ulmus pumila</i>
UNDERSTORY	
Amaranth	<i>Amaranthus palmeri</i>
Giant Reed	<i>Arundo donax</i>
Mustard	<i>Brassica species</i>
Poison Hemlock*	<i>Conium maculatum</i>
Bermudagrass*	<i>Cynodon dactylon</i>
Stinkgrass	<i>Eragrostis cilianensis</i>
Lehmann Lovegrass	<i>Eragrostis lehmanniana</i>
Cheese Weed	<i>Malva parviflora</i>
Horehound	<i>Marrubium vulgare</i>
White Mulberry	<i>Morus alba</i>
Watercress*	<i>Nasturtium officinale</i>
Tree Tobacco*	<i>Nicotiana glauca</i>
Tumbleweed*	<i>Salsola tragus</i>
Bristlegrass	<i>Setaria species</i>
London Rocket	<i>Sisymbrium irio</i>
Sowthistles	<i>Sonchus spp.</i>
Johnsongrass*	<i>Sorghum halepense</i>
Saltcedar	<i>Tamarix ramosissima</i>

* Indicates species observed during field visits

A key indicator species used to assess riparian health is the Fremont cottonwood (*Populus fremontii* var. *fremontii*). This species relies heavily on accessible groundwater, with roots capable of extending up to approximately 6 meters to reach saturated zones. Cottonwood distribution along the river reflects these hydrologic conditions, with the most substantial stands occurring in the Tumacácori and Tubac reaches, consistent with historical patterns. While mature cottonwoods remain present throughout much of the river corridor, recruitment of younger individuals is notably limited, creating an aging and uneven population structure.

Successful cottonwood recruitment depends on specific hydrologic, hydraulic, and geomorphic conditions, including the presence of sandy overbank alluvium and relatively slow-moving flows associated with either baseflow conditions or receding floodwaters. However, altered flow regimes—characterized by more intense storm events and increased erosive forces—have reduced the availability and stability of these recruitment surfaces. As a result, flood events that might otherwise support regeneration increasingly



contribute to the erosion of soils where seedlings and saplings attempt to establish, further limiting long-term population sustainability. Stage 0 Streams and floodplains as described above with good groundwater connectivity is the geomorphic stage that will support cottonwood recruitment.

5.6 WILDLIFE

Wildlife within the Santa Cruz River corridor reflects the complex interaction between hydrology, water quality, and riparian habitat conditions. The river supports a range of aquatic and riparian species, including fish, aquatic invertebrates, insects, amphibians, mammals, and migratory and resident bird populations, all of which depend on the presence, timing, and quality of flow.

Beavers historically populated Arizona's Rivers, including the Santa Cruz River, but were quickly trapped out of the area in the 1800s. Beavers naturally build debris jams and dams allowing the river to pool and spread its flow. Beavers have been reintroduced in other southwest areas of the state, primarily within the San Pedro River, and though numbers have decreased, the benefits they have provided for the San Pedro River system can be seen in the riparian health and groundwater levels. Unlike the SCR, the San Pedro River is mainly ephemeral throughout the year, which could stress the beaver communities as they do not have water flowing through their complexes as frequently.

The reintroduction of beavers to the SCR presents a unique opportunity to support long-term restoration goals by reestablishing a natural process driver that historically shaped riparian and floodplain systems in the region. Beaver activity, including dam construction and channel modification, promotes the slowing and spreading of water across the floodplain, increasing inundation, surface water storage, enhancing groundwater recharge, and reducing stream power. These processes directly support restoration objectives by reconnecting the River with its floodplain, increasing sediment retention, and improving geomorphic stability. Additionally, beaver-created pond and wetland complexes increase habitat diversity, provide refugia for aquatic species and supporting riparian vegetation recruitment, and overall enhance ecosystem resiliency.

As areas for the river are considered for implementation of restoration concepts as provided in this document, beaver establishment may be of interest in the future as means to further improve the health of the river. Beaver reestablishment would occur as a later phase of restoration project implementation provided there is an area suitable for beavers, and feasibility isn't a concern, as well as further studies being carried out to ensure that the beavers would be beneficial for the area and the River system as a whole.

5.7 THREATENED AND ENDANGERED SPECIES

The U.S. Fish and Wildlife Service (USFWS) Information for Planning and Consultation (IPaC) system were accessed and reviewed for the project limits. The species listed in **Table 9** below may be located within the project limits thus are potentially affected by project activities. The IPaC also identifies the project limits as overlapping with Critical Habitat for the Southwestern Willow Flycatcher and Yellow-billed Cuckoo. As part of this Masterplan, the project limits were not reviewed by a qualified biologist. As restoration projects move forward into design, a Biological Evaluation (BE) will be needed for each project.



Table 9 – Federally Listed Threatened and Endangered Species

Species (common name)	Species (scientific name)	Status
Mammals		
Jaguar	<i>Panthera onca</i>	Endangered
Ocelot	<i>Leopardus pardalis</i>	Endangered
Sonoran Pronghorn	<i>Antilocapra americana sonoriensis</i>	Experimental Population
Birds		
Cactus Ferruginous Pygmy-owl	<i>Glaucidium brasilianum cactorum</i>	Threatened
California Least Tern	<i>Sternula antillarum browni</i>	Endangered
Masked bobwhite (quail)	<i>Colinus virginianus ridgwayi</i>	Endangered
Mexican Spotted Owl	<i>Strix occidentalis lucida</i>	Threatened
Southwestern Willow Flycatcher	<i>Empidonax traillii extimus</i>	Endangered
Yellow-billed Cuckoo	<i>Coccyzus americanus</i>	Threatened
Amphibians		
Chiricahua Leopard Frog	<i>Rana chiricahuensis</i>	Threatened
Fishes		
Desert Pupfish	<i>Cyprinodon macularius</i>	Endangered
Gila Topminnow	<i>Peociliopsis occidentalis</i>	Endangered
Insects		
Monarch Butterfly	<i>Danaus Plexippus</i>	Proposed Threatened
Flowering Plants		
Arizona Eryngo	<i>Eryngium sparganophyllum</i>	Endangered
Beardless Chinchweed	<i>Pectis imberbis</i>	Endangered
Huachuca Water-umbel	<i>Lilaeopsis schaffneriana var. recurve</i>	Endangered
Pima Pineapple Cactus	<i>Coryphantha scheeri var. robustispina</i>	Endangered

5.8 LAND OWNERSHIP

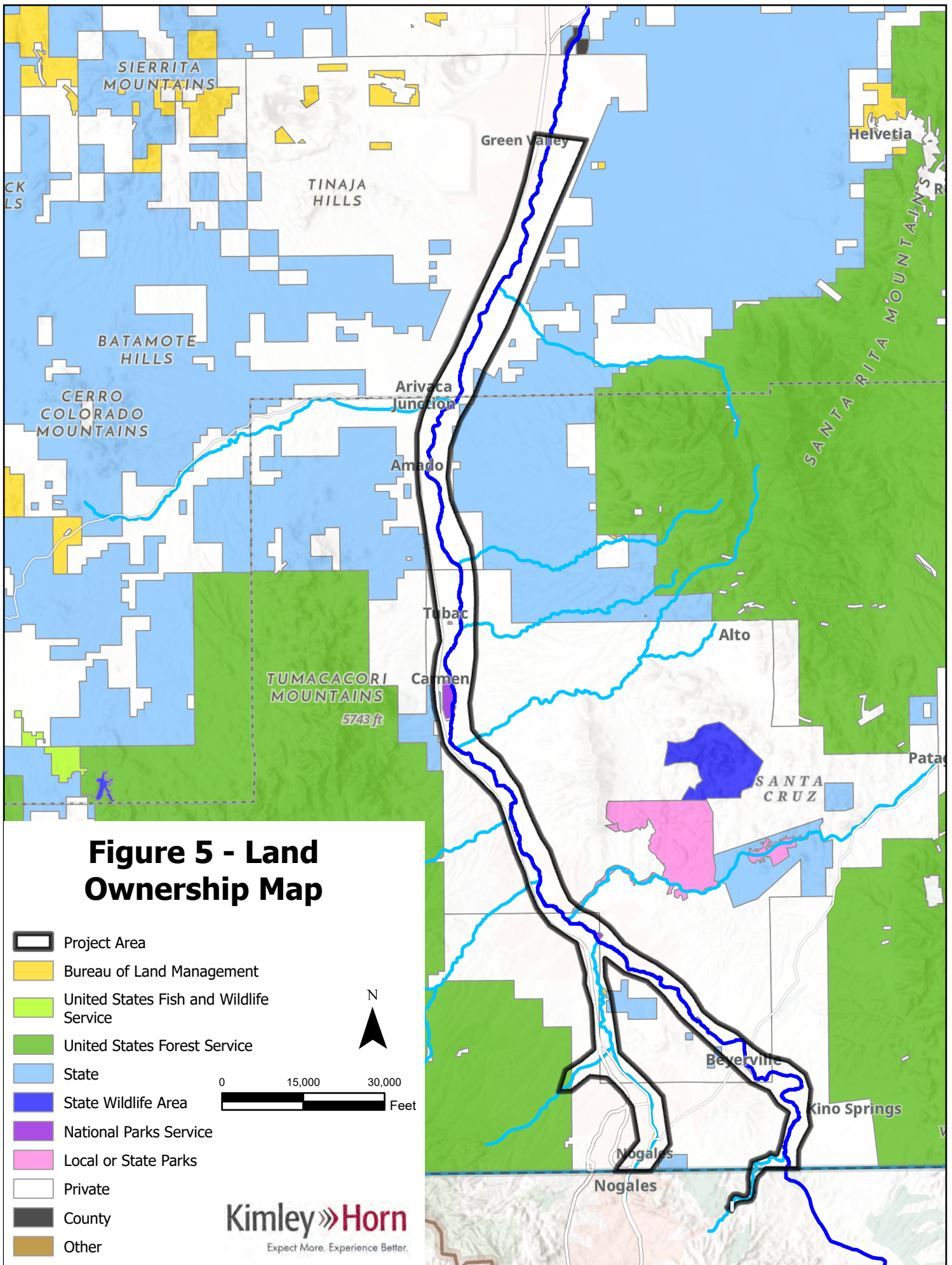
Land ownership within the project limits, including the active river corridor and geologic floodplain, is predominantly private. The private lands are comprised of large tracts of land with single owners, single owners of multiple adjacent parcels, and single owners of individual parcels. Arizona State Trust Lands comprise a small portion of the project limits, especially along the fringes of the river corridor. The National Park Service is also an important land owner, operating the Tumacácori National Historical Park.

The Santa Rita and Patagonia Mountains to the east and Atascosa and Tumacácori Mountains to the west are managed by the Coronado National Forest. The surrounding Nationals Forests, State Trust Lands, and



Private Ranches provide important natural open space habitat and corridors for many species that also utilize the Santa Cruz River.

See **Figure 5** for a Land Ownership Map.





5.9 RECREATION AREAS

The Juan Bautista De Anza Historical Trail, Tumacácori National Historical Park, and Coronado National Forest are among several recreation assets in and adjacent to the project corridor, **Figure 5** shows Land Ownership along and adjacent to the project corridor and **Figure 6** provides a Trails Map.

Along the De Anza Trail interpretive signage and guideposts are present, with fingerposts existing more internally within the trail network. Trailheads were observed to be in fair to good conditions while wayfinding posts were observed as poor to fair conditions. Maintenance of these features is important for both user experience and overall presentation, as they support community engagement and contribute to the social and economic value of the corridor.

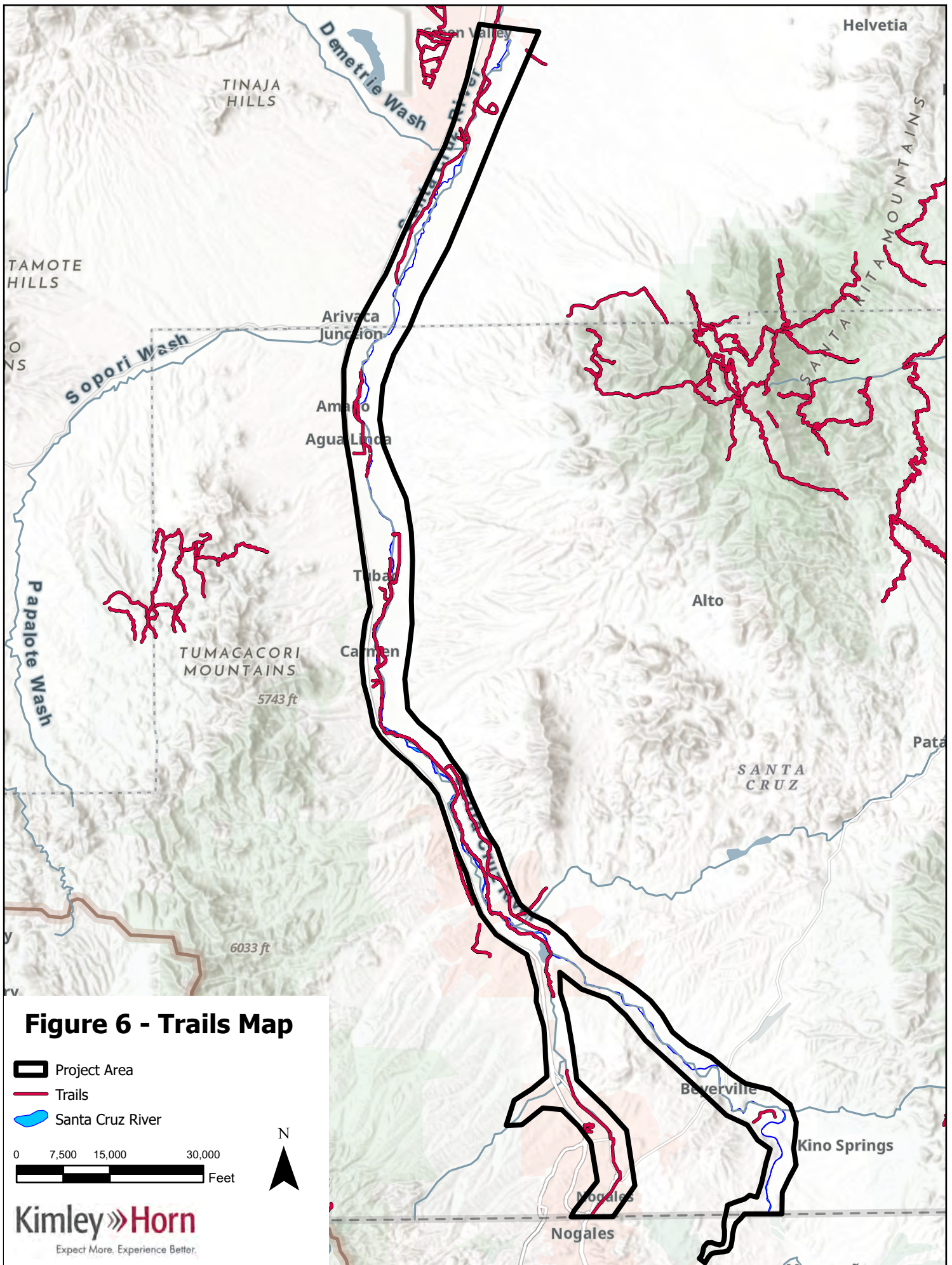
A large driver for outdoor recreational activities along the project corridor is birding, particularly in the Tubac and Tumacácori-Carmen area with locations such as Santa Gertrudis Lane. This area provides the space and habitat for many migratory and resident bird species throughout the seasons, drawing a large community of birders to seek out these recreational areas. Along with birding, these areas also frequent hikers and equestrians. Access for the De Anza trail is uneven and varies by reach, with northern sections within project limits being more accessible and open to the public and the southern areas having limited access to the public.

Implementation of restoration concepts is expected to improve river conditions and expand recreational and educational opportunities. Feedback from the SAG indicated that the number of existing trailheads is generally sufficient; however, targeted improvements—such as enhanced signage, wayfinding, and amenities (e.g. restrooms at Guy Tobin and/or Palo Parado trailheads) would improve usability and overall visitor experience.

With restoration concepts being implemented, the conditions of the River will be improved, hopefully encouraging better and more recreational and learning opportunities for the community and visitors. This subject was discussed in the SAG meetings and was determined that the number of existing trail access points was sufficient, with improvements to the conditions of the trailheads and particular reaches of the De Anza trail needing minor improvements to further attract the public eye. The Guy Tobin and Palo Parado trailheads are in good condition, but updates to informative signing and wayfinding as well as installing bathrooms could tremendously benefit the appeal of these areas. The SAG also documented multiple informal access points, such as Santa Gertrudis Lane, that could benefit from formal trailheads.

Implementation of restoration concepts has the potential to impact recreation features in the project limits, most notably trails. Further development and design of restoration projects shall consider these recreation features, and plan for continued and uninterrupted use of the recreation facilities.

SCC is currently completing a study on pedestrian and recreation connectivity along the corridor. This results of the separate study should compliment this Restoration Masterplan.





5.10 ADJACENT INFRASTRUCTURE (EXISTING AND PLANNED)

The project limits are generally bound by the Union Pacific Railroad (UPRR) on the east and I-19 on the west with varying levels of development throughout the river corridor. Development is typically denser on the west bank of the river and throughout much of the river corridor the development encroaches on the natural (aka historic) floodplain. Land uses of the encroached development are heavily agricultural, but also include industrial, residential, and commercial. The UPRR runs north/south connecting Nogales to Tucson. The railroad crosses the SCR near the confluence of Sonoita Creek and the SCR. From that point north the UPRR is located along the east bank of the SCR and throughout much of the project limits the UPRR encroaches into the historic floodplain, limiting the geomorphic floodplain available to the river to occupy during larger storm events and to meander across. Tributaries from the east and west cross UPRR and I-19, respectively, before entering the SCR. In many cases, but most notable along the UPRR, the drainage infrastructure to convey these tributaries is undersized. These structures disrupt the natural conveyance of runoff and sediment from the tributaries into the SCR which has further disrupted the hydraulic and geomorphic balance of the SCR.

The most notable planned infrastructure improvements along the river corridor are the improvements to NIWTP and the IOI. These planned improvements would result in a greater capacity of the treatment plant and collection system, resulting in fewer breaches of the system thus greater overall water quality, along with an anticipated increase in effluent discharge of up to 15 MGD (100% increase).



6 STAKEHOLDER ENGAGEMENT

Outreach efforts for the SCR Restoration Master Plan focused on building a Stakeholder Advisory Group (SAG) for people and organizations that have a vested interest in land use surrounding the River. Initial outreach began in late 2025 with invitations to the identified stakeholders, comprised of representatives of landowners, local agencies, environmental organizations, and technical experts. The SAG included several private landowners adjacent to the SCR as well as member of the following organizations:

- U.S. International Boundary & Water Commission
- Consulate General of Mexico in Nogales, AZ
- Arizona Department of Environmental Quality
- Santa Cruz County
- Pima County Regional Flood Control District
- City of Nogales, AZ
- Nogales International Wastewater Treatment Plant
- Tubac Nature Center
- Tumacácori National Historical Park
- Friends of Santa Cruz River

The SAG convened a total of three times between December 2025 and April 2026 through facilitated hybrid (in-person and virtual) meetings. Each meeting included presentations on project progress, breakout discussions, and interactive activities designed to gather feedback on existing conditions, restoration priorities, and proposed concepts.

Engagement activities captured both qualitative and quantitative input for the Master Plan.

- Activities for the first Stakeholder Advisory Group meeting on December 10, 2025, included a live polling exercise through the platform Mentimeter to identify high-level stakeholder values, priorities, and concerns. The polling exercise was followed by a hands-on map review where participants were asked to mark site-specific feedback directly on Master Plan maps.
- Engagement for the second SAG meeting on February 25, 2026, incorporated a virtual survey to refine and rank restoration priorities across categories such as water quality, habitat connectivity, groundwater recharge, and recreation. A virtual fieldwork photography tour further supported stakeholder understanding by highlighting on-the-ground conditions along key river segments.
- The final SAG meeting on April 22, 2026, focused on presenting and gathering feedback on conceptual restoration approaches, allowing stakeholders to react to varying levels of intervention treatments and allowed them to share their considerations related to implementation, environmental impacts, and coordination needs associated with those options.

Throughout the Stakeholder Engagement process the SAG completed surveys and provided feedback to define restoration priorities. The survey respondents provided their ranked choices for their goals and objectives for stream restoration projects. The top 5 restoration outcomes were:

1. Increased Surface Water Quantity
2. Improved Groundwater Recharge / Availability
3. Additional Habitat and Green Space Connectivity
4. Improved Water Quality
5. Enhancement of Native Vegetation



In addition to SAG meetings, Kimley-Horn conducted public-facing outreach through participation in the Sonoran Institute's Santa Cruz River Research Day, held on April 28, 2026. This hybrid event at Pima Community College's Downtown Campus provided an educational presentation overview of the Master Plan, fostered collaboration among researchers and practitioners, and offered both English and Spanish comment opportunities on the restoration concepts. Attendees were subsequently invited to submit feedback through paper and online comment forms. The comment forms also allowed attendees to opt-in for email updates when the Master Plan is produced in draft and final forms.

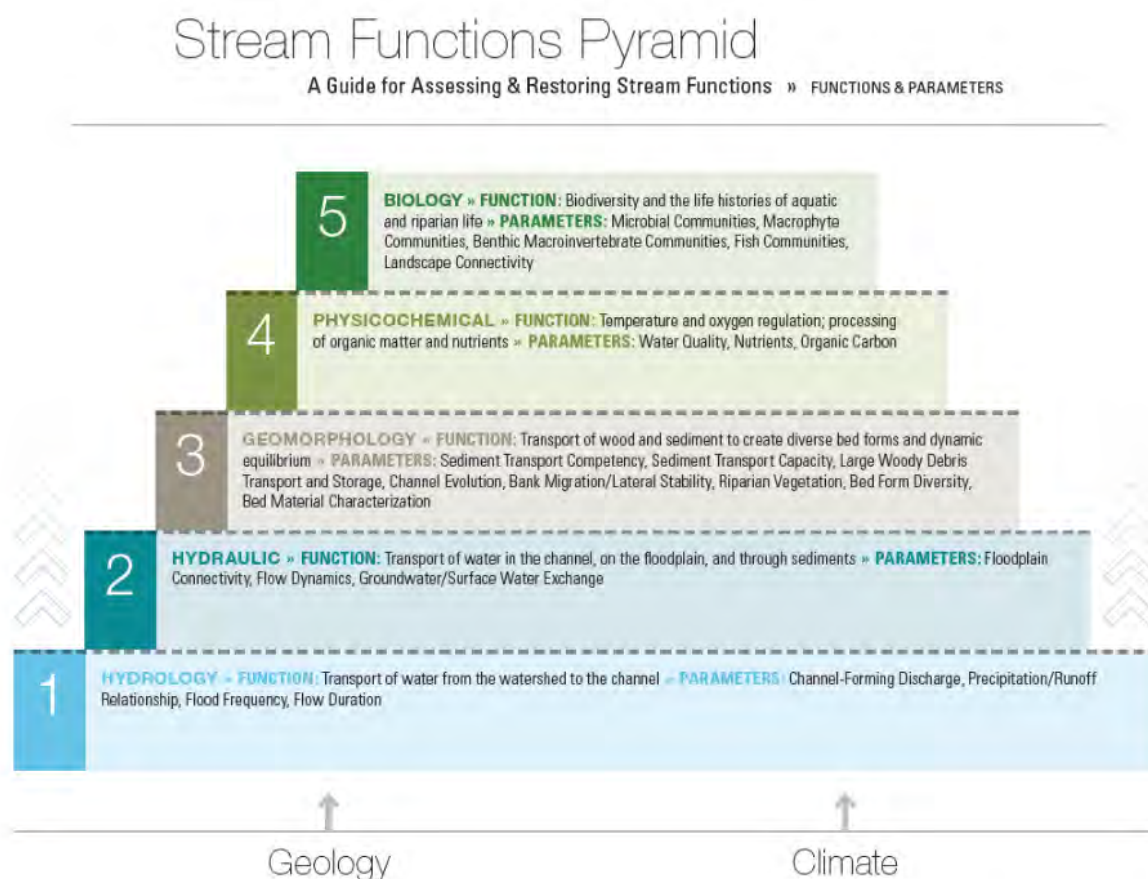
A full report of all outreach activities and detailed notes on feedback received during each SAG meeting is included in the Appendices.



7 RESTORATION APPROACH

The Restoration Goals, Objectives, and Approach for this Masterplan were defined based on the feedback from the SAG following the EPA's *A Functional-Based Framework for Stream Assessment and Restoration*. This function-based framework was expanded with other literature including the NRCS *National Engineering Handbook (Part 654) Stream Restoration Design* and the USDA *Guidance for Stream Restoration and Rehabilitation*. The functional based approach and these documents shall continue to be used as resources for the future advancement of the concepts presented in this Masterplan.

The Functional-Based Framework outlines a hierarchy of five general functional categories. Assessment of stream health and function, along with restoration approach require an understanding of how the categories work together and build upon each other within the hierarchy. It is also critical in stream restoration to develop approaches, based on the goals and objectives, which address the appropriate functional categories within the hierarchy. The stream function framework showing the hierarchy of the five general functional categories is shown in the EPA's Functional-Based Stream Pyramid (see **Figure 7**).



Harman, W.A., 2009

Figure 7 – Functional-Based Stream Pyramid



7.1 GOALS AND OBJECTIVES

Goals for the project describe long-term SCR conditions and outcomes whereas objectives give a defined framework for measurable or actionable steps used to advance those goals. Objectives include specific projects and restoration approaches that can be applied to select areas along the River corridor. The restoration alternatives designed for this project, as discussed in **Section 7.2**, act more as implementation tools that can be applied to multiple stretches of the 40-mile project area as opposed to goals themselves. Site-specific objectives will be established and refined as the project alternatives are advanced in future phases beyond the project's current scope. The goals below were developed to achieve the priority outcomes defined by the SAG.

1. Increased Surface Water Quantity
2. Improved Groundwater Recharge / Availability
3. Additional Habitat and Green Space Connectivity
4. Improved Water Quality
5. Enhancement of Native Vegetation

Primary Restoration Goals

Goal 1 – Re-establish a Self-Sustaining, Process-Driven River and Floodplain

Starting with the Functional-Based categories that make up the River system; restore hydrologic, hydraulic, geomorphic, and ecological processes such that the River evolves toward a dynamic but stable condition capable of self-maintenance under existing and future effluent flow changes, climate changes, and evolving sediment regimes.

Goal 2 – Maximize Floodplain Connectivity where Feasible

Where valley geometry, infrastructure, and land use allow, reconnect the River to an active floodplain. This goal will require restoration techniques that focus on the hydraulic and geomorphic stream function categories.

A reconnected and active floodplain will reduce the capacity of the main channel, allowing flow to spread out across the floodplain with an increased frequency of inundation. The wider flow across the floodplain slows down, increasing storage of the flood wave and time available for groundwater recharge. The reduced capacity within the main channel also reduces the power and shear stress within the channel resulting in less bed and bank erosion, thus stabilizing the incision that is a widespread challenge throughout the project limits. These actions have a secondary result of increasing sediment storage, enhancing the availability of water to riparian vegetation, and improving habitat diversity.

Goal 3 – Guide River Evolution Toward Stable Equilibrium, Not Arrest

Enable the River to transition away from persistent degradation or incision toward a recovering quasi-equilibrium state, recognizing that channel movement and episodic (storm/flood) disturbances are natural *and* necessary processes. This goal will require restoration techniques that focus on the hydraulic and geomorphic stream function categories.

A more stable Santa Cruz River is highly dynamic, with multiple braided and meandering flow paths. These flow paths have minimal capacity above that of the base flow and the meandering and braided nature results in a low-flow channel flow length that is substantially longer than that of the floodplain valley. The long flow



path has a low slope, resulting in low flow velocities, sheer stress, and energy, thus less opportunity for bed and bank erosion, and ultimately channel incision.

Allowing the river to be dynamic, within a quasi-equilibrium state reduces the risk of failure of restoration projects, limits the need for continuous management of the stream functions, and allows the project to meet the goals, objectives, and priority outcomes for the long term.

Goal 4 – Protect Critical Infrastructure and Essential Land Uses

Reduce unacceptable risks to infrastructure, utilities, trails, and private property while avoiding unnecessary confinement of river processes and preserving restoration potential wherever possible.

As previously discussed, throughout the project limits, much of the River has been encroached upon by different land uses and/or infrastructure. In many areas the encroachment is at risk to erosion and lateral migration of the River, and is unprotected. Protection of these encroachments may be necessary in the future. These projects shall consider the stream function hierarchy and opportunities to apply stream restoration techniques, which will further reduce velocity within the channel, thus reducing the erosion risk to the land use / infrastructure.

Goal 5 – Integrate Community Access and the Public Realm

Provide access to the River, trails, and interpretive opportunities that complement rather than constrain river and floodplain processes, supporting long-term ecological function and community connection to the River and floodplain corridor, providing learning and integration opportunities.

Objectives Supporting Implementation

Objectives Supporting Goals 1 and 3: Process and Evolution

- Favor the least intrusive Restoration methods capable of re-initiating natural processes, prioritizing preservation, low-tech process-based restoration (Stage 0 of the geomorphic evolution cycle or LTPBR), and prioritizing approaches before form-based (heavy earthmoving) interventions
- Re-establish appropriate hydraulic geometry across multiple flow stages, including baseflow channels, inset floodplains, bankfull benches, secondary channels, and off-channel wetlands
- Increase geomorphic diversity at valley or floodplain scales to support multiple disturbance-adapted vegetation communities and habitat types

Objectives Supporting Goal 2: Floodplain Connectivity

- Increase frequency, duration, and extent of floodplain inundation appropriate to valley setting and baseflow conditions
- Increase groundwater recharge as secondary benefit of floodplain connectivity.
- Prioritize valley-scale reconnection approaches where space and risk tolerance allow; use inset floodplains (i.e. floodplain bench or Rosgen Priority 2 Restoration) where full reconnection is not feasible



Objectives Supporting Goal 4: Infrastructure Protection

- Constrain channels only where necessary to protect irreplaceable infrastructure, utilities, or development
- Avoid system-wide stabilization approaches that permanently arrest River evolution unless no viable alternatives exist

Objectives Supporting Goal 5: Public Realm Integration

- Design trails and access to accommodate changes in flood/flow inundation, favoring soft-surface trails, boardwalks, overlooks, and other site-specific approaches
- Incorporate interpretive features to communicate River functions and River rehab intent to the public
- Establish, reestablish or repair De Anza Trail interpretive signage, guideposts, and wayfinding.

Objective Across all Goals: Vegetation and Adaptive Capacity

- Restore riparian and floodplain vegetation as a process amplifier, focusing on natural recruitment, wood supply, shading, hydraulic roughness, and positive eco-geomorphic feedback

Alignment with Restoration Alternatives Matrix (see Appendices)

The goals and objectives outlined above directly inform the use of the SCR Restoration Alternatives Matrix (see Appendices). Alternatives function as implementation tools applied selectively based on valley setting, risk tolerance, hydrologic conditions and social constraints. Outlined below is a breakdown of the Alternatives Matrix and how each bucket correlates to the goals and objectives.

- Preservation (I): Highest priority action; supports all goals where existing high-functioning conditions occur
- Stage 0/PBR Approaches (A-1, A-2): Primary tools for achieving Goals 1-3
- Channel and Floodplain Re-Establishment (B, C): Transitional tools to achieve Goal 2, where valley-scale reconnection of the channel(s) to the floodplain is warranted
- Confined or Stabilized Channels (D, E): Risk management tools supporting Goal 4 only
- Hybrid Approaches (F): Corridor-scale strategies balancing process and infrastructure protection
- Vegetation Restoration (G): Supporting objective that amplifies outcomes of all active restoration approaches
- Human Connection Enhancements (H): Public realm improvements that do not constitute ecological restoration but certainly compliment them

7.2 STREAM REHABILITATION APPROACH AND ALTERNATIVES

Rehabilitation approaches for the project were determined using documented data collection and stakeholder engagement, as well as assessing the River's stability through geomorphic stage analysis and permitting/restricting factors in surrounding areas. River function and health vary substantially across project limits; therefore, the alternatives framework was intentionally developed as a suite of approaches



that can be applied selectively based on reach-specific needs and constraints. Consistent with the project's internal goals and objectives as outlined in **Section 7.1**, restoration alternatives are treated as implementation tools (rather than goals themselves) and are applied in a manner that supports long-term process recovery, floodplain connectivity where feasible, and protection of critical infrastructure where required.

Development of rehabilitation / restoration concepts took the EPA's Functional-Based Stream Pyramid into consideration, as shown in **Figure 7** with an understanding that restoring the physiochemical or biologic functions at the top of the pyramid require the hydrologic, hydraulic, and geomorphic functions to be in a state of equilibrium or quasi-equilibrium.

Primary drivers for these concepts are geomorphic condition of the River followed by constraints and risk tolerance, geomorphic condition being the most influential. Mapping of the channel evolution stage (**Exhibit B**) are coupled with existing stream functional standing and geomorphic condition in the Restoration Matrix. A comprehensive constraints analysis was not completed for this master plan, as several key factors—such as landowner willingness, archaeological resources, subsurface utilities, and water rights—are not fully defined at this planning level. As a result, these unknowns were not a limiting factor in the development of restoration concepts or approaches. Instead, opportunities were intentionally evaluated under relatively unconstrained conditions to illustrate the full range of potential restoration and rehabilitation approaches along the corridor. This approach supports development of a long-term vision for a more connected, resilient, and functionally dynamic river system

After the geomorphic conditions were established, considerations began focusing on the secondary driving factors such as risk tolerance and known or visual constraints, including valley setting, land use, and infrastructure limitations. The primary approach to developing rehabilitation / restoration concepts was to define alternatives to aid the river into returning to Stage 0 of the channel evolution process. Where known constraints limit lateral adjustment or floodplain reconnection, alternatives that provide functional gains while reducing unacceptable risks to utilities, recreational areas, private property, and other assets were chosen. Where these constraints exist, returning to Stage 0 may not be feasible, thus is not considered the primary approach.

Evaluation of the channel evolution stage, existing stream function, geomorphic conditions, and constraints and risks were assessed for the entire project limits. Restoration concepts were developed for nearly the entire project limits, with some areas having a 'do nothing' recommendation, as described below.

The reach of Oso Wash extending south into Sonora was evaluated for rehabilitation / restoration opportunities. This reach has a steep gradient and narrow valley, typical with smaller tributaries or near the headwaters of larger tributaries. Further upstream the wash is constrained by transportation infrastructure. The primary need for restoration is due to the poor water quality of effluent discharged from the Lomas de Anza and Puerta de Anza WWTP. Alternatives within this reach of the project should focus on improvements to the primary treatment processes or inclusion of secondary treatment processes to improve the quality of effluent discharged into Oso Wash.

Nogales Wash and Potrero Creek drain the most urbanized areas of the project, Nogales, Sonora and Nogales, Arizona. The watersheds are heavily developed and the watercourses are engineered for flood control. The channels are undersized for flood conveyance with much of the businesses and homes along Nogales Wash and Potrero Creek located in the FEMA Floodplain. These constraints significantly limit opportunities for rehabilitation / restoration. **Section 7.3** of this report discusses trash. Alternatives within the Nogales Wash and Potrero Creek reaches should focus on trash capture opportunities.



The Santa Cruz River from Kino Springs downstream to the confluence with Potrero Creek is one of the ephemeral stretches of the corridor. As discussed in **Section 5.1**, Potrero Creek and Sonoita Creek are two of the larger tributaries into the system, meaning that not only does the SCR begin to receive perennial effluent discharge, but the valley naturally changes here as well. Downstream the geologic floodplain, or valley width, is much wider than this ephemeral reach upstream. Within this ephemeral reach the channel appears highly dynamic, meandering across the valley. Incision is minimal to non-existent. Erosion control features exist within the overbanks at key locations and appear to be functioning well. Overbank vegetation is limited due to the lack of water. This reach of the SCR could be preserved as-is, with rehabilitation / restoration opportunities focused on native vegetation enhancement.

The remainder of the project corridor had restoration concepts prepared, within the categories shown in the Restoration Matrix. Many areas were candidates for multiple different restoration concepts. See **Exhibit D** for an overall of the restoration alternatives and **Exhibits E – L** for a breakdown of each category.

The progression of restoration concepts begins with processed based restoration solutions (PBRs) which are low-tech and intended to mimic or amplify natural processes using local materials and efforts. From there, concepts become more intensive as constraints, risk tolerance, and reach conditions warrant greater intervention.

Typical sections for restoration concepts A, B, C, & D/E were prepared to aid in visualization of the rehabilitation. These typical sections are shown as **Exhibit N**.

When considering the components driving the restoration concepts, levels 2, 3 and 5 of the Stream Functionality Pyramid are the main areas the restoration concepts will treat; Hydraulics, Geomorphology, and Biology. Hydrology and Physiochemical levels is more-so regarded with upgrades to the NIWTP, both the quantity and quality of the effluent.

Hydraulics

Restoration considerations would include reconnecting the floodplains by lowering the overbanks or raising channel bed elevations, encouraging flows to spread by introducing secondary channels, and grade control structures or rock weirs.

Geomorphology

Managing the incision and widening processes of the River and balancing sediment transport regimes will strengthen the structural complexity and integrity of the channel banks. LTPBR such as beaver dam analogs (BDAs) and post assisted log structures (PALs) can be utilized, along with resetting bed elevations, inset floodplain creation and sediment retention strategies.

Wetland Encouragement and Creation

The river historically was similar to a low and slow-flow wetland as mentioned in **Section 4**. Wetland preservation, enhancement, restoration, and creation is more likely to occur at outfalls of large tributaries to the SCR due to high sediment deposition and more water running through the area, likely contributing to the groundwater levels in the area.

During site visits, the confluence of Peck Canyon and the SCR is comparable to what historical cienegas could have looked like, with the exception of low cottonwood recruitment, observed garbage, and cattle activity. Enhancing and amplifying the natural processes occurring at this confluence could promote further wetland development, with similar opportunities at other tributary junctions where conditions may be



modified to encourage wetland formation. These areas are likely to coincide with zones of elevated groundwater, supporting soil moisture retention, and facilitating the establishment and expansion of riparian vegetation. Over time, this would improve habitat quality, strengthen ecological resilience, and enhance floodplain connectivity. Such restored confluence areas could become high-value habitat features while also providing opportunities for passive recreation and education. Wetland opportunities are shown on **Exhibit K**, showing the Oso Wash confluence as one of these key potential areas. The confluence provides favorable conditions for wetland development due to its ability to promote flow dispersion, increased floodplain interaction, and sediment deposition, giving the area means to retain soil moisture. Santa Cruz County is currently evaluating options to add secondary collection and treatment for the wastewater that enters the U.S. via Oso Wash, as well as increasing treatment capacity which would allow larger volumes to be discharged into the wash.

Wetland creation or other restoration activities at tributary confluences or further upstream in tributaries must consider the importance the tributaries play on the sediment supply and geomorphology of the SCR.

Riparian Vegetation Restoration Scheme

Vegetation planting and seeding, along with establishment will be an important aspect of all the restoration concepts. Removal and control of toxic and invasive species will also be critical to the success of restoration concepts. Additionally, areas along the project corridor could also benefit from stand-alone vegetation enhancements. See **Exhibit M** for a map of Vegetation Enhancement opportunities.

The riparian vegetation restoration approach will supplement preserved buffer through additional plantings. The restoration area will be planted with a mix of pioneer and climax species selected and arranged to meet the following objectives:

- Establish a mix of shade-intolerant canopy and shade-tolerant understory species.
- Provide or protect a vegetative source of dominant species.
- Establish or protect a local seed source for those species less likely to migrate into the restoration area.
- Stabilize disturbed or high stress areas.
- Provide a variety of habitats (i.e., some sections shaded and some unshaded) based on River hydrology, hydraulics, and geomorphology.

Two primary planting schemes have been developed considering site hydrology, soils, and disturbance regimes and are referenced to natural communities. These include hydro/meso-riparian plant communities (base flow to tie out slope areas) and xeroriparian plant communities (secondary banks to overbanks). Within these primary planting schemes, two categories of improvements are proposed. These include:

- **Revegetation Areas:** These areas are generally lacking in the associated plant communities and are recommended for intensive revegetation efforts.
- **Supplemental Revegetation Areas:** These areas contain existing, desirable plant communities that are recommended for selective revegetation efforts to target specific restoration strategies including increasing cottonwood recruitment or overall hydro/meso-riparian plant canopies.

Planting lists for the two primary planting schemes should be developed based on the existing vegetation found in the area that is associated with each scheme (refer to **Section 5.5, Tables 5 and 6**). The planting list should include species that are readily available and have a reasonable expectation of survival. For a



given zone and species, a plant source and planting type (e.g., containerized, treepot, or bare root/tubeling, live stake/pole planting) should be recommended based on the existing plant community. The selection of species also will depend on availability from local nursery sources.

7.3 TRASH REMOVAL AND CAPTURE APPLICATIONS

Trash is a pervasive and persistent factor seen in the field and discussed as a concern in the SAG, with buildup or “dams” occurring in various places along the River corridor. The primary sources of trash along this corridor are the urbanized areas in Nogales, Sonora and Nogales, Arizona. The trash from these areas is conveyed into the SCR via Nogales Wash/Potrero Creek.

Removal of trash can supplement the restoration concepts along the length of the project, with basic clean-up measures being taken in all stretches and larger measures being taken for areas that experience extreme trash deposition and/or buildup over time. The “Trash Dam” near Tumacácori is one of the well known areas where trash buildup has impacted the stream function. The Peck Canyon confluence is another area of major concern, with garbage depositing in the braided channels, creating multiple large trash piles that block flow. Removal of this waste and monitoring the locations for additional trash-removal outings would benefit these areas greatly. Capture of trash near its source as well as the implementation of trash-capture devices/infrastructure upstream could be implemented to better manage rubbish in the River. Areas that could be considered for trash capture can be seen in the attached Restoration Exhibits.

Sonoran Institute has been involved in trash-removal and monitoring on the SCR in the Tucson area for six years. The River has improved tremendously in beauty and health in part by the help of SI and the community/volunteers who help keep the River clean. A similar program could benefit the SCR in the project corridor.

7.4 PILOT PROJECTS

The three pilot projects depicted on **Exhibit O** represent restoration concepts at specific locations in the project. From low-tech, process-based restoration (LTPBR) approaches to more intensive, large-scale earthwork designed to realign the channel. These projects are not uniformly aimed at returning the river to a pre-disturbance or “Stage 0” condition within the channel evolution framework. Instead, they are strategically designed to incrementally improve geomorphic function by shifting the system toward more stable and connected states. In many cases, this involves facilitating a transition from a more degraded condition (e.g., Stage 5) to a less incised and more floodplain-connected phase (e.g., Stage 4), rather than attempting full historical restoration. This phased approach acknowledges existing constraints while targeting achievable improvements in channel stability, floodplain interaction, and overall ecological function.

Collectively, these pilot projects are intended to function as a learning laboratory, providing opportunities to implement and evaluate varying levels of intervention across a range of geomorphic settings and scales. By testing both process-based and more structural approaches, the projects are designed to address different drivers of instability and restoration objectives within the corridor. Monitoring of hydraulic, geomorphic, and ecological responses will inform adaptive management, allowing refinement of design approaches over time. The projects were intentionally selected to represent diverse conditions and treatment strategies, generating transferable insights that can guide and scale future restoration and rehabilitation efforts throughout the river system and as this master plan is fully implemented.

Pilot Project 1 - Amado



This pilot project restores hydraulic and geomorphic connectivity along the Santa Cruz River valley by re-establishing an active floodplain supported by increased perennial baseflow from future effluent increases. This increased flow enables a transition from a confined single-thread channel to a more distributed, resilient river–floodplain system.

The design re-meanders the primary thalweg within the valley bottom to better align with natural form and reduce risk to adjacent infrastructure, including localized channel relocation to protect the railroad. Secondary flow paths and distributary channels are incorporated to disperse flow, increase residence time, and reduce erosive forces in the main channel.

Valley-scale grade control features are installed to maintain bed elevations and prevent long-term incision while allowing sediment to move through the system. Smaller scale restoration structure promotes the creation of a pool-riffle sequence within the meandering thalweg. Floodplain grading reconnects low-lying areas, increasing the frequency of inundation and potentially promoting development of wet meadow and emergent wet conditions if future hydrology and base flow increases allows.

Revegetation with native species, potentially including willow, cottonwood, and mesquite (if hydrology allows). Together these hydraulic, geomorphic, and vegetation rehabilitation will support bank stability, increases hydraulic roughness, and enhances habitat complexity. Together, these elements create a more dynamic, self-sustaining system that improves groundwater recharge, water quality, supports diverse habitat, and better maintains long-term stability with lower maintenance.

This location is downstream of the current perennial base flow extents, thus within an ephemeral channel reach. Increase effluent discharge would likely extend the baseflow extents and this project location could become perennial in the future. The project could be phased, with channel and floodplain restoration along with establishment of xeroriparian vegetation. As surface flow and/or groundwater conditions allow, a later phase could include establishment of mesoriparian and riparian vegetation.

Pilot Project 2 - Palo Parado

This pilot project focuses on enhancing the existing Santa Cruz River channel without altering its alignment by applying low-tech, process-based restoration (LTPBR) measures to improve bank stability, maintain bed elevations, and adapt the riparian corridor to increased perennial baseflow from the upstream wastewater treatment facility. The approach relies on distributed, nature-based interventions that work with channel processes rather than imposing rigid structural controls.

Bank stability is improved through the installation of post-assisted log structures (PALS), engineered log jams, and beaver dam analogs (BDAs) placed at targeted locations along the channel margins and within the active channel. These features increase hydraulic roughness, promote localized sediment deposition, and reduce near-bank shear stress, allowing banks to stabilize gradually through sediment accumulation and vegetation establishment. Unlike continuous hard armoring, these measures create a patchwork of roughness elements that dissipate energy while maintaining channel variability and habitat complexity.

Bed stability and vertical control are achieved using strategically placed channel-spanning and partial-spanning wood structures that function as distributed grade controls. These features raise local water surface elevations, reduce stream power, and limit progressive incision under the increased baseflow regime while allowing sediment to pass through and adjust naturally. The cumulative effect is a series of small elevation controls that maintain overall channel grade and enhance floodplain interaction without creating abrupt drops or hydraulic discontinuities.



The increased baseflow regime is leveraged to promote greater lateral connectivity and sustained soil moisture along channel margins. LTPBR structures help reconnect low benches and secondary channels by backing up water locally and encouraging overbank flow during relatively frequent events. This results in expanded zones of saturation that support riparian and wetland vegetation establishment within the existing corridor footprint.

Vegetation treatments focus on accelerating the transition to a riparian community adapted to higher and more persistent moisture conditions. Native species such as willow, cottonwood, and mesquite are planted in association with wood structures and depositional areas where moisture and fine sediments accumulate. Over time, vegetation reinforces the roughness elements, further stabilizes banks, and contributes to self-sustaining feedback between flow, sediment, and plant growth.

Pilot Project 3 - Oso Wash

A nature-based, process-driven wetland system is proposed at the confluence of Oso Wash and the Santa Cruz River that promotes flow dispersion, sediment sorting, and floodplain interaction to support the development of a dynamic mosaic of emergent wetland and riparian habitats. The system relies on distributary flow paths, roughness elements, and topographic variability rather than fixed infrastructure, allowing wetland conditions and water quality benefits to evolve naturally over time with minimal maintenance.

Downstream of the confluence, restoration efforts would extend these process-based principles along the river corridor by enhancing floodplain reconnection, increasing channel complexity, and improving overall geomorphic function. This includes selectively reintroducing meanders within the available valley bottom to lengthen flow paths, reduce stream power, and promote more frequent interaction with the floodplain. Floodplain grading and targeted lowering of inset surfaces would increase the frequency and extent of overbank flow, supporting greater groundwater recharge, soil moisture retention, and establishment of riparian vegetation.

Vegetation improvements would focus on establishing native riparian species, such as willow and cottonwood (where hydrologically supported), to reinforce channel stability, increase hydraulic roughness, and enhance habitat complexity. Together, these downstream treatments build upon the wetland system at the confluence to create a more continuous, connected, and resilient river–floodplain corridor that improves water quality, supports diverse habitat, and sustains geomorphic function over time.



8 PROJECT COST

Construction costs were evaluated for the different rehabilitation / restoration categories. Costs were broken into the following categories to assist in estimating.

Site Prep consists of items such as clearing and grubbing, removal and treatment of noxious and invasive species, pruning of trees to allow equipment access, preservation fencing for areas to be preserved, and dewatering and/or diversions of the flowing water.

In-stream restoration structures include items such as post-assisted log structures (PALS), engineered log jams, beaver dam analogs (BDAs), boulder and/or woody debris bank stabilization, rock sills, scour aprons, and rooting mats. Larger engineered grade control structures should be considered in stages 3-5 of channel evolution where incision is significant and the channel flowline needs to be re-set before more process based restoration activities can be completed.

Vegetation plantings will be an importation aspect of all restoration activities. These costs include items such as pole or pot plantings, focused areas for planting of trees, shrubs, and grasses, seeding, as well as an establishment period where newly planted vegetation is monitored and replaced if necessary. Irrigation during an establishment period is assumed for the restoration concepts that include re-grading and or planting away from the perennial base flow. Browser cages may be needed to protect newly planted vegetation from browsing animals and allow the plants to mature to a point they are more resilient.

Earthwork will be significant on some alternatives with minimal earthwork costs on other alternatives. Earthwork could consist of significant removal of material in overbanks that are no-longer connected, creation of channel plugs in incised sections, preparation of terraces and benches, bank stabilization prep grading, and fine grading to shape the channel, banks, pools, and riffles.

Soft costs include items such as design and permitting, mobilization of the contractor, management of the contractor, survey and layout, and stormwater pollution prevention.

Table 10 provides a cost per acre for the predominant restoration concepts prepared in this Masterplan. These unit costs were derived from other restoration projects throughout the west, generally less than 50-acres in size, and constructed by contractors. Concepts A1, and to a lesser degree A2 are commonly constructed by conservation organizations with significant volunteer labor, which can dramatically reduce project costs.



Table 10 – Stream Restoration Costs

Category	Cost per acre
Concepts A1/A2	
Site Prep	\$9,000
In-stream Restoration ¹	\$12,000
Planting ²	\$26,000
Earthwork	\$10,000
Soft Costs	\$17,100
Total	\$74,100
Concept B	
Site Prep	\$19,000
In-stream Restoration ¹	\$45,000
Planting ²	\$134,000
Earthwork	\$96,000
Soft Costs	\$88,200
Total	\$382,200
Concept C	
Site Prep	\$13,000
In-stream Restoration ¹	\$36,000
Planting ²	\$78,000
Earthwork	\$51,000
Soft Costs	\$53,400
Total	\$231,400
Concept D	
Site Prep	\$11,000
In-stream Restoration ¹	\$27,000
Planting ²	\$37,000
Earthwork	\$42,000
Soft Costs	\$35,100
Total	\$152,100

1 – Costs do not account for engineered grade control structure. Larger projects could require valley-scale grade control structures to set the thalweg elevation at the downstream and/or upstream ends of the project. Depending on the size of the engineered grade control structure, planning level costs should account for \$250k-350k per grade control.

2 – Concepts B & C assume irrigation would be necessary to establish vegetation that does not have access to perennial baseflow.

Concept B is the most intrusive restoration concept, thus the highest unit cost. Additionally, each project associated with Concepts B and C will cover a greater area than Concepts A1/A2 or D, which are more focused on the active channel and immediate overbanks, rather than the wider valley floodplain. Phasing may be necessary to complete projects over time and to restore the river as funds become available. With large projects, an economy of scale can be expected which would reduce the overall project cost vs phasing.



Table 11 provides the total acreage of restoration proposed for each category, as shown on Exhibits D – L. Many of these acreages reported are duplicate, as in some cases along the corridor, restoration areas could utilize more than one concept to achieve a level of restoration. These areas of overlap are not intended to be cumulative. For example, an area listed as B or D could utilize concept B to restore the river and the wider valley floodplain, or concept D to just focus on stabilizing the constrained channel.

Table 11 – Total Restoration Acreage

Restoration Concept	Total Area (acres)
A1	1,574
A2	1,538
B	3,162
C	3,681
D	2,890
Wetland	257

Table 12 provides the total acreage of vegetation enhancement concepts. As previously mentioned, these are stand-alone vegetation enhancement areas to be considered separately from the stream restoration concepts. Each stream restoration concept will also require planting of vegetation.

Table 12 – Vegetation Enhancement Acreage

Vegetation Enhancement	Total Area (acres)
Revegetation, Mesoriparian	355
Supplemental, Mesoriparian	270
Supplemental, Cottonwoods	432
Revegetation, Xeroriparian	379



9 IMPLEMENTATION AND DESIGN CONSIDERATIONS

The project covers approximately 40-stream miles of the Santa Cruz River with a significant percentage of that in a degraded evolutionary stage. Implementation will likely require decades and with the dynamic nature of the River continuous reassessment and adaptive management will be critical. Implementation will be heavily dependent upon funding. Potential funding source include, but are not limited to the following:

- Santa Cruz County Flood Control District and/or Pima County Regional Flood Control District
- State of Arizona Water Finance Authority (WIFA)
- U.S. Army Corps of Engineers, Continuing Authorities Program (CAP) Section 206 (Aquatic Ecosystem Restoration)
- National Fish and Wildlife Foundation (NFWF)
- U.S. Environmental Protection Agency (EPA), Wetland Program Development Grants
- U.S. EPA, Clean Water State Revolving Fund
- FEMA, Hazard Mitigation Grants
- U.S. Department of Agriculture, Natural Resources Conservation Service (NRCS)
- AZ Water Protection Fund
- U.S. Bureau of Reclamation, Enhancing Water Resources
- U.S. Bureau of Reclamation, Cooperative Watershed Management
- Conservation and/or Volunteer Organizations
- Public/Private Partnerships

The following is a list of considerations that should be further investigated as concepts advance into designs. Many of these are discussed above and have been taken into consideration in the development of the goals, objectives, and restoration approaches shown in the attached Exhibits. These will need to be further developed or refined as designs move forward and concepts are selected for advancement.

- Continue to incorporate input from the SAG on concepts, priorities, and changing conditions along the river.
- Continue to evaluate changes in the channel evolution stage and adjust concepts as necessary.
- Coordinate with prior hydrogeological studies (Lacher, etc.) to better understand correlations between surface water and groundwater and expected conditions with additional effluent discharge.
- Define geomorphic values, dimensionless ratios, and physical characteristics of reference reaches to generate more detailed rehabilitation / restoration designs.
- Use hydraulic modeling to evaluate hydraulic conditions of reference and degraded reaches.
- Evaluate floodplain impacts and regulation compliance.
 - FEMA and local Floodplain Ordinance Regulations
- Evaluate environmental and cultural constraints.
 - Federal and State Environmental and Cultural Clearances Required
- Coordinate with Landowners for partnership opportunities.
- Identify funding for design advancement and construction.
- Look for opportunities to 'piggy back' restoration onto other funded projects.
- Evaluate phasing and prioritization.
- Complete detailed topographic survey of priority reaches.
- Find opportunities for small projects, to operate as pilot studies to inform adaptive management and future restoration.



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11 EXHIBITS

Exhibit A – FEMA Floodplain Maps

Exhibit B – Existing Stream Function

Exhibit C – Existing Vegetation Function Class

Exhibit D – Stream Restoration Concepts

Exhibit E – Stream Restoration Concept A1 & A2

Exhibit F – Stream Restoration Concept B

Exhibit G – Stream Restoration Concept C

Exhibit H – Stream Restoration Concept D

Exhibit I – Stream Restoration Concept D

Exhibit J – Stream Restoration Concept F

Exhibit K – Stream Restoration Concept G (Wetlands)

Exhibit L – Stream Restoration Concept I

Exhibit M – Vegetation Enhancement Concepts

Exhibit N – Typical Sections

Exhibit O – Pilot Projects



12 APPENDICES

A. RESTORATION MATRIX

B. STAKEHOLDER ENGAGEMENT SUMMARY REPORT

Santa Cruz River Restoration Approach Alternatives - Summary Matrix

Alt ID	Restoration Approach	Process-Focused Design Intent	Construction Complexity	Appropriate Application / Required River State
A-1	Stage 0 / Process-Based Restoration (PBR)	Initiate and amplify natural processes using low-tech, temporary secured log/brush structures (PALS, BDAs); outcomes intentionally deferred to river behavior.	Mostly manual labor / small equipment	Wide valley bottom; structurally-starved riverscape; shallow to moderate incision (Bank Heigh Ratios (BHR) < 2.0) ; lateral and vertical adjustment acceptable.
A-2	Stage 0 / Raise the River usign floodplain grade control (likley rock sill or similar structures).	Initiate and amplify natural processes raise the river (1-3' typically) with structural grade control, ; outcomes intentionally deferred to river behavior.	Heavy Equipment / Rock Import .. Grade cotrol would need to extend across the	Wide valley bottom; structurally-starved riverscape; shallow to moderate incision (Bank Heigh Ratios (BHR) < 2.0) ; lateral and vertical adjustment acceptable.
B	Re-establish and Re-meander Main Channel on Former Geomorphic Floodplain	Return channel to pre-incision elevation using reference reach form; abandon incised "ditch/gully".	Heavy Construction (excavators/track-hoes, etc.). Can likely balance cut fill	Relic floodplain available; incised or entrenched existing condition; inundation acceptable.
C	Construct New Small Inset Geomorphic Floodplain or Add in Some Floodplain Sloughs (Secondary Channels)	Create inset floodplain at constrained elevation while maintaining reference channel geometry. Or create some secondary channels at or below bankfull/floodplain stage.	Heavy Construction (excavators/track-hoes, etc.). May have off-haul	Moderate incision; limited access to historic floodplain.
D	Convert to Stable Confined Stream Type (Rosgen Classification B/Bc)	Form-based stabilization to step-pool morphology; lateral adjustment constrained.	Heavy Construction (excavators/track-hoes, etc.). May need to import rocks and boulders	Confined valley or infrastructure limits present.
E	Bank Stabilization / Stabilize in Place / Infrastructure Protection	Hard or hybrid controls to arrest erosion and protect assets.	Heavy Construction (excavators/track-hoes, etc.). May need to import rocks and boulders with on-site logs.	Immediate infrastructure risk; no room for adjustment.
F	Hybrid PBR + Targeted Rosgen Controls	Process-based restoration in low-risk areas with stabilization at pinch points.	See A and B above	Mixed constraints along reach.
G	Riparian & Floodplain Vegetation Re-establishment (Process-Support, Addative to all Above)	Restore vegetation recruitment and succession to support geomorphic processes.	Planting only	Hydrology supportive or improving; paired with other approaches.
H	Urban Corridor Enhancement (Non-Restorative)	Social and aesthetic improvements with constrained geomorphic behavior.	Trail Construction and Amenity Construction (no in-channel work).	Highly urbanized.
I	Preservation Only (i.e. Do Nothing)	Preserve High Quality Areas	No Construction - Possibly Livestock Management, Cattle Exclusion or Similar	Stable River

Alt ID	Expected Functional Improvements to River & Floodplain	Evolutionary Trajectory Target (Baseflow -Adjusted)	Compatible Public Realm / Amenities
A-1	Frequent inundation, groundwater recharge, sediment storage, multi-thread habitat complexity, could promote cottonwood recruitment.	Without added baseflow: Stage 3–4 → Stage 8 (episodic, drought-limited). With added baseflow: Stage 3–4 → Stage 0 feasible and self-sustaining.	Soft trails, overlooks, interpretive access; seasonal flexibility (i.e. may have more trail flooding), education nodes.
A-2	Increased floodplain inundation, groundwater recharge, sediment storage, multi-thread habitat complexity. In areas with perenial flow could promote cottonwood recruitment.	Without added baseflow: Stage 3–4 → Stage 8 (episodic, drought-limited). With added baseflow: Stage 3–4 → Stage 0 feasible and self-sustaining.	Soft trails, overlooks, interpretive access; seasonal flexibility (i.e. may have more trail flooding), education nodes.
B	Immediate floodplain reconnection, reduced shear stress, potential groundwater improvements.	Without baseflow: Stable C/E channel with intermittent floodplain wetting. With baseflow: Persistent floodplain wetlands and riparian corridor.	Boardwalks, terrace trails (since increased inundation), educational nodes
C	Partial reconnection, reduced velocities, sediment storage.	Without baseflow: Stage 4–5 equilibrium with limited wetland persistence. With baseflow: Stage 5–6 with sustained inset floodplain function.	Multi-use trails, overlooks
D	Local stability, improved aquatic habitat; minimal floodplain function.	Without baseflow: Arrested evolution (Stage 6–7). With baseflow: Stage remains arrested, ecological condition improved only.	Linear greenways, viewpoints
E	Local bank erosion addressed only.	Without or with baseflow: No evolutionary recovery; permanently arrested condition.	Urban riverwalks
F	Broad process benefits retained while protecting assets.	Without baseflow: Stage 3–4 → Stage 8 with localized arrested nodes. With baseflow: Stage 3–4 → Stage 8+ approaching Stage 0 between constraints.	Phased trail networks, interpretive nodes
G	Bank roughness, shading, wood recruitment.	Without baseflow: Limited persistence, drought regression likely. With baseflow: Positive feedback toward target evolutionary stage.	Shaded trails, stewardship areas
H	Recreational and aesthetic value.	Without or with baseflow: Static, non-evolutionary condition.	Trails only.
I	Preserve Existing - Reference Reach Status	Stage 0 or 1 preservation - Should be resilient to future changes	Could compliment with Public Access/trails.



Santa Cruz River Restoration Master Plan Stakeholder & Engagement Summary Report

Prepared For:



Prepared By:

Kimley»Horn



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Project and Stakeholder Advisory Group Overview

The Santa Cruz River is a tributary of the Gila River, spanning approximately 184 miles between the United States and Mexico. A vital waterway of the southwestern U.S., the river has suffered from groundwater overuse, urban encroachment, and reduced flows, with many stretches of its once-vibrant riparian corridor left dry and degraded.

The Santa Cruz River Restoration Master Plan (Master Plan) will collect data on existing river conditions focusing on the stretch from Oso Wash to Green Valley, and will create and prioritize restoration concepts, identify costs and funding opportunities, and create a final plan that will guide the Sonoran Institute's future prioritization and implementation of identified restoration efforts. To create a comprehensive plan that identifies a management strategy and that optimizes restoration practices, early coordination and strong partnerships with key stakeholders is essential. An economic analysis of restoration efforts will be conducted as well.

The project team consists of:

- Sonoran Institute (project managers)
- Kimley-Horn (Master Plan consultants)
- AECOM (economic analysis consultants)

The project team developed a Stakeholder Advisory Group, and initial outreach and invitations to stakeholders were sent in January 2026. Advisory Group members convened for the second time in February 2026.

Advisory Group members include individuals that represent organizations with a vested interest in the land use surrounding the Santa Cruz River or private landowners that may potentially be impacted from identified improvements. The Advisory Group will inform the development of the Master Plan through their input on development milestones.

Advisory Group Meeting Schedule

The Advisory Group met multiple times throughout the project, and were conduct as hybrid (both in-person and virtual). The table below highlights the meeting dates and times.

Meeting Number	Meeting Date	Meeting Time
1	December 10, 2025	4:00 p.m. – 6:00 p.m.
2	February 25, 2026	3:00 p.m. – 5:00 p.m.
3	April 22, 2026	12:00 p.m. – 2:00 p.m.

Note: Additional outreach efforts separate from the Advisory Group meetings, were conducted throughout the project, and are included in this summary report as well.



Stakeholder Advisory Group Meeting #1

The initial Stakeholder Advisory Group meeting was held at the Tubac Community Center on Wednesday, December 10, 2025, from 4:00 to 6:00 p.m. Fifteen stakeholders were in attendance, as well as nine project team members.

Introductions, Overview of Restoration Master Plan and Economic Analysis

The Sonoran Institute conducted introductions and provided an overview of the project, as well as background information on the funding driving the development of the Master Plan and economic analyses. One stakeholder raised a question regarding the Sonoran Institute's engagement with the County's Wildfire Prevention Planning effort, which could align invasive species treatment with wildfire risk reduction and ecological benefits.

AECOM then provided an overview of the planned economic analyses, including a discussion of the comparative cost-benefit analyses and tactics to estimate operations and maintenance costs for sustaining river conditions.

Before planned group activities, Kimley-Horn provided an overview of the restoration master plan, reaffirming initial points raised by the Sonoran Institute regarding the project background and context. Kimley-Horn elaborated on how the development of the plan intends to utilize the feedback of members of the Stakeholder Advisory Group. Kimley-Horn emphasized that reference areas and points along the river provided by the group would be especially helpful in determining focused solutions for restoration efforts.

Stakeholder Advisory Group Charter Activity

The Advisory Group developed an initial draft project charter which read: *The purpose of the Santa Cruz River Restoration Master Plan project is to develop a management strategy focused on the preservation and enhancement of the Oso Wash to Green Valley riparian area while also remaining mindful of flood risk management, infrastructure protection, water recharge, land use and recreational opportunities, and the economic value of the river restoration for residents and local users.*

The Sonoran Institute, Kimley-Horn, and AECOM developed a set of six questions to engage stakeholder priorities, goals, and visions for the Master Plan. The questions were hosted on Mentimeter, a live survey platform, and presented during the initial Stakeholder Advisory Group meeting to build out a draft group charter. Feedback from the activity would be collected and synthesized to build and present a revised charter for formal review and approval at a future Stakeholder Advisory Group meeting.

Key themes from Stakeholder Advisory Group members' feedback included:



- The state of the current river can best be described as impacted and degraded; simultaneously, members remain optimistic about the possibility of various creative opportunities for restoration.
- Members' future visions for the river center around water quality, functionality, resiliency, and enhanced biodiversity.
- "Preserving natural habitats within and along the river corridor" emerged as the group's top priority for the Master Plan, with options centered around resiliency ("mitigating flood risk" and "responding to extreme weather events and conditions") ranking lower overall.
- Hydrology and hydraulic elements were the group's top concern for what the master plan addresses. Water quality and biological preservation also ranked highly, with "recreational opportunity expansion" ranking last.
- "Maximize benefits for plant and animal habitats" was the most selected goal for what the Master Plan accomplishes.

Notes on additional member questions or comments were taken during the activity. Members specifically mentioned additional goals and priorities for the Restoration Master Plan, including:

- Mitigation of contaminants (including PFAs and BFOAs) and heavy metals in the water supply
- Implementation of youth and community science program engagement opportunities
- Untreated effluent management
- Recreational pursuits and opportunities
- Specific biodiversity initiatives, including cottonwood tree recruitment and invasive plant management
- Overbank water storage
- Mitigation of riverbank erosion

Full results from this activity can be viewed in **Appendix A – Mentimeter Activity**.

Map Analysis and Comments

After providing feedback through the Mentimeter activity, Stakeholder Advisory Group members were asked to interact with physical maps of sections of the river corridor. Members indicated and marked any comments, input, or suggestions around and within the planning area before the meeting concluded. Transcribed comments can be reviewed in **Appendix B – Map Comments**.

Stakeholder Advisory Group Meeting #2

The second stakeholder meeting was held virtually on Wednesday, February 25, 2026, from 3:00 to 5:00 p.m. Twenty stakeholders were in attendance, as well as nine project team members.

Introductions, Overview of Restoration Master Plan Status

The meeting opened with re-introductions of Stakeholder Advisory Group members representing landowners, county and federal agencies, environmental organizations, and technical consultants. The project team then provided an overview of the status of the Santa Cruz River (SCR) Master Plan effort and framed the discussion around understanding current river conditions to inform future restoration strategies.

The team emphasized a geomorphology-based approach to their analysis, encouraging participants to view the river as a dynamic system shaped by water, sediment, vegetation, and human influence. Healthy river systems were described as including not only the channel, but also the larger valley and floodplain extents, with periodic overbank flows that support groundwater recharge and ecological function. Additionally, the Santa Cruz River was noted to be in multiple stages of channel evolution simultaneously, due to historical disturbances and land use changes.

Field Work Photography Tour

The project team led a virtual photography tour along the Santa Cruz River, focusing on reaches previously identified by the group. The tour moved from south to north and highlighted a range of channel features, areas of concern/opportunity, and existing conditions. Key locations included the Oso Wash, Rio Rico (Guy Tobin Trailhead and Peck Canyon), Tumacacori, Tubac (Bridge Road), and multiple reaches near Amado. Observations included differences in incision, floodplain connectivity, sediment deposition, vegetation health, and wildlife presence. Several areas demonstrated highly dynamic conditions with active sediment movement, while others showed signs of long-term degradation, limited cottonwood recruitment, and reduced surface flow. The Tubac (Bridge Road) reach was identified as a strong reference reach due to recent flow and high floodplain connectivity, while Peck Canyon was noted as being closest to pre-disturbance conditions.

Advisory Group Meeting #1 Survey Review

The project team provided a high-level summary of the Advisory Group Meeting #1 survey that members completed. Participants generally described the river as impacted or degraded, while also expressing optimism about restoration potential. Common themes included improving water quality, restoring river function and resiliency, enhancing biodiversity, and preserving natural habitats. Primary concerns focused on hydrology, water quality, and biological resources, with shared goals centered on maximizing benefits for plant and animal habitats.



Advisory Group Meeting #2 Priorities and Rankings Survey

A second, more detailed survey was presented to the group. Participants were encouraged to complete the survey and coordinate with the project team if they had suggestions for additional stakeholders who should participate with their unique feedback.

The survey focused on asking advisory group members their opinions and preferences on restoration projects and priorities for a variety of topic categories including:

- Groundwater Recharge / Availability
- Surface Water Quantity
- Water Quality
- Habitat and Green Space Connectivity
- Enhancement of Native Vegetation
- Removal of Invasive Species
- Recreation and Tourism
- Flood Risk
- Land Use and Property Values
- Ease of Implementation
- Improved trash/waste management

A total of 17 stakeholders participated in the survey either during the February 25 meeting or in the weeks following the meeting. Key feedback themes include:

- **Existing Conditions:** Nearly 53% of respondents characterized river conditions as “not good,” and over 40% of respondents labeled surface water quality as either “poor” or “very poor.” In open-ended responses, nearly half of members stated that they were concerned about the presence of contaminants such as E. coli. or PFAS.
- **Restoration Priorities:** 50% of respondents ranked “groundwater recharge and availability” as their highest priority outcome for stream restoration projects. Respondents also indicated that restoration efforts would be most beneficial to natural/vacant land and recreational land, reflecting a strong emphasis on prioritizing ecological and open-space benefits.
- **Solution Approaches:** Responses showcased varied perspectives on the best focus areas, means, and timelines for restoration actions. While several open-ended responses mentioned the value of smaller, more incremental interventions, responses to multiple choice questions on project scale and timeline were split and indicated no strong consensus. Questions about trash mitigation also drew mixed responses. However, a hypothetical combination of nature-based flooding solutions and structural improvements were overwhelmingly favored.
- **Recreation Enhancements:** Just under 70% of respondents favored the addition of new interpretive or wayfinding signage along the river; simultaneously, over 70% expressed that



they believed the river did not need more surrounding trailheads. Improving existing trail connectivity was a solution favored slightly by respondents, but when weighted against other priorities, “recreation and tourism” fell in the bottom 50% of all response choices.

- **Restoration Project Priorities:** The survey respondents provided their ranked choices of what stream restoration project types should be focused on. The top 5 project types are:
 - 1) Surface Water Quantity
 - 2) Groundwater Recharge / Availability
 - 3) Habitat and Green Space Connectivity
 - 4) Water Quality
 - 5) Enhancement of Native Vegetation

A full export of survey results can be found in **Appendix C – Priorities and Rankings Survey**.



Stakeholder Advisory Group Meeting #3

The third Stakeholder Advisory Group meeting was held at the Tubac Community Center, and virtually, on Wednesday April 22, 2026, from 12:00 p.m. to 2:00 p.m. Nineteen stakeholders were in attendance, as well as seven project team members.

Introductions, Overview of Restoration Master Plan Status

The meeting opened with re-introductions of Stakeholder Advisory Group members representing landowners, county and federal agencies, environmental organizations, and technical consultants. The project team then provided an overview of the status of the Santa Cruz River (SCR) Master Plan effort and framed the discussion around understanding current river conditions to inform future restoration strategies.

A Power Point was developed and presented by Kimley-Horn which focused on Master Plan restoration concepts, and followed up with a presentation by AECOM regarding the associated economic analysis portion of the project.

While the Master Plan will include various levels and types of alternatives applicable to the entire project area, four concepts were presented to the Advisory Group.

These concepts included:

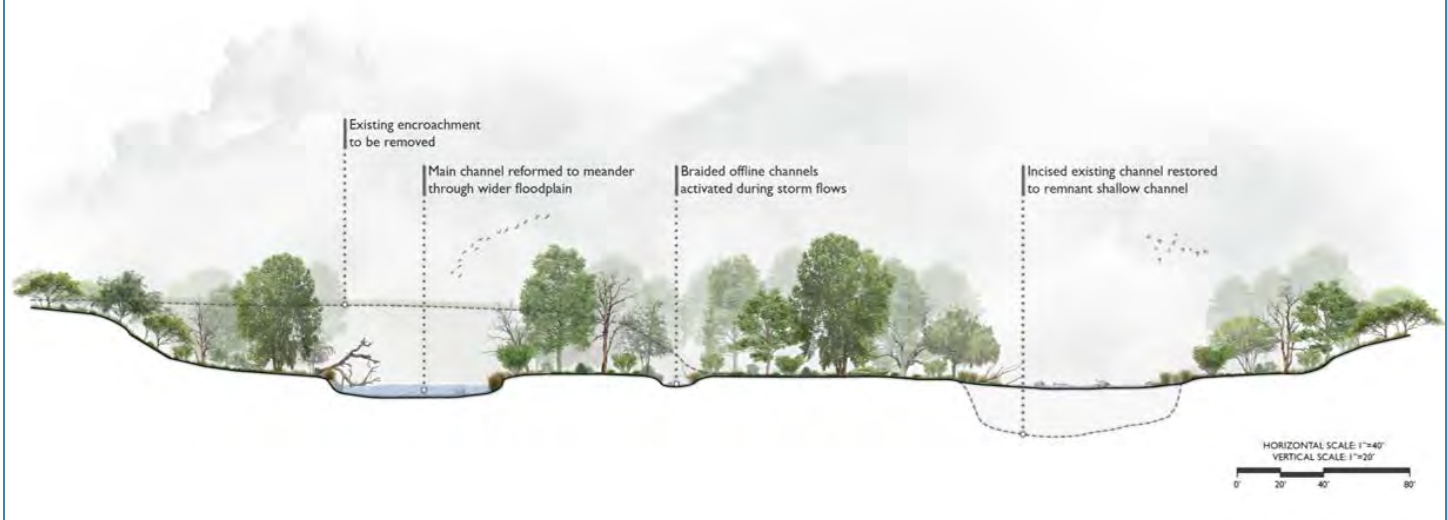
- **Concept A1/A2**, which is largely minimally invasive or intense, and may include:
 - Initiating and/or amplifying natural processes using low-tech structures and grade controls
 - Beaver analog structures
 - Large boulders
 - Invasive species and trash removal followed by revegetation with native species
- **Concept B**, which involves more invasive and heavier construction elements, and may include:
 - Earthwork to raise the bottom of primary channel to a pre-incised elevation
 - Repositioning the primary channel and create smaller inset channels to act as secondary flow paths to re-establish meandering
 - Invasive species and trash removal followed by revegetation with native species
- **Concept C** and **Concept D**, which is somewhat of a hybrid approach including structural and non-structural solutions, and may include:
 - Grade control/structures to raise the bottom of primary channel
 - Stabilizing steep banks and create floodplain terraces
 - Creating smaller inset channels to act as secondary flow paths to re-establish meandering
 - Invasive species and trash removal followed by revegetation with native species

Draft renderings of these concepts are shown below, and are current as of April 22, 2026:

Sections A1 and A2



Section B





Section C and D



Advisory Group Comments

The Advisory Group provided their comments on the restoration concepts and general comments that the project team should consider.

Comments included:

Restoration Concept Related

- Before starting on restoration work, there will need to be coordination with the railroad in one way or another.
- It is important to consider the larger old growth along river banks proposed to be altered to meet historical conditions. Often they stabilize the banks and losing those old growth trees could be hard on the surrounding area.
- Look into improving the transition between the different sections of the river when it comes to tying in the different restoration bucket concepts. It could be more difficult since restoring one area of the river will likely have benefits to both the upstream and downstream. Need to consider those potential effects to the adjacent sections of the river project areas.
- Something else to consider is how these kinds of restoration projects will affect infiltration.

Locations to Consider / Further Analyze

- North of Clark Crossings Road may be incised by roughly 8 feet or more and that there is much grazing from cattle and horses that attribute to eutrophication (the over-enrichment of water by nutrients), leading to a very unstable reach.



General Comments

- There is concern for the potential to uncover archeological sites during excavation/earthwork for the restoration projects. This will be analyzed and dealt with during design and construction as applicable.
- Based on current conditions of the river and the river's watershed, something that may be worth considering and/or looking into could be projects taking place within the watershed that could cause more or less sediment deposit and pollutants. The health of the watershed is just as important as the health of the river.
- Programming for this project and future efforts needs to be strengthened across entities and jurisdictions to secure funding for the actual restoration/rehabilitation concepts and alternatives derived.



Santa Cruz River Research Day

The Sonoran Institute hosted the Santa Cruz River Research Day and was held in-person at the Pima Community College Downtown Campus. This event was also hosted virtually and included live Spanish translation.

This annual event provides a venue for learning about research and conservation efforts while exploring the Santa Cruz River's natural and cultural resources. The event featured multiple speakers with this year's theme to *"aim to inspire new research questions, strengthen your professional network, catalyze collaborative projects, and foster awareness of research and conservation efforts [in the Santa Cruz River]."*

Kimley-Horn presented a version of the Power Point presentation developed for the Stakeholder Advisory Group Meeting #3. Online and paper copy comment forms were developed in English and Spanish to allow for attendees to provide their comments on the Master Plan. The form also included a section for individuals to provide their name and email address to be notified when the eventual Master Plan is produced in draft and final forms.

Comment card comments are included in **Appendix D – Comment Cards**. Email addresses have been excluded from the Appendix results.

*Email Sign-Up and Project Comment Form
(in Spanish)*

Santa Cruz River Restoration Master Plan
Oso Wash to Green Valley

El Plan Maestro de Restauración del Río Santa Cruz ayudará a determinar la mejor manera de mejorar las oportunidades recreativas y de vida silvestre a lo largo del Río Santa Cruz. El plan final orientará las prioridades y los esfuerzos de implementación futuros del Sonoran Institute en todo el corredor.

Para mantenerse informado sobre futuras actualizaciones del Plan Maestro, por favor ingrese su información y/o cualquier comentario a continuación.

Nombre (con apellido): _____

Correo electrónico: _____

Comentarios o preocupaciones: _____

¿Tiene preguntas adicionales?
Contáctenos: SW-Public-Involvement@kimley-horn.com

Comentarios en Línea



Appendix A – Mentimeter Activity

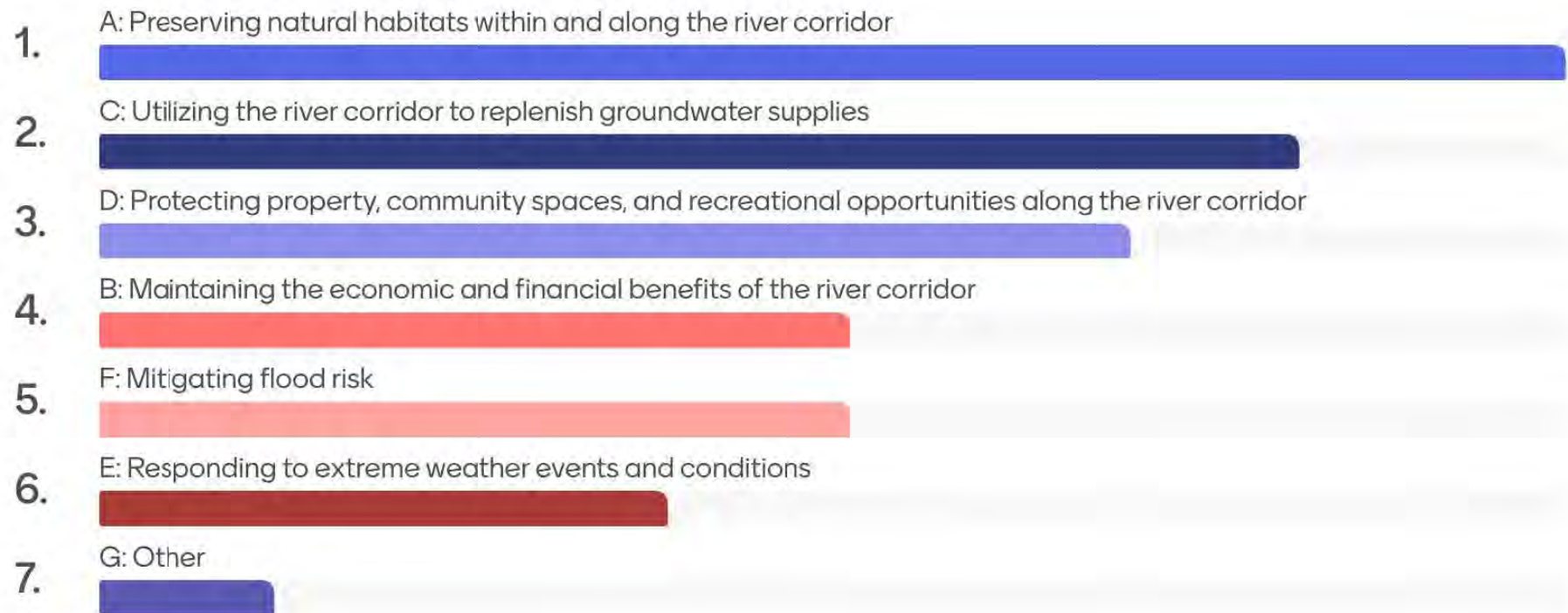
In one word, describe the current condition of the river corridor.



In one word, how would you like to describe this section of the Santa Cruz River in 10 years?



Rank your priorities for the Restoration Master Plan.



My main concerns for what the master plan addresses are... (select 2)



9 A: Hydrology and hydraulics (supply and movement of water)



2 B: Geomorphology (channel shape and location)



6 C: Physiochemical (water quality)



6 D: Biological preservation



1 E: Recreational opportunity expansion



5 F: Trash management



5 G: River and floodplain vegetation (preserve or enhance)

Select your top two goals for the outcome of the master plan.



7 A: Increase water visibility and availability



4 B: Create practices that will enhance recreational elements near the river (parks, community events, and facilities)



5 C: Recommend economically viable river management solutions



6 D: Establish management practices that address river resiliency to the effects of extreme weather events and conditions



9 E: Maximize benefits for plant and animal habitats



4 F: Formulate a comprehensive groundwater management strategy

After completing the visioning exercise, please share an additional word you would like to use to describe this section of the river in 10 years.

A word cloud visualization of responses to a visioning exercise. The words are arranged in a circular pattern, with 'recovering', 'resilient', 'healthy', and 'sustainable' being the most prominent. Other words include 'accessible', 'loved', 'potential', 'revitalized', 'safe', 'improvement', 'restored', 'fun', and 'cottonwoods of many ages'. The colors of the words are blue, red, and purple.

recovering
resilient healthy
sustainable
accessible loved
potential revitalized
safe
improvement restored fun
cottonwoods of many ages



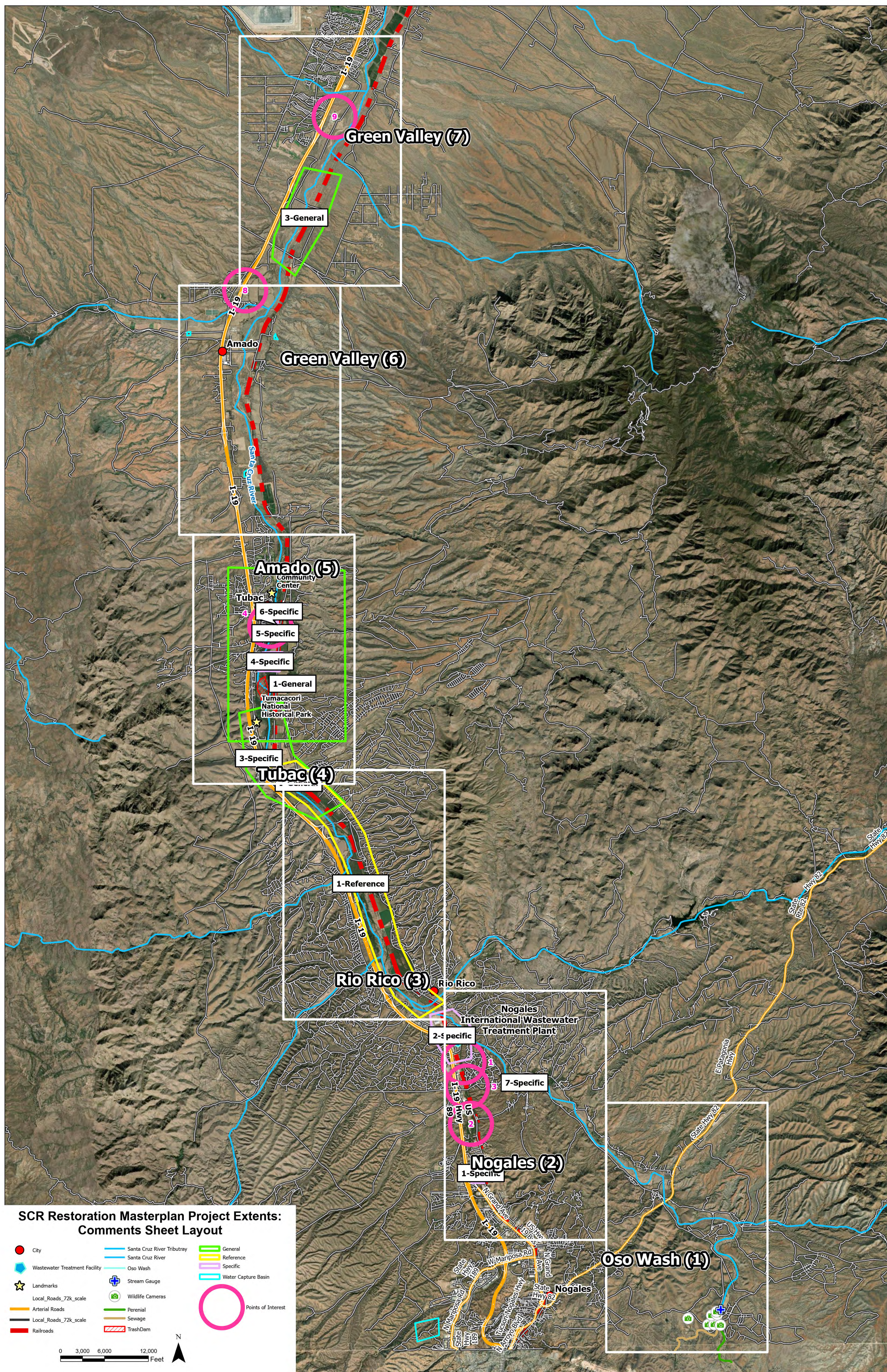
Appendix B – Map Comments

General Area Comments

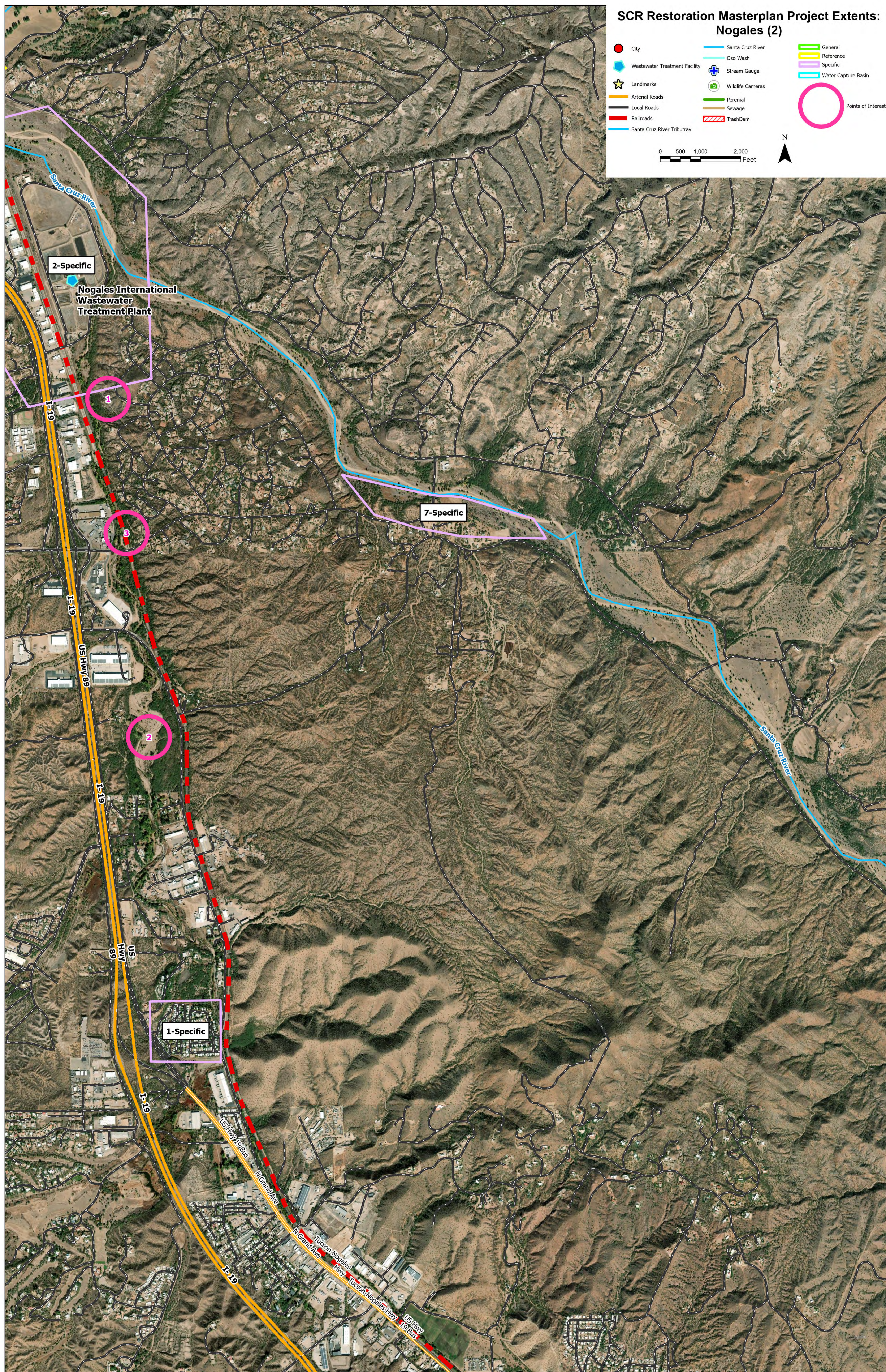
OBJECTID	Comments	Number	Type
1	Bifurcation of this whole region with the river flow, some due to trash bars/dams that will be marked in the points of interest.	1	General
2	Flood study needs to be done (?)	1	Specific
3	Areas where partners can create recreational possibilities for Rio Rico.	2	Specific
4	Concern for flooding from Rock Canal Wash to the SCR, with debris and sand build up around a windmill (?)	3	Specific
5	Tumacacori is a very beautiful stretch of river, full of wildlife (birds, turtles, fish, and bugs), but the water quality is atrocious. Cottonwoods are struggling, and the trash dams are a big issue (Charlotte). One of the more functional areas along the river. The park has worked to control invasive species, and the area has generally flowing water, fireflies, bats, topminnow, etc. This area is also affected by the trash dam stalling tree recruitment.	2	General
6	The River South of Clark crossing is badly degraded.	4	Specific
7	Powerline easement has good cottonwood easement. Unisource (?) recently cleared this area.	5	Specific
8	Stretch south of Bridge Road to Clark Crossing Tubac Nature Center has mapped stream conditions.	6	Specific
9	Area that Pima County can potentially restored.	3	General
10	Beautiful stretch of river from Rio Rico to Carmen--Tumacacori that might serve as a reference condition!	1	Reference
11	Good Cottonwood recruitment in this area potentially	7	Specific

Points of Interest

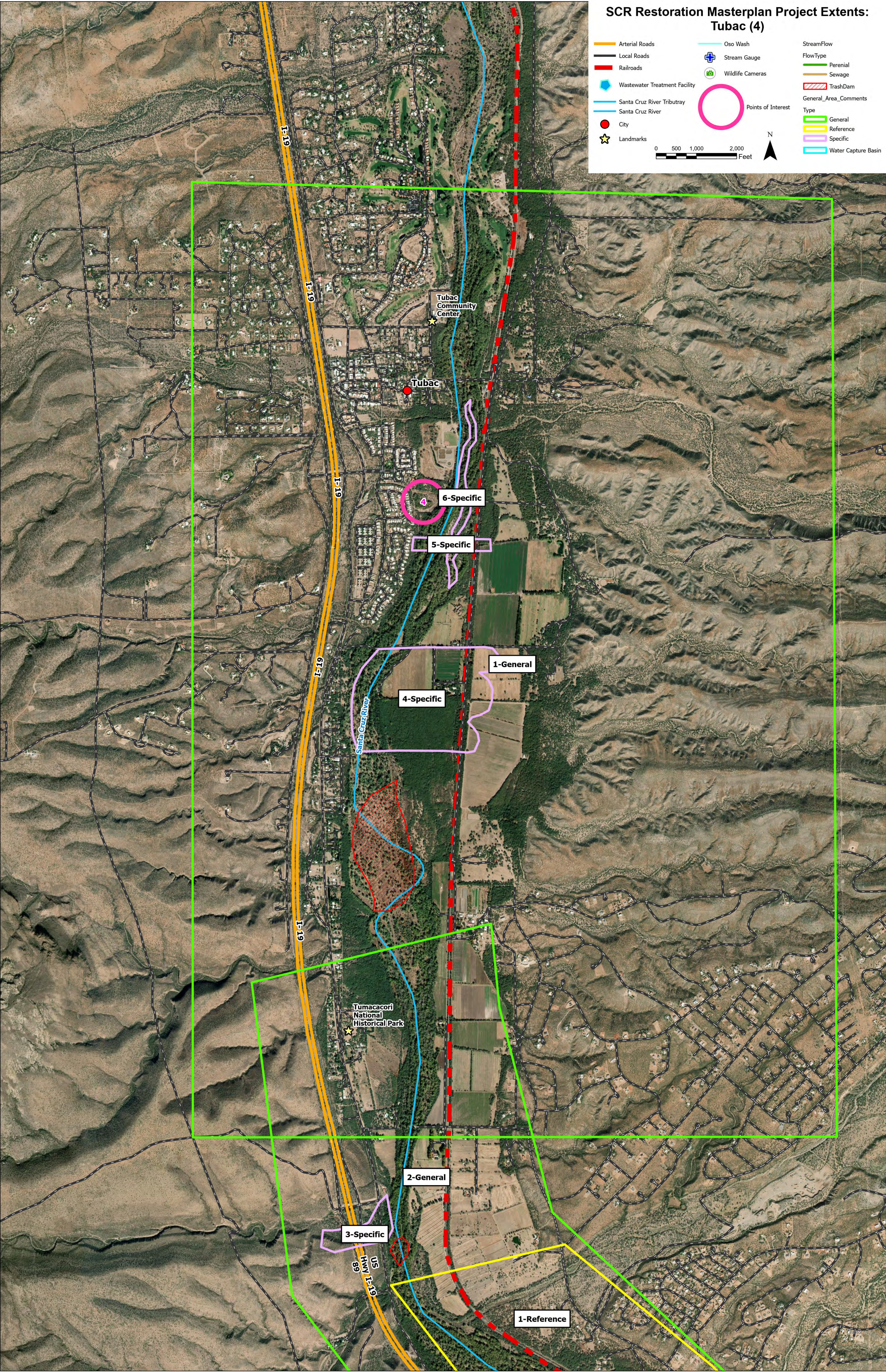
Number	Comments
1	Cotton Wood recruitment in this area to the east as well as trash build up on the west side(?).
2	Erosion is an issue, and mitigation may be needed.
3	Cotton Wood Recruitment in this area.
4	Tubac borrow pit, perhaps an opportunity for wetland restoration.
5	Amado WTP attracts lots of water flow.
6	Noteworthy Pima County Conservation work at Canoa Ranch, Cienega (wetland/marsh) area.

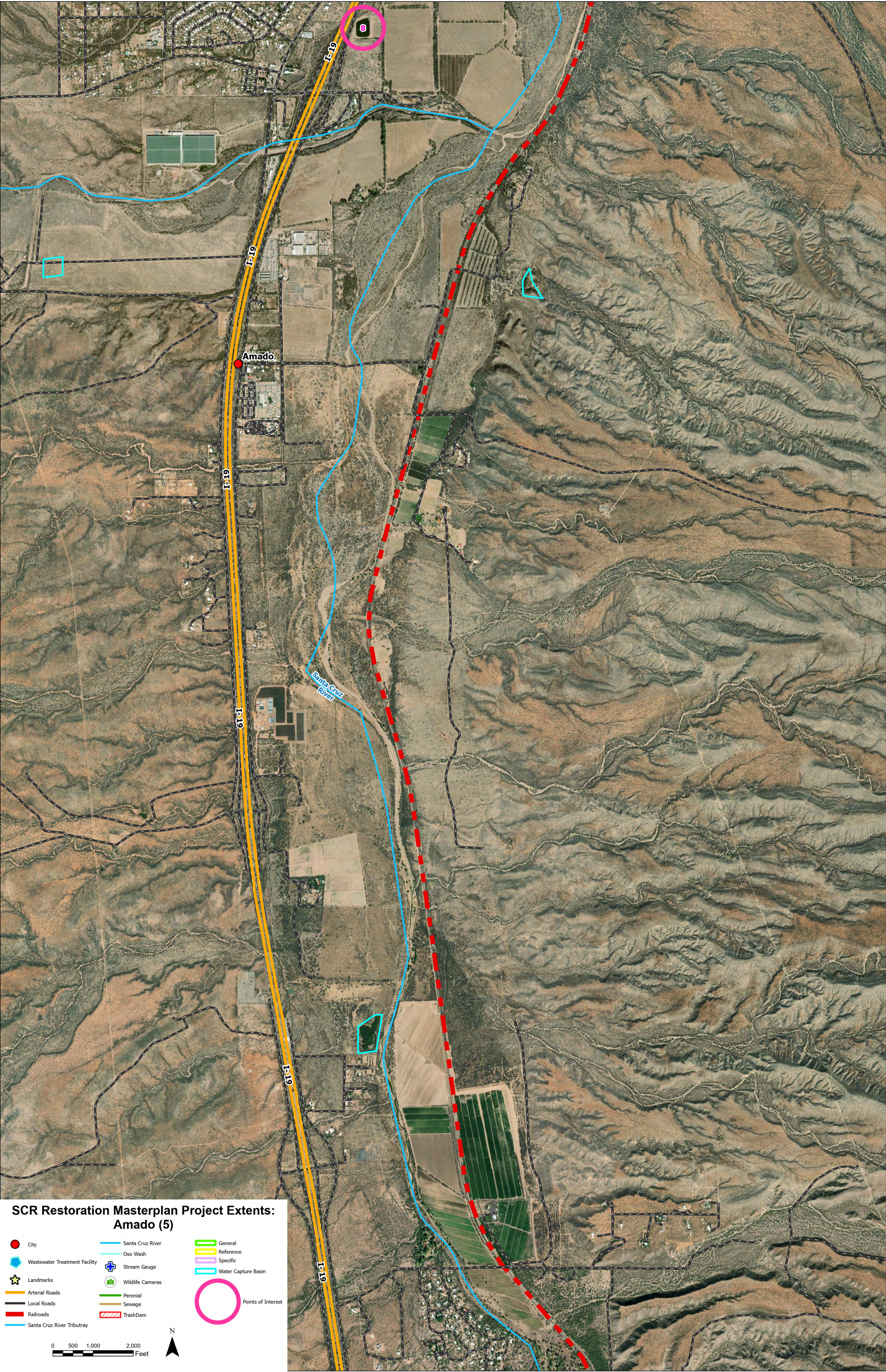




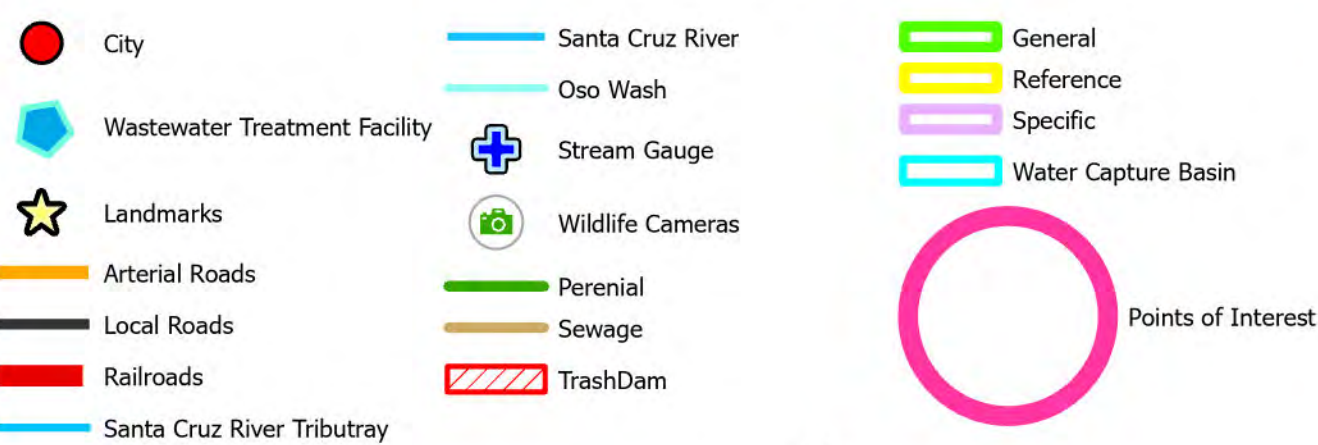




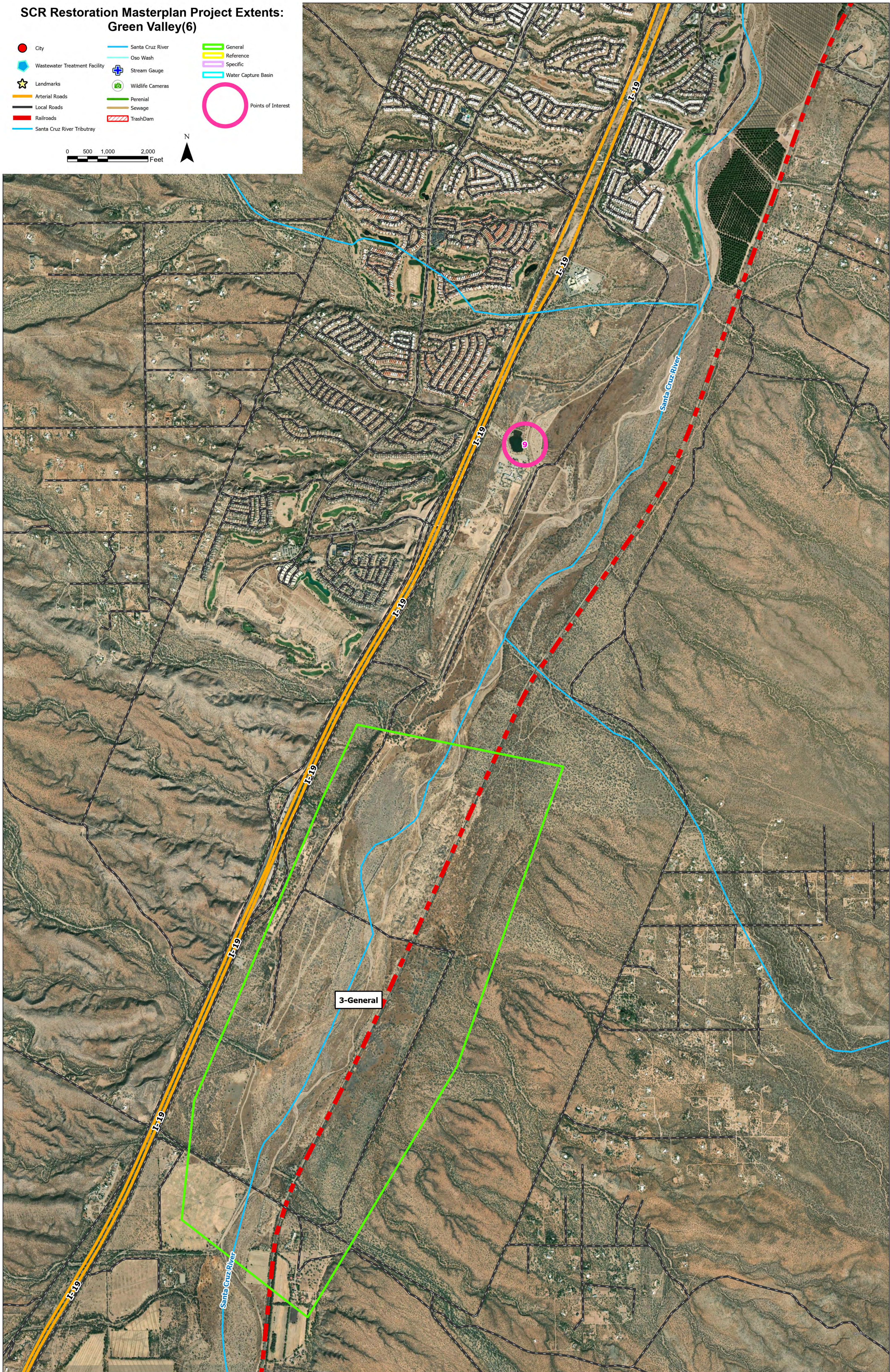




SCR Restoration Masterplan Project Extents:
Green Valley(6)



0 500 1,000 2,000
Feet





Appendix C – Priorities and Rankings Survey

Q1 Please enter your name and the organization you represent

Answered: 17 Skipped: 0

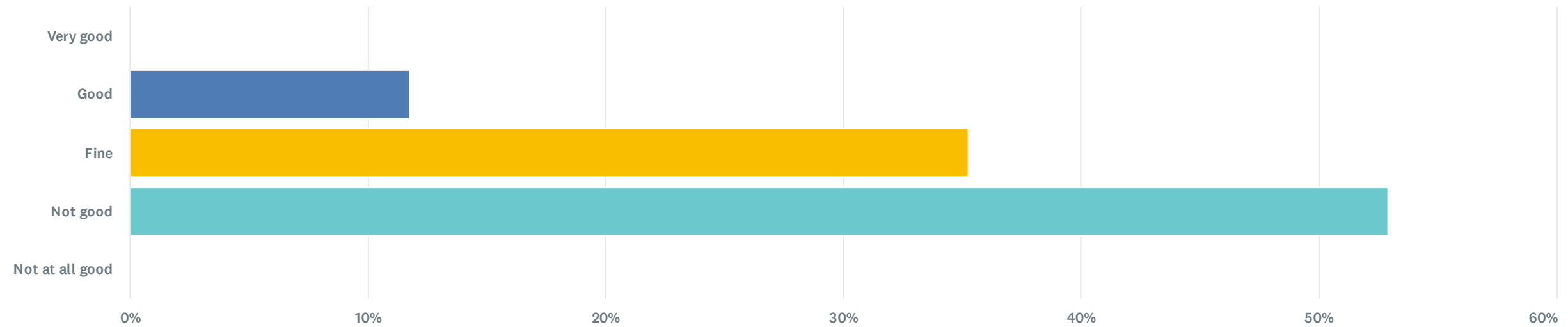
ANSWER CHOICES	RESPONSES	
Your name	100.00%	17
Your organization	94.12%	16

Santa Cruz River Restoration Master Plan Priorities and Rankings

1	USIBWC	3/4/2026 11:25 AM
2	Consulmex Nogales	3/4/2026 9:41 AM
3	City of Nogales	3/3/2026 9:04 PM
4	City of Nogales	3/3/2026 1:48 PM
5	Friends of the Santa Cruz River	2/28/2026 12:51 PM
6	None	2/28/2026 7:04 AM
7	Santa Cruz County Community Development Department	2/27/2026 3:38 PM
8	NPS Tumacácori National Historical Park	2/27/2026 10:35 AM
9	Santa Cruz County GIS/PW and FCD	2/27/2026 9:33 AM
10	NPS	2/26/2026 5:06 PM
11	Santa Cruz County	2/26/2026 9:03 AM
12	Santa Cruz County	2/26/2026 8:13 AM
13	Tubac Nature Center	2/25/2026 8:01 PM
14	Tubac Nature Center	2/25/2026 4:50 PM
15	Middleton Ranch	2/25/2026 4:47 PM
16	Land Advisors Organization	2/25/2026 4:14 PM

Q2 17 responses

What is your opinion of the condition of the Santa Cruz River in the project area?



#	PLEASE EXPLAIN YOUR RESPONSE	DATE
1	It has some issues but overall, it is a benefit to the community, wildlife, and the environment as a whole	3/4/2026 11:25 AM
2	The river requires a full intervention in order to recover it's beauty.	3/4/2026 9:41 AM
3	Good parts and bad areas.	3/3/2026 9:04 PM
4	Well we have the headwaters from the IWBC most of the year.	3/3/2026 1:48 PM
5	Too much salt cedar, trash, entrenchment, poor water quality, and at risk of another IOI spill.	2/28/2026 12:51 PM
6	The water is flowing, Trail is being maintained and at the moment, trash and debris is less	2/28/2026 7:04 AM
7	Trash, sediments, habitat management	2/27/2026 3:38 PM
8	Better in some places than others	2/27/2026 10:35 AM
9	The constant flow from the WWTP is helping with growth of vegetation along the flow line, public access to the channel is limited	2/27/2026 9:33 AM
10	I think the condition varies across the study area too much to really hone in here.	2/26/2026 5:06 PM

Santa Cruz River Restoration Master Plan Priorities and Rankings

11	It could be better. The water quality and removal of trash needs addressing. I don't feel qualified to comment on more than that.	2/26/2026 9:03 AM
12	I am very concerned about trash and possible contamination.	2/26/2026 8:13 AM
13	Wide variation in condition, but conditions sufficient for cottonwood recruitment are rare. Overgrazing is occurring in several reaches. Invasive plants are abundant. There is less water than a few years ago.	2/25/2026 8:01 PM
14	parts of the river are better that others. sort of between Fine and Not Good	2/25/2026 4:50 PM
15	Too much storm water leaving the watershed	2/25/2026 4:47 PM
16	The river condition varies from good (stable channel) to degraded, so I chose the neutral response of “fine” to really mean that it varies.	2/25/2026 4:14 PM
17	Poorly treated effluent discharge from Oso Wash into the SCR	2/25/2026 4:10 PM

Q3 In your opinion, how do we make the river sustainable, resilient, and healthy?

Answered: 17 Skipped: 0

#	RESPONSES	DATE
1	Can't answer	3/4/2026 11:25 AM
2	By conducting minor interventions that help the river recover itself	3/4/2026 9:41 AM
3	Get more information and people involved.	3/3/2026 9:04 PM
4	Getting the Federal Government involved in all aspects of the water from Mexico, coming down the wash, to the trash from Nogales Sonora.	3/3/2026 1:48 PM
5	Eradicate invasive species, address trash problems with appropriate traps, racks, rakes, booms, etc., outreach education, litter enforcement, clean-ups, signage, and education/outreach. Watershed improvements, sustainable land uses, some grade control, vegetation plantings and management, and bank protections.	2/28/2026 12:51 PM
6	Maintenance of main channel, I'm concerned with flooding when trees fall and Make diversions. Maintain water, quality and debris and trash maintenance.	2/28/2026 7:04 AM
7	Create a Rio Rico-Santa Cruz River Resilience Corridor. Purpose The Resilience Corridor is an initiative to address stormwater flooding, channel instability, environmental restoration, and community connectivity within Rio Rico through an integrated, long-term framework. The initiative intentionally reframes drainage infrastructure as a multi-benefit public asset—one that protects residents, restores living ecological systems, and supports community and economic vitality. Why This Matters Rio Rico's drainage corridors experience episodic, high-energy storm flows that create flood risk, erosion, and long-term infrastructure challenges. Historically, responses have been reactive and localized. The Resilience Corridor approach allows the County to proactively plan at a corridor scale—reducing risk while simultaneously delivering ecological, community, and economic benefits in a fiscally responsible manner.	2/27/2026 3:38 PM
8	Restore flow, reduce garbage, eliminate invasives, correct issues to ensure it functions ecologically and hydrologically. Return to a near natural cycle of flooding.	2/27/2026 10:35 AM
9	Allow the river to continue to flow and establish its equilibrium on its own	2/27/2026 9:33 AM
10	Increase water capture	2/26/2026 5:06 PM
11	Address litter problems, correct water quality, and involve the community in the process.	2/26/2026 9:03 AM
12	We need to strengthen our ties with Mexico so that trash and contamination become more of an international topic.	2/26/2026 8:13 AM
13	It is a daunting challenge, probably unattainable. Incremental steps in key areas is the only way to have a measure of success. Preservation should be the top priority. Beyond that, livestock grazing in the floodplain needs to be eliminated in any preserved area. Restoration can be considered on a priority basis in key areas. Hydrology needs to be assessed and groundwater managed sustainably.	2/25/2026 8:01 PM
14	remove all grazing. the health of the river is directly related to the stability of the vegetation. With cattle and horses grazing along the river, vegetation does not stand a chance to develop.	2/25/2026 4:50 PM
15	Raise the water table	2/25/2026 4:47 PM

Santa Cruz River Restoration Master Plan Priorities and Rankings

16	Support creation of the proposed National Wildlife Refuge.	2/25/2026 4:14 PM
17	Effluent is the only growing source of water. If treated properly it can be a healthy resource.	2/25/2026 4:10 PM

Q4 In your opinion, how can this portion of the Santa Cruz River be improved?

Answered: 17 Skipped: 0

#	RESPONSES	DATE
1	Personal and professional opinions differ	3/4/2026 11:25 AM
2	By the planting of local fauna, some cleaning brigads, and the general immprovment of the area.	3/4/2026 9:41 AM
3	Same, get more information and people involved with the issues and what needs to be done.	3/3/2026 9:04 PM
4	Keep the trash out.	3/3/2026 1:48 PM
5	Same answer as #3 above.	2/28/2026 12:51 PM
6	More ot the above	2/28/2026 7:04 AM
7	Rio Rico-Santa Cruz River Resilience Corridor The project will integrate flood risk reduction, channel stability, riparian habitat restoration, and community-oriented amenities within a resilient, low-maintenance framework appropriate for arid-region hydrology. The County recognizes the Rio Rico-Santa Cruz River Resilience Corridor as critical stormwater infrastructure and a long-term community asset that can support public safety, ecological function, quality of life, and sustainable economic development.	2/27/2026 3:38 PM
8	Reduce garbage, eliminate invasives.	2/27/2026 10:35 AM
9	Construct grade break structures using "living infrastructure materials" (University of Texas, Alexandra Clara Saracho Ph.D) to encourage meandering of the channel. Increased Zoning restrictions by the County.	2/27/2026 9:33 AM
10	Still pondering...	2/26/2026 5:06 PM
11	I will leave this to those with a technical background, but addressing the trash is extremely important.	2/26/2026 9:03 AM
12	The first step is education and understanding root causes of what needs to be improved. The second step would continue to push for some form of a wildlife refuge that would protect the area from future problems.	2/26/2026 8:13 AM
13	Again, incrementally through a combination of river channel restoration projects, invasive plant management, restoration of other critical habitats such as wetlands, and larger scale efforts to manage groundwater sustainably. Let us not forget the need to educate the public so that they are the advocates for conservation.	2/25/2026 8:01 PM
14	Increase water flow, increase water spread into the floodplain	2/25/2026 4:50 PM
15	Slow the flow so more water infiltrates	2/25/2026 4:47 PM
16	Flow restoration projects (e.g.,adding treated effluent, improving stormwater management, retiring irrigation) and trash removal/management.	2/25/2026 4:14 PM
17	Proper treatment of effluent.	2/25/2026 4:10 PM

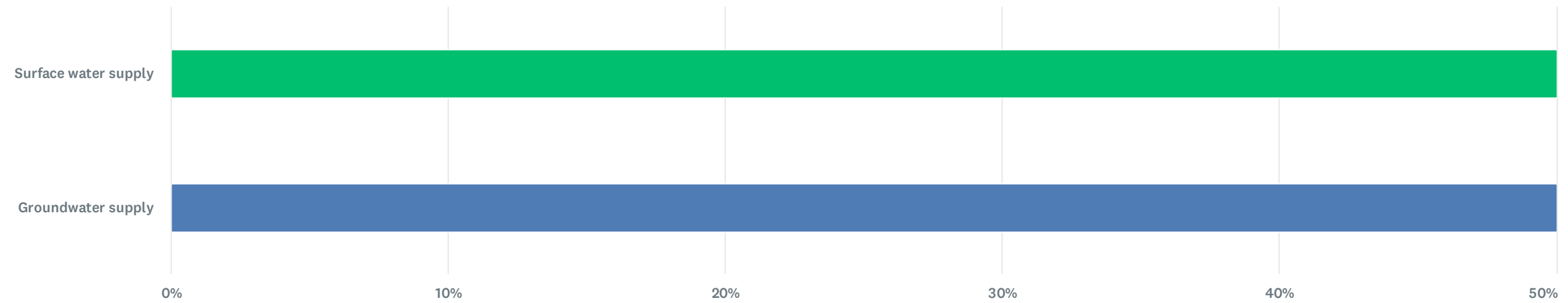
Q5 What does the term "stream restoration" mean to you in relation to the Santa Cruz River?

Answered: 17 Skipped: 0

#	RESPONSES	DATE
1	Restoration means back to original but with environmental changes such as climate, adaptation seems more appropriate	3/4/2026 11:25 AM
2	The abbility of regulating and improving *by natural ways, with minor interventions.	3/4/2026 9:41 AM
3	Recover our river path way, clean and open the flow for the waters old path.	3/3/2026 9:04 PM
4	Having a natural flow of water coming in, which may not happen.	3/3/2026 1:48 PM
5	I prefer "stream function improvement", because "restoration" implies identically returning it to some undefined previous timeframe conditions, instead of its natural potential condition.	2/28/2026 12:51 PM
6	Making the river stream clean and safe for fish and recreation.	2/28/2026 7:04 AM
7	See Rio Rico-Santa Cruz River Resilience Corridor	2/27/2026 3:38 PM
8	Flowing water, native species, healthy mix of ages of trees, little garbage.	2/27/2026 10:35 AM
9	Bringing the Santa Cruz River back to a Stage 0, before the influence of farming within the flood zone	2/27/2026 9:33 AM
10	It means clean water in the river, and a thriving ecosystem around it.	2/26/2026 5:06 PM
11	Improving water quality, removing trash, protecting and reestablishing native habitat that supports wildlife, and connecting the community.	2/26/2026 9:03 AM
12	I am not sure what "stream restoration" means since everything is always evolving either naturally or manmade. For me, the stream should support recharge for ground water and be secured for sustainable recreation for the community.	2/26/2026 8:13 AM
13	Attaining a better condition than when you started in terms of geomorphology, native plant and animal diversity and abundance.	2/25/2026 8:01 PM
14	meandering river and establishment of natural vegetation	2/25/2026 4:50 PM
15	We can never restore the river, however we can recover parts of it	2/25/2026 4:47 PM
16	Flow restoration (adding flow), storm water management, and channel modification.	2/25/2026 4:14 PM
17	On my stretch it's effluent management and stream bank protection e.g. slowing and spreading the channel.	2/25/2026 4:10 PM

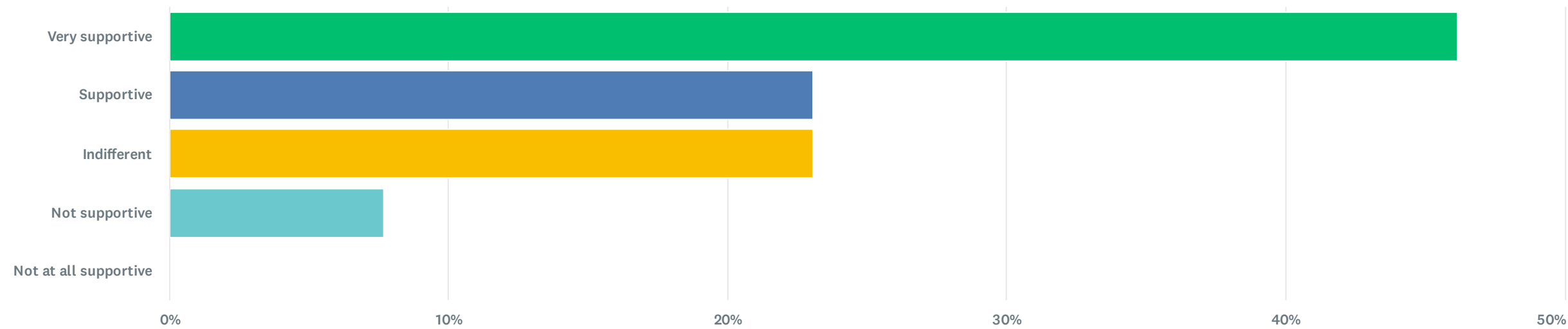
Q6 10 responses

Should improvements focus on surface water or groundwater supply?



Q7 13 responses

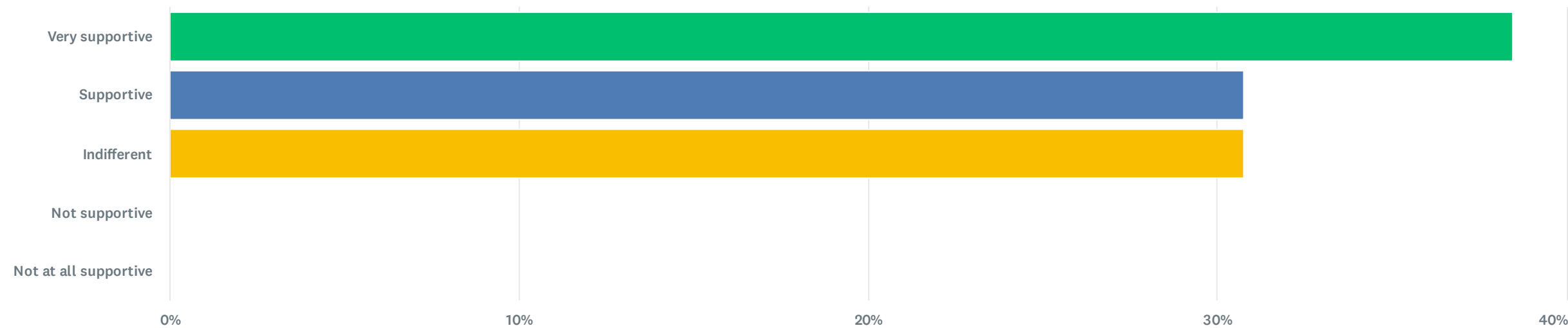
If the extents of perennial base flow reached further north (downstream), how would you feel?



#	WHY DO YOU FEEL THIS WAY?	DATE
1	I don't see it as a bad thing to extend the zone	3/4/2026 12:00 PM
2	I kno the primary importance is the santa cruz river, however, nature dosen't distinguish borders between countries or countys.	3/4/2026 9:44 AM
3	Because that would mean the water table has been replenished to some degree, depending on how far downstream the surface expression is manifested..	2/28/2026 1:38 PM
4	I worry about our well	2/28/2026 7:16 AM
5	Restores balance to the area	2/27/2026 4:46 PM
6	Would mean more water in the system and provide opportunities for restoration of native species.	2/27/2026 10:54 AM
7	If it means that we will be getting more water as a County, I support it. If it means that we are taking away or being less efficient in another way, than I do not support it.	2/26/2026 8:25 AM
8	More water is better, to the extent that flooding does not cause loss of life and property. So assuming the increased perennial flow is due to an increase in reclaimed water delivered to the river or precipitation captured that would otherwise have run off,, I'm enthusiastic.	2/25/2026 8:23 PM
9	It seems that the amount of water available will be the determining factor. How does that get increased? More water from the treatment plant?	2/25/2026 4:58 PM

Q8 13 responses

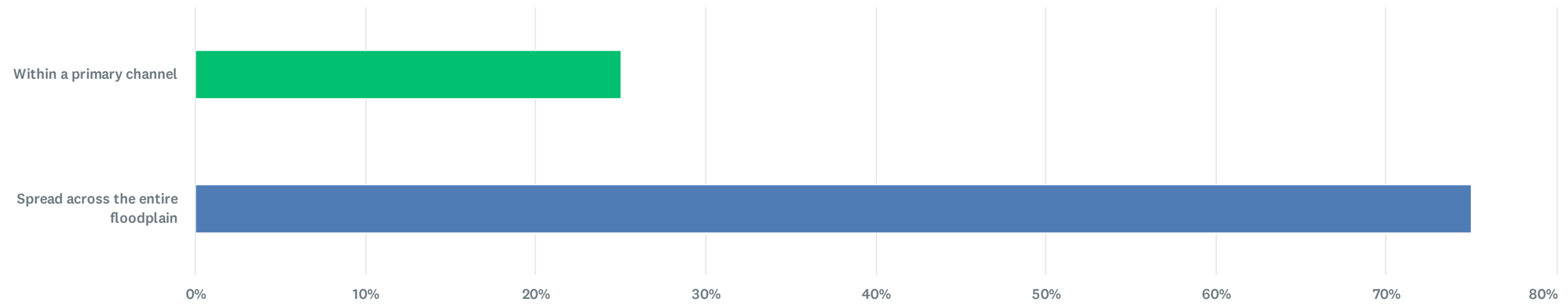
If perennial base flow spread across more of the floodplain, how would you feel?



#	WHY DO YOU FEEL THIS WAY?	DATE
1	I don't see it as a bad thing to extend the zone. Slowing the flow promotes infiltration but going too broad could increase evaporation.	3/4/2026 12:00 PM
2	Better functioning condition with more groundwater recharge, lower flood velocities, and better riparian habitat opportunities/conditions.	2/28/2026 1:38 PM
3	Again, I'm worried about our well and water supply	2/28/2026 7:16 AM
4	Would enhance adjacent habitats (such as mesquite bosque) and species that live there.	2/27/2026 10:54 AM
5	I do not know enough about streams to understand the pros and cons of this.	2/26/2026 8:25 AM
6	It is closer to a natural, pre-anthropogenic, state.	2/25/2026 8:23 PM
7	increasing the ability of the river to recharge the aquifer will add to the health of the surrounding riparian zone.	2/25/2026 4:58 PM
8	Healthy river	2/25/2026 4:27 PM

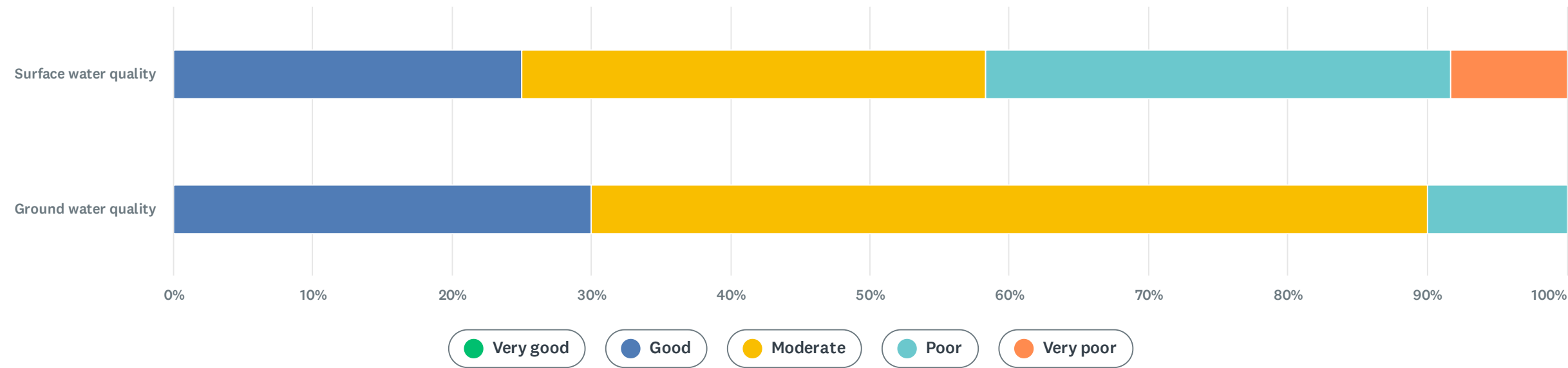
Q9 12 responses

Should storm flows that happen a few times a year, be in a primary channel or be spread across the floodplain to create wetlands/riparian areas?



Q10 12 responses

How would you rate the current water quality of...



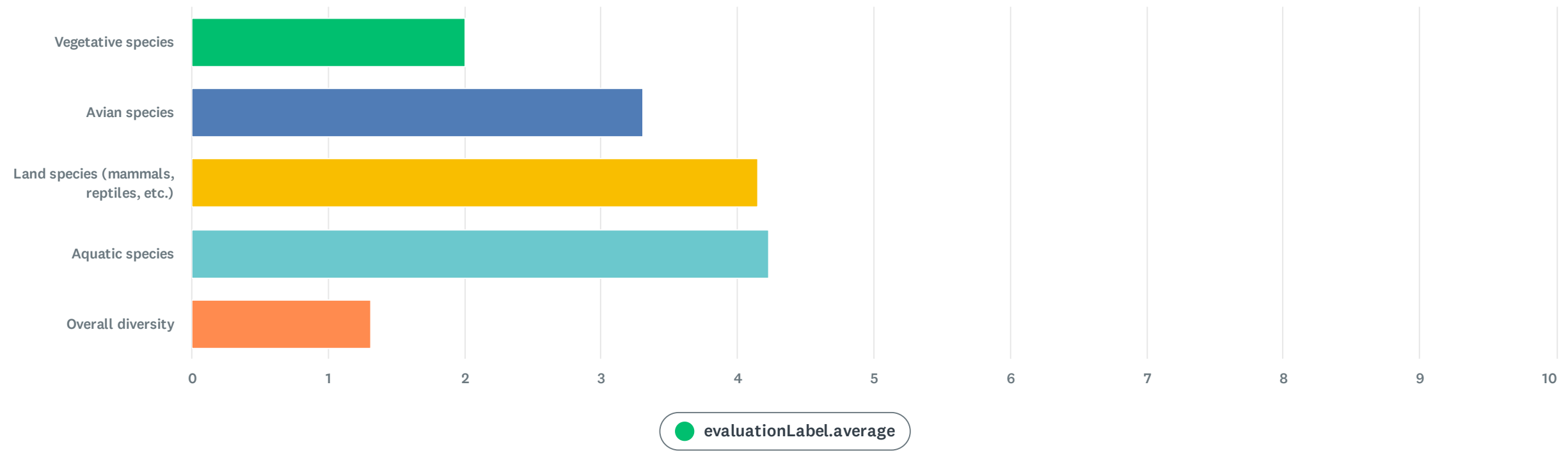
Q11 For water quality, what are your concerns?

Answered: 12 Skipped: 5

#	RESPONSES	DATE
1	na	3/4/2026 12:00 PM
2	Heavy metals, trash, sewage contamination, (E-coli, etc.), turbidity, TDS, PFAS, PFOAS, etc.	2/28/2026 1:38 PM
3	Safe for wildlife in groundwater supply for wells	2/28/2026 7:16 AM
4	Point source and nonpoint source pollution	2/27/2026 4:46 PM
5	I don't not know what the ground water conditions are. Surface water is contaminated with E. coli. Otherwise, surface water is not too bad.	2/27/2026 10:54 AM
6	E. coli	2/26/2026 5:26 PM
7	Trash, PFAS, E.coli, MX	2/26/2026 9:25 AM
8	PFAS and E. coli	2/26/2026 8:25 AM
9	Excessive nutrients, trash, to a lesser extent pathogens.	2/25/2026 8:23 PM
10	I do not have any experience with water quality	2/25/2026 4:58 PM
11	Poorly functioning septic systems, storm water drainage issues, effluent and trash management upstream in source areas.	2/25/2026 4:33 PM
12	I don't know about ground water quality.	2/25/2026 4:27 PM

Q12 13 responses

What is most important to you in regards to riparian / floodplain habitat? (1 being most important, 5 being less important)



Q13 Are there specific locations along the river corridor where you consider the vegetation to be exemplary?

Answered: 10 Skipped: 7

#	RESPONSES	DATE
1	I don't know	3/4/2026 12:00 PM
2	No	3/4/2026 9:44 AM
3	Not really, all reaches are at risk even where present vegetation looks OK recruitment is insufficient for perpetual sustainability.	2/28/2026 1:38 PM
4	Not sure	2/28/2026 7:16 AM
5	North of Santa Gertrudis towards Tubac.	2/27/2026 10:54 AM
6	It's pretty good in the park, but I don't think I'd say anywhere is fully exemplary.	2/26/2026 5:26 PM
7	I enjoy the area around the bridge off of exit 17.	2/26/2026 8:25 AM
8	There is nowhere that I would consider exemplary, because invasive plants are pretty much everywhere. But there are some spots that are very nice, where a mostly native understory persists in the forest. A few spots north of the Tubac Bridge come to mind.	2/25/2026 8:23 PM
9	north of Tubac Bridge	2/25/2026 4:58 PM
10	Peck wash confluence	2/25/2026 4:27 PM

Q14 Are there specific locations along the river corridor that cottonwood restoration/establishment should be focused?

Answered: 10 Skipped: 7

#	RESPONSES	DATE
1	Areas where water is reliable. I don't know specific areas	3/4/2026 12:00 PM
2	No	3/4/2026 9:44 AM
3	Wherever there is too much Tamarisk that should be removed.	2/28/2026 1:38 PM
4	Yes, as identified for success probability through enhancing conditions to support	2/27/2026 4:46 PM
5	Anywhere conditions are good for restoration (water availability) and where it could enhance biodiversity and stream channel stabilization.	2/27/2026 10:54 AM
6	I'd love to see that along the park stretch. We have the established cottonwoods, but sorely lacking in recruitment. Our tribal partners have bemoaned that our cottonwoods are too tall to collect parts needed for ceremony.	2/26/2026 5:26 PM
7	It is my understanding that the Mesquite tress have a negative impact on the Cottonwood. I would not be against removing some Mesquite trees in order to restore Cottonwood trees.	2/26/2026 8:25 AM
8	As much of the cottonwood forest as possible should be preserved. The miles of connectivity in SC County from Tubac south to Rio Rico create a major migratory pathway for birds and wildlife. For example, the Tubac Hawk Watch would not exist without this corridor because so many hawks orient to the river areas with forest and perennial flow. Within this area, restoration opportunites need to carefully assessed and aggressively pursued. The Nature Center has identified areas along the river in Tubac where restoration should be pursued, and recommended some methods. See Q #31 , below.	2/25/2026 8:23 PM
9	The Nature Center has identified areas along the river in Tubac where cottonwood establishment could succeed.	2/25/2026 4:58 PM
10	Everywhere that it is possible and has a good chance of success	2/25/2026 4:27 PM

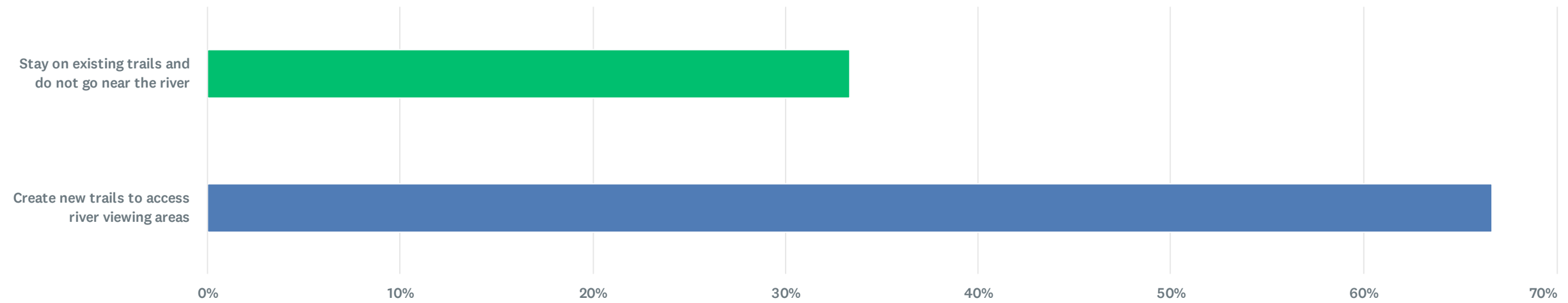
Q15 Are there specific locations along the river corridor that invasive species removal should be focused?

Answered: 11 Skipped: 6

#	RESPONSES	DATE
1	I don't know.	3/4/2026 12:00 PM
2	No	3/4/2026 9:44 AM
3	Yes, several within the South River Road, Carmen, and Tumacácori reaches.	2/28/2026 1:38 PM
4	Hemlock near national park	2/28/2026 7:16 AM
5	Triage through risk matrix and then form action plan	2/27/2026 4:46 PM
6	Upstream and work downstream. Locations that have been previously treated are getting reinfested due to upstream occurrence of invasives.	2/27/2026 10:54 AM
7	Anywhere there's trash. I'm seeing a high correlation between trash and garbage invasive plants (including poison hemlock).	2/26/2026 5:26 PM
8	I would like to know the impact of the Mesquite trees.	2/26/2026 8:25 AM
9	In general, the same areas that are targeted for cottonwood restoration. I would add that tamarisk control in the Tubac Borrow Pit is the priority of the Tubac Nature Center and Tucson Bird Alliance, because it is essential for successful wetland restoration.	2/25/2026 8:23 PM
10	The Tubac Nature Center has a 3-yr grant to remove invasive species in the area along the river in Tubac. This work is contracted with the Tucson Bird Alliance	2/25/2026 4:58 PM
11	Not sure but tamarisk and bull frogs are examples	2/25/2026 4:27 PM

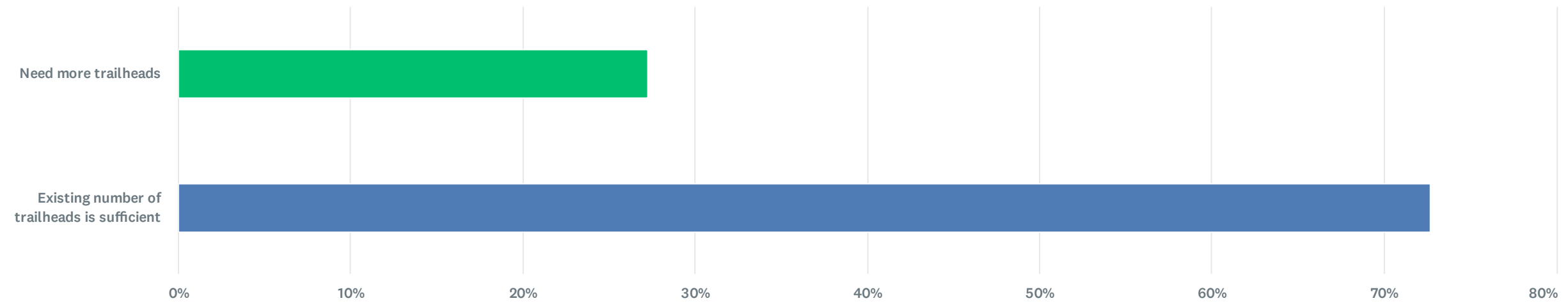
Q16 12 responses

How best should humans interact with the Santa Cruz River?



Q17 11 responses

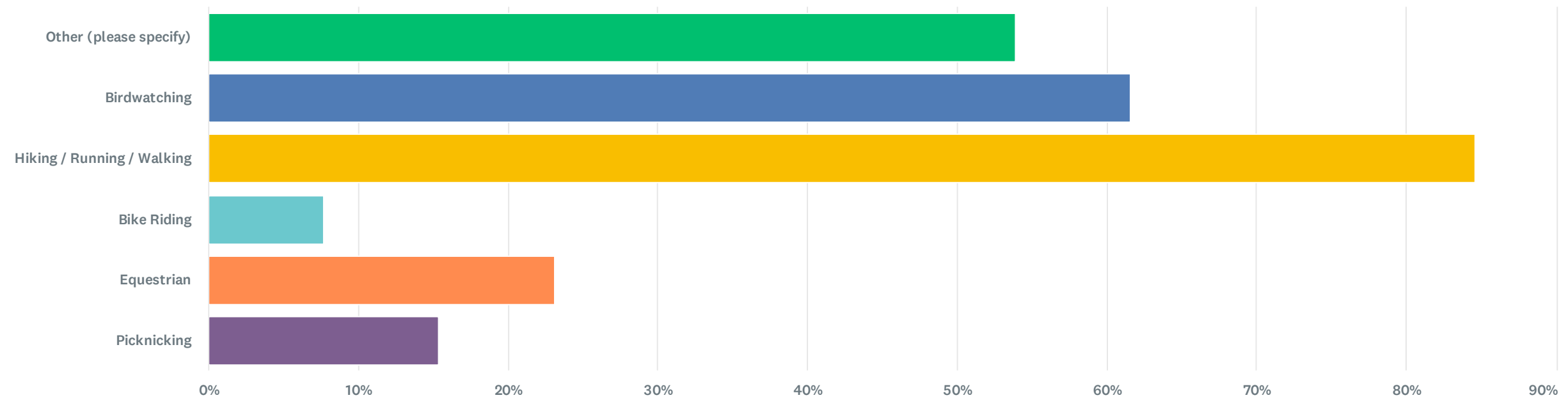
What is your view of the number of trailheads along the river?



#	WHAT OTHER AMENITIES COULD BE IMPLEMENTED AT EXISTING TRAILHEADS?	DATE
1	I don't know the answer to this question or the number of trailheads. Parking?	3/4/2026 12:00 PM
2	Trash cans/receptacles, interpretive signage maintenance, stable parking areas.	2/28/2026 1:38 PM
3	See Rio Rico-Santa Cruz River Resilience Corridor. Holistically match flood control to satellite sites of community water/nature amenities + river restoration	2/27/2026 4:46 PM
4	Information, garbage collection	2/27/2026 10:54 AM
5	Wish list: Bike racks, trail map board, markers, elevation, history, benches, picnic tables, art, "leave no trace" signage, information regarding wildlife and vegetation.	2/26/2026 9:25 AM
6	I believe that we are low on signage unifying mapping at the trailheads.	2/26/2026 8:25 AM
7	I'm all for more interpretive signage that also signals to the public that the access exists. And a judicious list of do's and don'ts may be appropriate in some areas.	2/25/2026 8:23 PM
8	restroom facilities	2/25/2026 4:58 PM
9	Education	2/25/2026 4:27 PM

Q18 13 responses

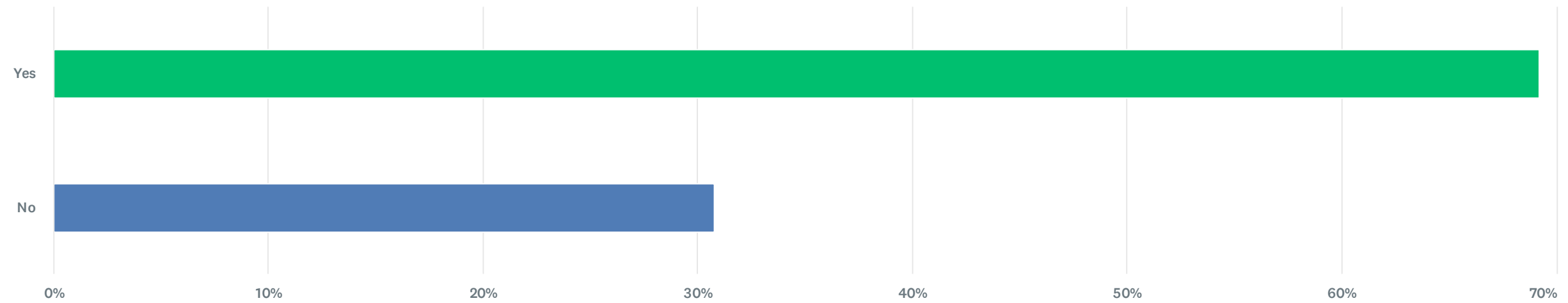
How do you use the current trail network? Select all that apply.



#	OTHER (PLEASE SPECIFY)	DATE
1	I currently don't "use" it. I enjoy the area for its beauty from the road.	3/4/2026 12:00 PM
2	Scientific/monitoring and educational activities.	2/28/2026 1:38 PM
3	Research, tourism	2/27/2026 10:54 AM
4	In my manager role I use the trails to check on health on the riparian corridor.	2/26/2026 5:26 PM
5	Looking for bugs, includiung but not limited to Odes and butterflies	2/25/2026 8:23 PM
6	Nature exploration	2/25/2026 4:58 PM
7	Ecological restoration e.g. tree planting, seeding and water harvesting	2/25/2026 4:27 PM

Q19 13 responses

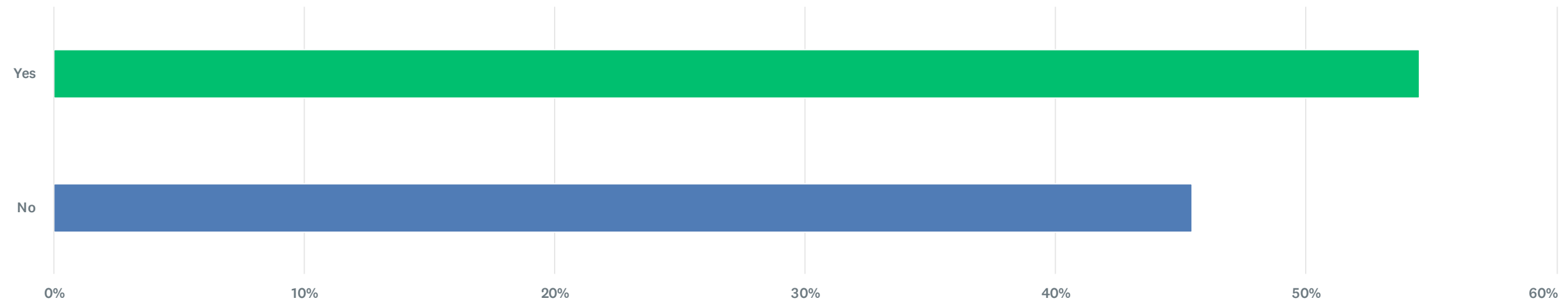
Do the trails need more interpretive or wayfinding signage?



#	IF YES, PLEASE INDICATE A LOCATION	DATE
1	I really don't know.	3/4/2026 12:00 PM
2	Palo Parado crossing.	2/28/2026 1:38 PM
3	A comprehensive plan should be created.	2/27/2026 10:54 AM
4	At the entrances to different jurisdictions with different rules.	2/26/2026 5:26 PM
5	The Anza Trail	2/26/2026 9:25 AM
6	Not much, but I believe the signage should also help link with other trail option.	2/26/2026 8:25 AM
7	I'm with Tubac Nature Center so I'll say Tubac.	2/25/2026 8:23 PM

Q20 11 responses

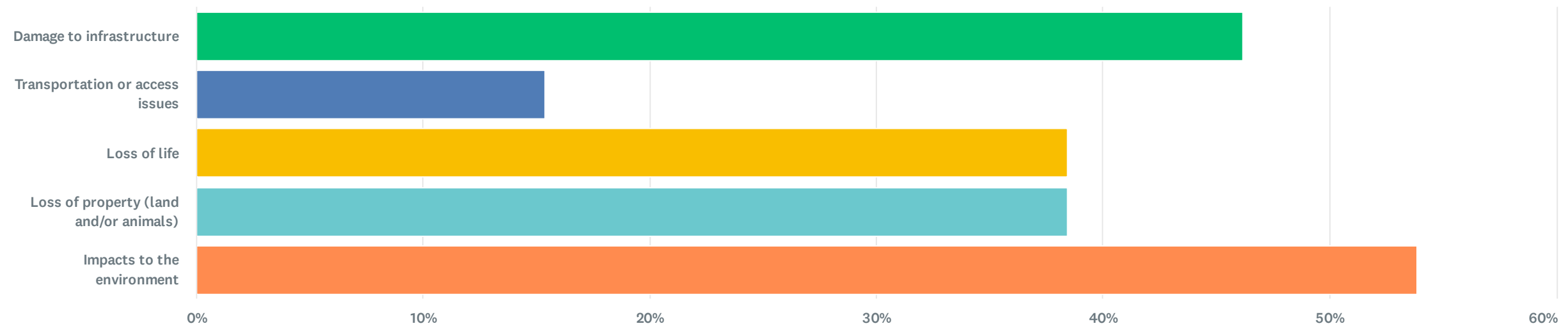
Should the trails connect to more features along the corridor?



#	IF YES, PLEASE INDICATE A LOCATION	DATE
1	I don't know. Connecting all the trails, creating a trail network with features, seems to be a good idea.	3/4/2026 12:00 PM
2	Trail markers to help with quickly identifying emergency locating.	2/28/2026 1:38 PM
3	Where opportunities exist that are not being used - local tourism in particular.	2/27/2026 10:54 AM
4	I'm not sure what this means. Popular tourist attractions? Schools?	2/25/2026 8:23 PM

Q21 13 responses

What is your concern related to flood risk along the river? Select your top-2 choices.



Q22 In your opinion, how does the condition of the river affect...

Answered: 9 Skipped: 8

ANSWER CHOICES	RESPONSES	
Adjacent Land Use	100.00%	9
Property Values	100.00%	9

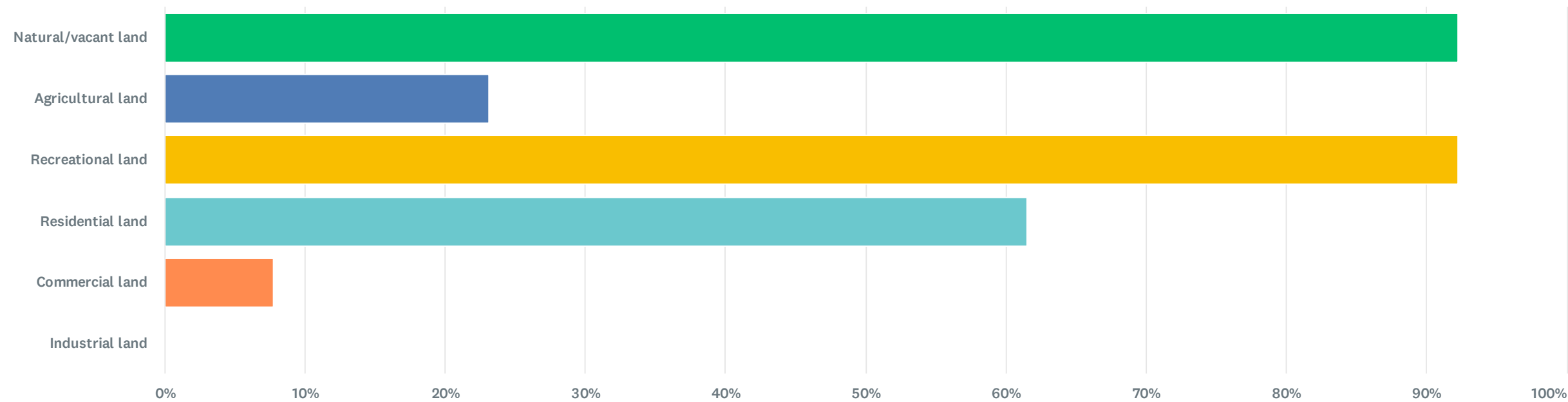
#	ADJACENT LAND USE	DATE
1	Good river condition should improve adjacent land use	3/4/2026 12:00 PM
2	Continued incisement can lower water tables and negatively impact riparian vegetation and water supplies..	2/28/2026 1:38 PM
3	Increased pedestrian and vehicular traffic	2/27/2026 4:46 PM
4	In Tubac, the Anza Trail, Ron Morris, and the little petting zoo are located close together which is amazing and I think they impact each other positively.	2/26/2026 9:25 AM
5	Since the land would most likely be in the flood plain, it has a big impact.	2/26/2026 8:25 AM
6	people want to be near the river if it's in good condition, so we could love it to death by building too many homes, and conversely people will oppose particularly destructive land uses if they love the river.	2/25/2026 8:23 PM
7	a healthy river environment is a bonus to the adjacent land	2/25/2026 4:58 PM
8	Enhances agricultural productivity and quality of life	2/25/2026 4:33 PM
9	Correlation	2/25/2026 4:27 PM
#	PROPERTY VALUES	DATE
1	Good river condition should improve property values for the whole area	3/4/2026 12:00 PM
2	Desiccation, downcutting, loss of habitat negatively impacts property values.	2/28/2026 1:38 PM
3	Enhances, even its current state	2/27/2026 4:46 PM
4	I feel the condition of the river would affect property value should it be restored.	2/26/2026 9:25 AM
5	I believe a clean river is a big plus for property values.	2/26/2026 8:25 AM
6	Having a river in good condition would generally increase property values, though it is not clear to me how big a factor this would be relative to other practical considerations.	2/25/2026 8:23 PM
7	healthy river will increase property values	2/25/2026 4:58 PM

Santa Cruz River Restoration Master Plan Priorities and Rankings

8	Increases property value	2/25/2026 4:33 PM
9	Correlation	2/25/2026 4:27 PM

Q23 13 responses

In your opinion, which land-uses benefit the most from a restored Santa Cruz River? Select your top-3.



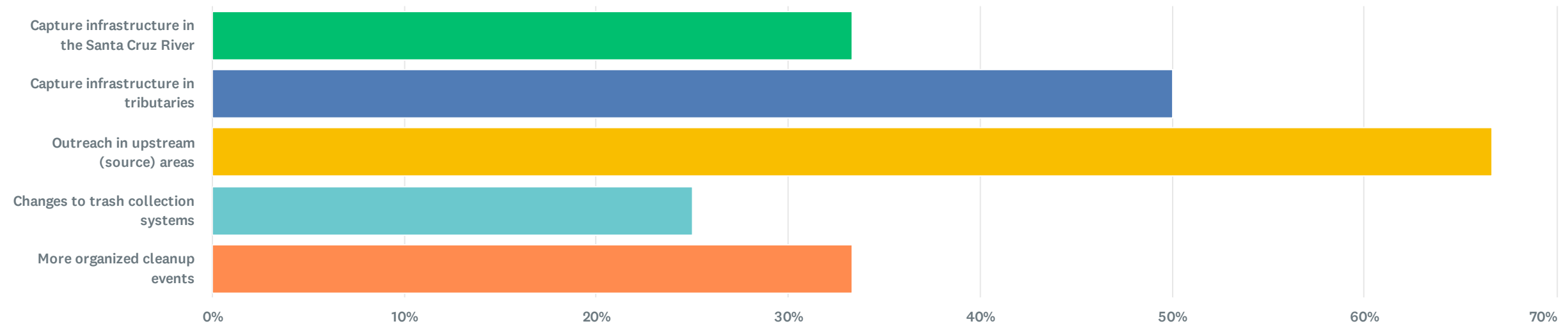
Q24 Where along the river have you encountered high amounts of trash?

Answered: 10 Skipped: 7

#	RESPONSES	DATE
1	I don't know	3/4/2026 12:00 PM
2	Mostly in Nogales Wash.	2/28/2026 1:38 PM
3	Between Palo Parado Road and Tumacacori	2/27/2026 4:46 PM
4	Tumacácori	2/27/2026 10:54 AM
5	Clearly the 16acres on the park. But, I know there's other smaller trash dams.	2/26/2026 5:26 PM
6	I think the Nogales Wash is the biggest culprit for litter and contamination.	2/26/2026 9:25 AM
7	We just cleaned up behind the pilot gas station a couple of weeks ago. The amount of trash was astonishing.	2/26/2026 8:25 AM
8	Nogales and Oso Wash, Tumacacori “trash dam” and occasionally smaller trash dams in Tubac. The latter are usually manageable enough to be removed by the Anza Trail Coalition.	2/25/2026 8:23 PM
9	On the ANZA trail north of the entrance at Ruby Road	2/25/2026 4:58 PM
10	Peck confluence	2/25/2026 4:27 PM

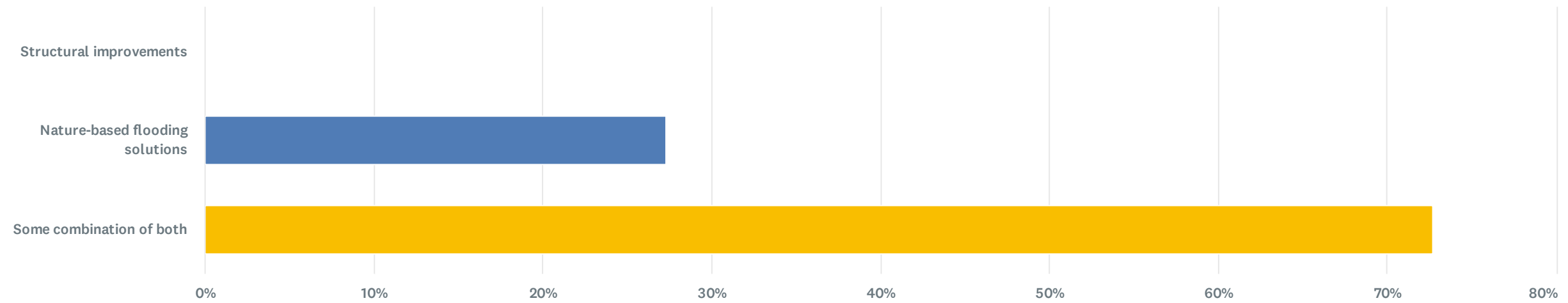
Q25 12 responses

How can trash in the Santa Cruz River best be mitigated? Select your top two choices.



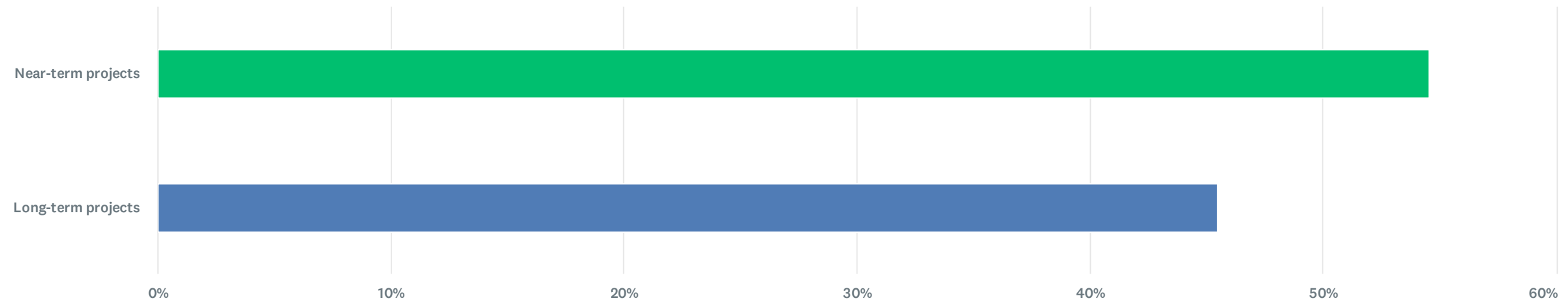
Q26 11 responses

Should the Master Plan include structural or nature-based solutions to aid in river restoration?



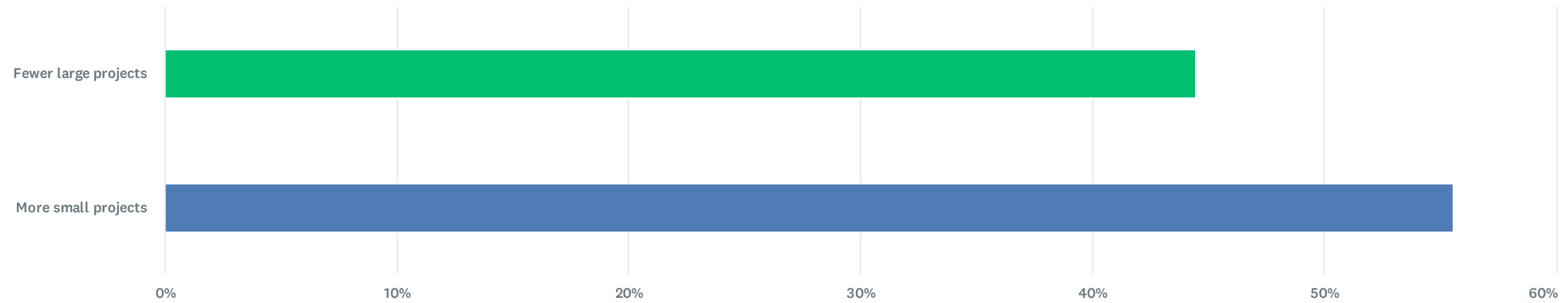
Q27 11 responses

Should we focus on near-term projects or long-term projects?



Q28 9 responses

Should we focus on fewer large projects or more small projects?

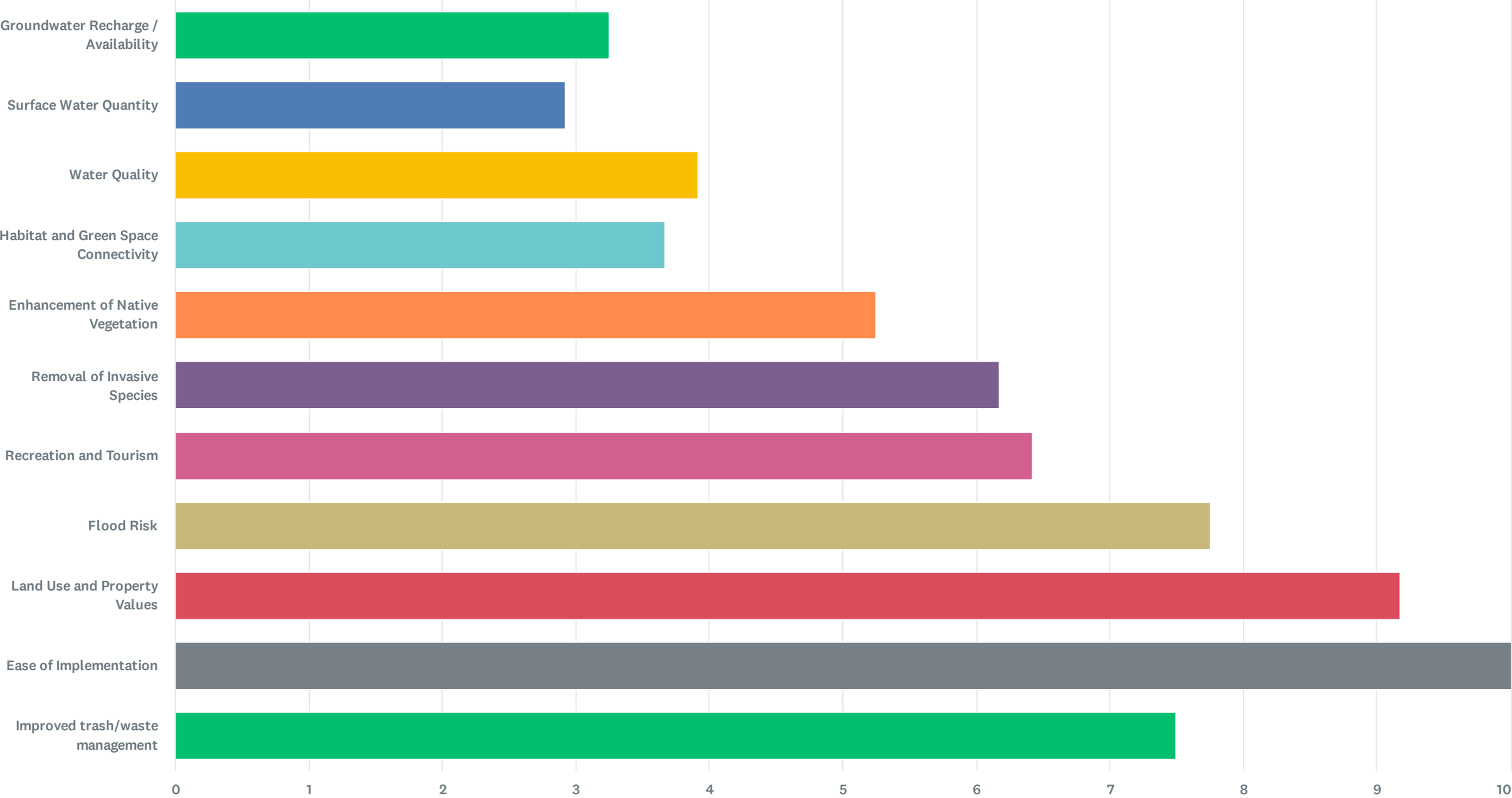


Q29

12 responses

When developing stream restoration projects, what should be the desired outcome? Rank the following in order of priority:

Santa Cruz River Restoration Master Plan Priorities and Rankings

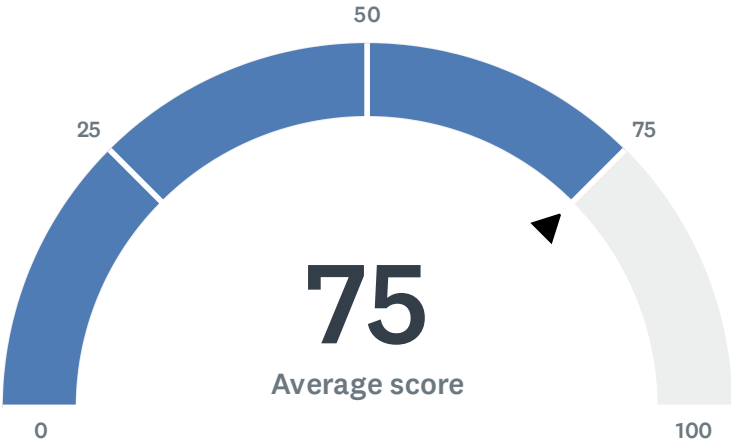


 evaluationLabel.average

Q30

8 responses

How important are water rights to you?



Basic statistics				
Minimum	Maximum	Median	Mean	Standard Deviation
60.00	100.00	75.00	75.00	14.14

#		DATE
1	60	2/28/2026 1:38 PM
2	90	2/28/2026 7:16 AM
3	60	2/27/2026 4:46 PM
4	80	2/27/2026 10:54 AM
5	80	2/26/2026 8:25 AM
6	60	2/25/2026 4:58 PM
7	100	2/25/2026 4:33 PM
8	70	2/25/2026 4:27 PM

Q31 Please add any general comments you have below.

Answered: 7 Skipped: 10

#	RESPONSES	DATE
1	Personal and professional considerations differ. Always happy to discuss.	3/4/2026 12:00 PM
2	Glad the river is getting some of the overdue well deserved attention. Survey should be shared with Connie Williams.	2/28/2026 1:38 PM
3	Ground water availability and surface flow are interconnected - not sure they can be prioritized one over the other. Maybe not a priority, but some mention of long term benefits of stream and habitat restoration on T&E or species sensitive to water availability issues like yellow-billed cuckoo, Gila topminnow, Mexican garter snake, fireflies, butterfly bush, etc.	2/27/2026 10:54 AM
4	There are many either/or questions that I couldn't answer or don't feel great about my choice. I don't think the realities on the ground will allow the either/or. More importantly, I think we have the opportunity within this study area to enact more than one option.	2/26/2026 5:26 PM
5	Thank you.	2/26/2026 9:25 AM
6	Regarding question #9, I'm not sure "entire" is the right word. Perhaps "much more". Regarding Q #17. There are already numerous social trails. A judicious assessment of these and incorporation into the formal trail network would provide the public with opportunity to appreciate the river. That's needed for public support. At the same time, most areas still need to remain off limits so that nature can flourish. Regarding Q #28. I do not have an absolute answer to this. In general I think incremental improvement is the correct approach because it is most feasible. This might imply "small" projects. But perhaps not. Regarding Q #30. I'm not sure how to answer that. I think we need to advocate for stronger laws and better behavior from land owners to ensure that our water use is sustainable. That means considering people and ecology, and limiting growth. The plan should focus on that. But, of course, existing water rights are inviolable, so that needs to be considered too. As a final note, the Tubac Nature Center has prepared plans for restoration of SC River habitats that should be incorporated into your master plan such that they form the basis of restoration priorities for the Tubac land. A summary of all our conservation efforts so far, plus all the plan documents we have developed, are available on our website. See: https://tubacnaturecenter.org/our-conservation-projects	2/25/2026 8:23 PM
7	good job	2/25/2026 4:58 PM



Appendix D – Comment Cards

Q3 Comments/concerns:

Answered: 5 Skipped: 4

#	RESPONSES	DATE
1	Thank you!	5/4/2026 12:13 PM
2	most interested in preservation of the West Branch of Santa Cruz river conservation area which we have looked after for 45 plus years. And keeping its connectivity to other areas of wildlife and habitat.	4/28/2026 5:12 PM
3	Restoration of ground and surface water flows.	4/28/2026 3:29 PM
4	Thank you for this!	4/28/2026 3:28 PM
5	Bank disturbance and impacts on sensitive plant and animal species within the riparian areas	4/28/2026 3:27 PM