Guadalupe River Watershed Reassessment 2022:

10-Year Reassessment of the Ecological Condition of Streams Based on the California Rapid Assessment Method

SANTA CLARA COUNTY

Technical Report prepared for the Santa Clara Valley Water District (Valley Water)
Safe, Clean Water and Natural Flood Protection Program,
Priority D, Project D5: Ecological Data Collection and Analysis

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SUBMITTED BY: **San Francisco Estuary Institute**

AUTHORS: **Sarah Pearce, Sarah Lowe, David Peterson, Denise Walker, and Pete Kauhanen • SFEI**
Zooey Diggory and Douglas Titus • Valley Water

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SFEI- ASC Project #8727.07
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Valleywater.org/d5-ecological-data-collection-and-analysis
or
https://www.sfei.org/projects/santa-clara-valley-water-districts-watershed-condition-assessments

Executive Summary

What is the Guadalupe River Watershed Stream Condition Reassessment?

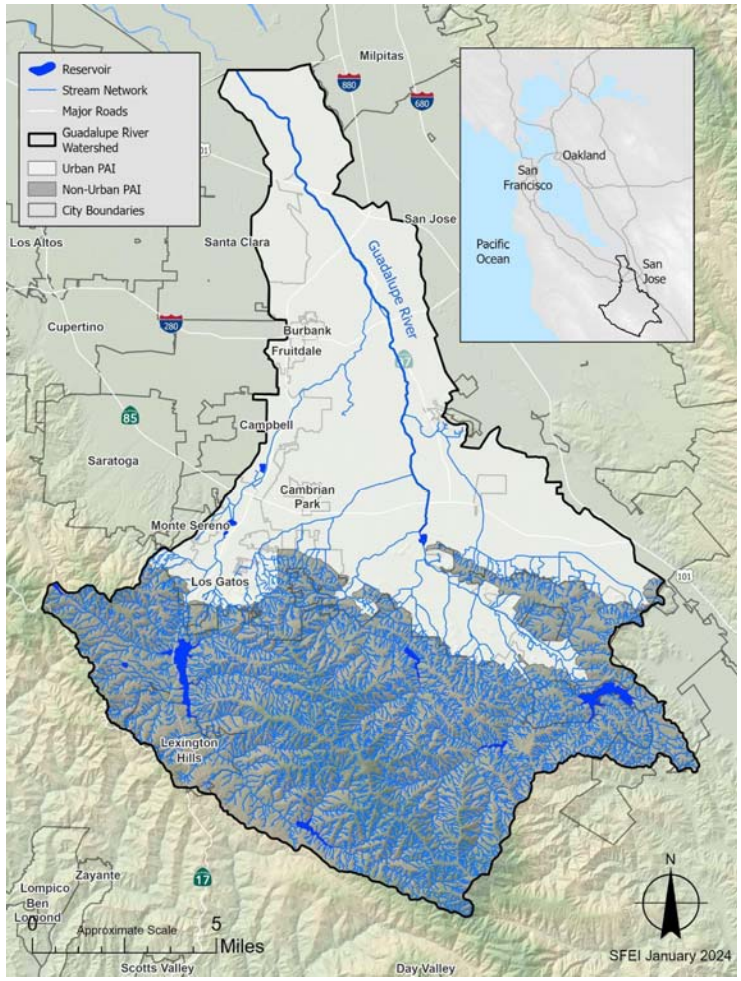
The Santa Clara Valley Water District (Valley Water) collects data on the health, or overall ecological condition, of streams across its five watersheds as a part of Project D5 of the Safe, Clean Water and Natural Flood Protection Program. The data collected, analyzed, and shared are helping Valley Water and other Santa Clara County agencies and organizations make informed asset management and natural resource decisions.

Project D5 employs the California Rapid Assessment Method (CRAM) to quantify ecological condition of the stream network. CRAM field surveys focus on four different aspects (or Attributes) of condition: the stream's buffer, its hydrology, its physical complexity, and vegetation. The method outputs a single overall numerical score of condition for each sample location (or Assessment Area), as well as a score for each component Attribute. Scores can be placed into three condition classes: Good, Fair, or Poor.

CRAM
California Rapid Assessment Method

The baseline survey of ecological condition of streams within the Guadalupe River watershed was completed in 2012, and this reassessment survey was completed ten years later in 2022. The survey focuses upon stream conditions in the watershed as a whole, and in two primary areas of interest: the Urban portion of the watershed within Santa Clara Valley, and the Non-urban portion of the watershed in the Santa Cruz Mountains. The survey was designed to answer two questions:

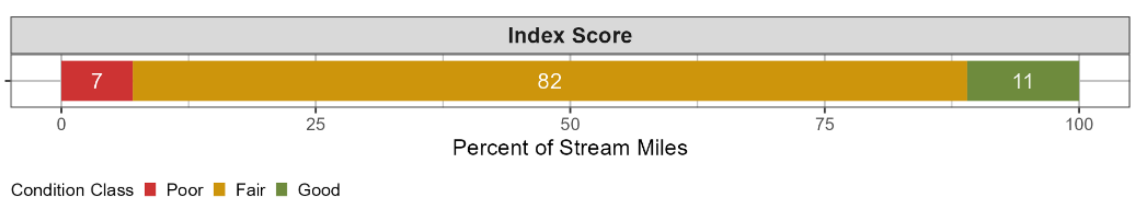
- What is the overall ecological condition of streams in the Guadalupe River Watershed, as well as in the Urban portion and the Non-urban portions of the watershed?
- How has stream condition changed over the past 10 years?



What results did the reassessment find?

Overall, the reassessment survey found that the streams in the Guadalupe River Watershed are primarily in Fair condition, and that condition largely has not changed in the past 10 years. However, much more detail about stream conditions and how they are changing can be uncovered. For example:

What is the overall ecological condition of streams in the full Guadalupe River Watershed?
Approximately 80% of the stream reaches in the Guadalupe River Watershed are currently in Fair ecological condition, about 10% are in Poor condition, and about 10% are in Good condition. This means that the majority of streams provide moderate levels of the ecological functions and services that we expect from stream systems, and that there is room for future improvement. However, the results also indicate that there are clear differences in stream conditions between the lower Urban and upper Non-Urban portions of the watershed.



What is the overall ecological condition of streams in the Urban portion of the watershed?

In general, and as expected, streams in the Urban portion are in lower condition than those upstream in the Non-urban areas. One-third of the Urban streams are in Poor condition as the result of:

- their simple shape and low complexity that is often found in engineered or modified channels,
- the common lack of floodplains,
- the simple vegetation that these streams support, sometimes missing tree canopy, and often dominated by non-native species,
- the proximity of development to the channels, and the adverse effects of urban runoff.

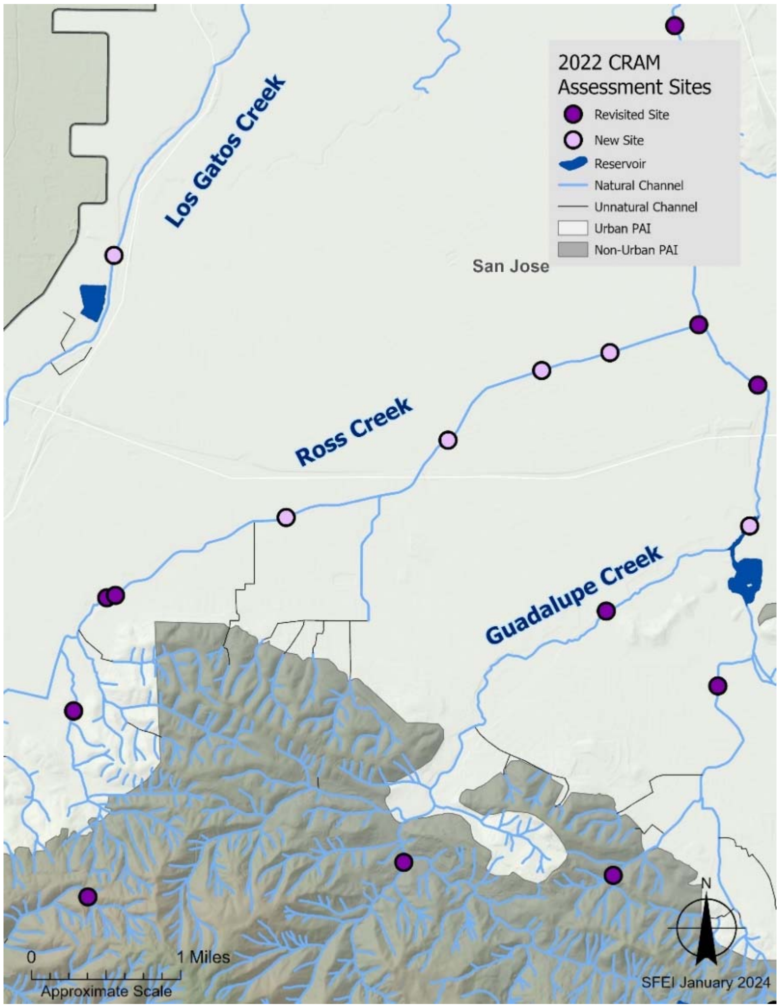
What is the overall ecological condition of streams in the Non-urban portion of the watershed?

Intuitively we might expect all of the stream reaches in the Non-urban area to be in Good condition, and certain aspects of condition do show this pattern. For example, 90% of these stream reaches have a Good condition buffer, and there are no stream reaches in Poor condition in the Non-urban area. However, the majority (87%) of stream reaches are still in Fair ecological condition and only 13% are in Good condition. It is important to recognize that, although some of the Non-urban streams could be targeted for actions to improve their condition, many of these streams are in their natural state, and have not been significantly impacted by human management or development. For these streams, Fair condition is appropriate, and likely the highest condition that should be reasonably expected, given their small size, steepness, and landscape position, which give rise to commonalities such as:

- a simple channel shape without floodplain areas,
- low physical complexity in the channel, and
- a simple and homogeneous vegetation community.

These commonalities are not necessarily deficiencies, but instead are characteristic of natural streams in this area. But, as compared to more complex streams in the watershed and across the state, these streams are simpler, and have a lower capacity to support the full suite of functions and processes expected from a stream, thus earning a slightly lower score.

How has stream condition changed over the past 10 years?



No statistically significant differences in stream condition could be discerned between 2012 and 2022 at the watershed scale. Significant drivers of stream condition change, such as large restoration projects, significant wildfires, or large areas of new development, have not occurred at sufficient scale over the past 10 years to detect change at the watershed scale.

There has been a small, but statistically significant decline in condition in the Urban area. Between 2012 and 2022, the amount of stream reaches in Poor condition has increased by 8%, and the amount in Good condition has decreased by 15%. There are two explanations for this decline: First, the 2022 reassessment added more sample locations to better characterize previously under-represented stream reaches in the Urban area (light purple dots, left); and second, the condition of the vegetation community declined.

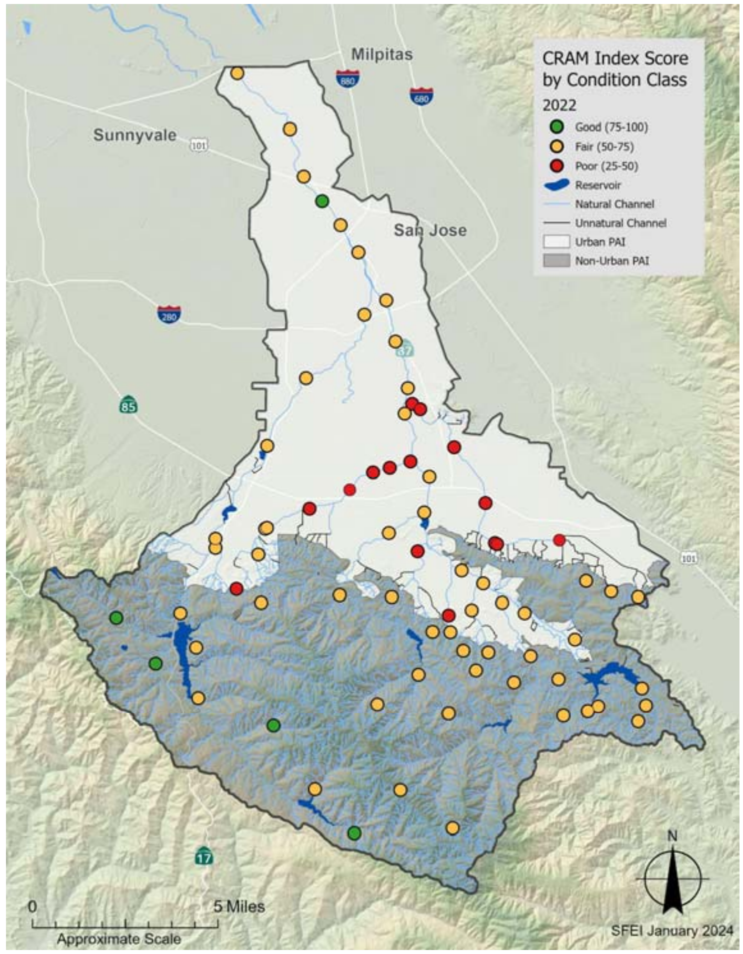
In the Non-urban area, the reassessment found a small, but statistically significant improvement in the Buffer and Landscape Context Attribute between 2012 and 2022, with a decrease in stream reaches in Poor condition and an increase in stream reaches in Good condition. This change is also driven by the addition of new sample locations in the Non-urban upper watershed.

While not statistically significant, the reassessment detected small declines in vegetation community condition scores that may be due to extended drought conditions in 2012-2016 and 2020-2022. Sixty-six percent of stream sites that were assessed in 2012 and revisited in 2022 experienced a decline in the Biotic Structure Attribute. This change was not large enough to be statistically significant, but notable because of the number of sites and the decline occurred equally between the Urban and Non-urban areas.

Why do these watershed surveys matter?

While the finding that overall Fair stream conditions have not changed significantly between 2012 and 2022 may seem underwhelming, the reassessment results are actually quite powerful for a number of reasons.

- First, before these surveys occurred, there was not a comprehensive understanding of stream conditions across the watershed. This is important for Valley Water because it only owns a small portion of streams in the watershed, and most of their stream management work occurs only in reaches that they own or have easement access to. These ambient watershed-wide assessments, that include stream reaches owned by Valley Water, other agencies and organizations, and private landowners, provide important context for site- or project-specific management decisions and the data necessary for partners across the watershed to work collaboratively.



- Second, the lack of significant ecological change in stream conditions over the last 10 years indicates relative stability, meaning that current resource management actions are maintaining stream conditions.
- Third, because the majority of stream reaches in the Guadalupe River watershed *are* in Fair condition, there is plenty of opportunity for targeted improvement in the future. The results provide information on which stream reaches could be targeted for restoration or enhancement to improve ecological conditions, as well as site specific details on the aspects of stream form and function that could be improved.
- And finally, the results provide data to support planning and management that increases stream and habitat resiliency for future climate conditions: increased periods of drought, warmer air temperatures, more intense precipitation events, flashier flows, increased wildfire risk, and sea level rise, among others.

How will these watershed surveys be used?

The stream condition surveys provide watershed-scale monitoring data that decision makers and resource managers are able to use in a number of ways.

Stream condition tracking

The results satisfy the objectives of the Safe, Clean Water and Natural Flood Protection Program's Project D5, namely collecting watershed monitoring data to track stream ecosystem health. The data from the Guadalupe River Watershed reassessment allow for tracking stream conditions across the watershed through time, as well as comparing it to other watersheds in Santa Clara County.

Supporting Valley Water's One Water Plan

The results support Valley Water's One Water watershed plan for the watershed by employing this CRAM data to identify opportunity areas for ecological enhancement and to help measure success towards a number of ecological performance metrics and goals.

Supporting Project Planning, Implementation, and Monitoring

The results can support restoration, mitigation, enhancement or preservation projects by providing context and information for project planning, implementation and monitoring. The ambient survey can help guide the selection of where projects could occur, what aspects of stream condition are in need of improvement, and which locations and enhancement actions are likely to have the largest positive impact on site-scale and watershed condition. Using CRAM to monitor projects after implementation allows Valley Water to track progress and evaluate project performance compared to other projects and streams in the watershed.

Before *After*

Pre- and post-project photos from the San Jose Water Company Low Flow Crossing Barrier Removal. For more information, visit the Valley Water Fish and Aquatic Habitat Collaborative Effort mapping webpage for the Guadalupe River Watershed at: https://valleywater.maps.arcgis.com/apps/MapJournal/index.html?appid=bda72eec90354c74b170b7826a33cd76.

Long-term Stewardship

By reassessing the ecological conditions of streams over decades, Valley Water is assembling a standardized environmental dataset that supports both a short and long-term vision for coordinated resource planning and management at a watershed scale. In addition, Valley Water is utilizing EcoAtlas (www.EcoAtlas.org) to make the survey data publicly available. Sharing of data and synthesized results are key components of monitoring and assessment programs, because it provides transparency that streams are being stewarded effectively.

EcoAtlas

The reassessment survey confirms that current efforts have not been extensive enough to improve overall stream condition in the watershed, and that more and larger stewardship action will be needed. Climate change, and its effects upon stream ecosystems only intensify the need for action. The surveys indicate that in order to "move the needle" and show stream condition improvement at the Urban or watershed scale, Valley Water will need to take advantage of opportunities to enhance the condition of highly modified channels that it owns. In addition, because of limited land ownership by Valley Water, new and strengthened existing partnerships will be needed to accomplish watershed-scale improvements. These Project D5 surveys provide a starting point for a coordinated watershed approach to implementing large-scale projects by a variety of proponents. These projects will aim to improve stream condition and improve our ability to effectively manage the stream resources in the watershed.

List of Abbreviations

AA	Assessment Area
BAARI	Bay Area Aquatic Resources Inventory
CAL FIRE	California Department of Forestry and Fire Protection
CARI	California Aquatic Resources Inventory
CCED	California Conservation Easement Database
CDF	Cumulative Distribution Function estimate
CFS	Cubic Feet Per Second
CPAD	California Protected Areas Database
CRAM	California Rapid Assessment Method for wetlands
CWMW	California Wetland Monitoring Workgroup
DEM	Digital Elevation Model
GIS	Geographic Information System
GRTS	Generalized Random Tessellation Stratified
KPI	Key Performance Indicator
NHD	National Hydrography Database
NWI	National Wetlands Inventory
PAI	Valley Water's Primary Area of Interest
RipZET	Riparian Zone Estimation Tool
SFEI	San Francisco Estuary Institute
SMP	Valley Water's Stream Maintenance Program
USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USDA	United States Department of Agriculture
USGS	United States Geological Survey
Valley Water	Santa Clara Valley Water District
WRAMP	Wetland and Riparian Area Monitoring Plan

Table of Contents

1. Introduction

The Santa Clara Valley Water District (Valley Water) is a California Special District water resources agency in Santa Clara County providing safe, clean water for a healthy life, environment and economy, flood protection, and stewardship of streams on behalf of the county's residents. Valley Water shares most of its boundary with Santa Clara County (Figure 1), serving 15 cities within a 1,300 square mile area. This area includes five watersheds or groupings of watersheds: Coyote Creek, Guadalupe River, West Valley watersheds, Lower Peninsula watershed, and Upper Pajaro River (Valley Water's service area does not include the Alameda Creek watershed in Santa Clara County, nor any of the Pajaro River watershed outside of Santa Clara County).

In 2012 and 2020, Santa Clara County voters approved the Safe, Clean Water and Natural Flood Protection Program that identified a number of local priorities. The ecology focused *Priority D*[1] implements projects that aim to restore and protect wildlife habitat. Project D5[2] focuses on ecological data collection and analysis to track stream ecosystem health.

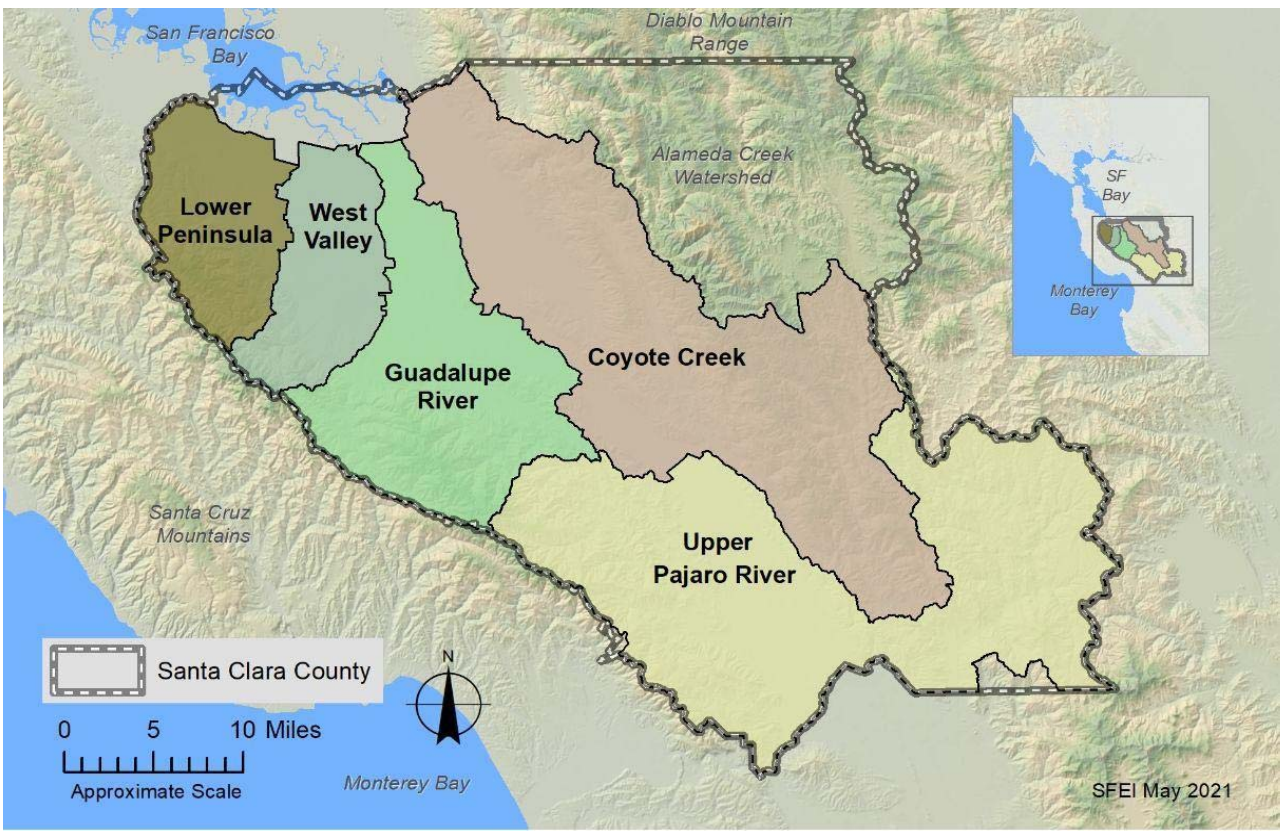


Figure 1. Map of Santa Clara County's five major watersheds. Alameda Creek drains north to Alameda County and is not part of Valley Water's district.

[1] https://www.valleywater.org/safe-clean-water-and-natural-flood-protection-program/priority-D

[2] https://www.valleywater.org/project-updates/d5-ecological-data-collection-and-analysis-0

The 2022 Guadalupe River Reassessment Survey focused on streams within the Guadalupe River watershed in Santa Clara County, CA. The survey was completed by Valley Water's Project D5 with science and implementation support from the San Francisco Estuary Institute (SFEI).

1.1. Project D5 History

In 2010, when developing the foundational roots of One Water and Project D5, Valley Water consultants, EOA Inc. and SFEI, piloted a watershed approach to environmental monitoring and assessment in the Coyote Creek watershed to characterize the amount, distribution, and condition of aquatic resources (EOA and SFEI, 2011). Then known as the Environmental Monitoring and Assessment Program (EMAP), Valley Water employed a watershed approach called the Wetland and Riparian Area Monitoring Plan guided by the newly endorsed *Tenets of the State Wetland and Riparian Monitoring Program* (WRAMP; CWMW, 2010) of the California Wetland Monitoring Workgroup (CWMW) of the State Water Quality Control Board's Water Quality Monitoring Council. The WRAMP recommended the United States Environmental Protection Agency (USEPA) 3-level wetland monitoring and assessment framework to establish standardized monitoring and assessment programs at the watershed or regional scale, and to support state and federal wetland protection policies, resource planning, and stream and wetland restoration performance tracking. It also recommended standards for data collection and online access to data.

The USEPA's 3-level monitoring and assessment framework provides a logical and economical structure for organizing and implementing a large regional or statewide wetlands monitoring program.

Level 1 data consist of geospatial datasets used to generate tables, imagery, or maps to determine the distribution, abundance, and diversity of aquatic resources, or other relevant ecological information. This data is essentially any geospatially referenced information that supports environmental monitoring and assessment. The data may be collected by remote sensing or ground surveys, and can always be represented by dots, polygons, or lines in a geographical information system (GIS). The California Aquatic Resource Inventory (CARI v1.1, SFEI, 2022), Bay Area Aquatic Resources Inventory (BAARI v2.1, SFEI ASC, 2017), Valley Water's "Creeks" GIS-layer, and Project Tracker's Habitat Projects are all examples of Level-1 data.

Level 2 data consist of rapid field assessments, cost-effective evaluations of conditions based on visible ecological indicators that do not require the collection or processing of materials from the field, but instead are field measures. These methods output numerical scores of conditions. The California Rapid Assessment Method (CRAM) is a standardized, statewide Level 2 methodology that assesses the overall ecological condition of streams and wetlands and their adjacent riparian habitat (CWMW, 2013a).

Level 3 data are 'intensive site assessments' providing detailed information on how well the stream or wetland is functioning, or to address specific regulatory monitoring requirements. Quantitative flow measures, water quality testing, hydrogeomorphic assessments, and number of species observed per unit area are examples of Level 3 data.

Valley Water adopted and implemented the 3-level monitoring and assessment framework (see side bar), and utilizes the statewide California Rapid Assessment Method (CRAM) data management and access tools (see Appendix D) to support regional resource management and restoration planning within Santa Clara County, and to help Valley Water track the performance of projects, maintenance activities, and on-the-ground stewardship actions; including protecting and restoring healthy riparian areas, floodplains, managing invasive plants, improving fish passage and spawning habitat, and stabilizing stream channels.

Upon county voter approval of the Safe, Clean Water and Natural Flood Protection Program in 2012, Valley Water evolved EMAP into Project D5. It was tasked to assess stream ecosystem conditions in Valley Water's five major watersheds, to reassess those conditions every 10 years, and to share the information with the public to help make informed watershed and asset management decisions. Project D5 completed baseline surveys of ecological condition in the five watersheds between 2010 and 2018 (*Santa Clara County Five Watersheds Assessment: A synthesis of Ecological Data Collection and Analysis conducted by Valley Water* (termed the Five Watershed Synthesis Report in this report) (Lowe *et al.*, 2020); see https://www.valleywater.org/project-updates/d5-ecological-data-collection-and-analysis-0).

In 2020 voters renewed the Safe, Clean Water and Natural Flood Protection Program with updates to Project D5's key performance indicators (KPIs):

KPI #1: Reassess and track stream ecological conditions and habitats in each of the county's five (5) watersheds every 15 years.

KPI #2: Provide up to $500,000 per 15-year period toward the development and updates of five (5) watershed plans that include identifying priority habitat enhancement opportunities in Santa Clara County.

Because they had already been planned and budgeted under the original Safe, Clean Water Program's 10-year cycle, Coyote Creek and Guadalupe River watersheds were reassessed in 2020 and 2022, respectively. Future watershed reassessments will switch towards the prescribed 15-year timeframe.

KPI #2 facilitates the application of Project D5 and other environmental data to watershed plans and other efforts that identify habitat protection and enhancement opportunities in the five watersheds. Progress toward KPI#2 is reported annually on the Project D5 and Safe Clean Water Program webpages (https://www.valleywater.org/safe-clean-water-and-natural-flood-protection-program/safe-clean-water-program-archive).

2. Guadalupe River Watershed Setting

The Guadalupe River watershed is a 170 mi^2 (440 km^2) watershed that is the third largest watershed within the five major watersheds in Santa Clara County, behind the Upper Pajaro River and Coyote Creek. It covers about 16 percent of the total five-watershed extent, and includes 13 percent of the stream resources (not including 1st order streams). The Guadalupe River begins in tributaries near the summits of Loma Prieta (elevation 3,786 ft) and Mount Umunhum (elevation 3,489 ft), draining the eastern Santa Cruz Mountains of Santa Clara County. The tributaries flow north from the mountains into the Santa Clara Valley, becoming the Guadalupe River downstream of the confluence of Alamitos Creek and Guadalupe Creek. The Guadalupe River continues to flow north through the City of San Jose, draining into South San Francisco Bay through Alviso Slough (Figure 2).

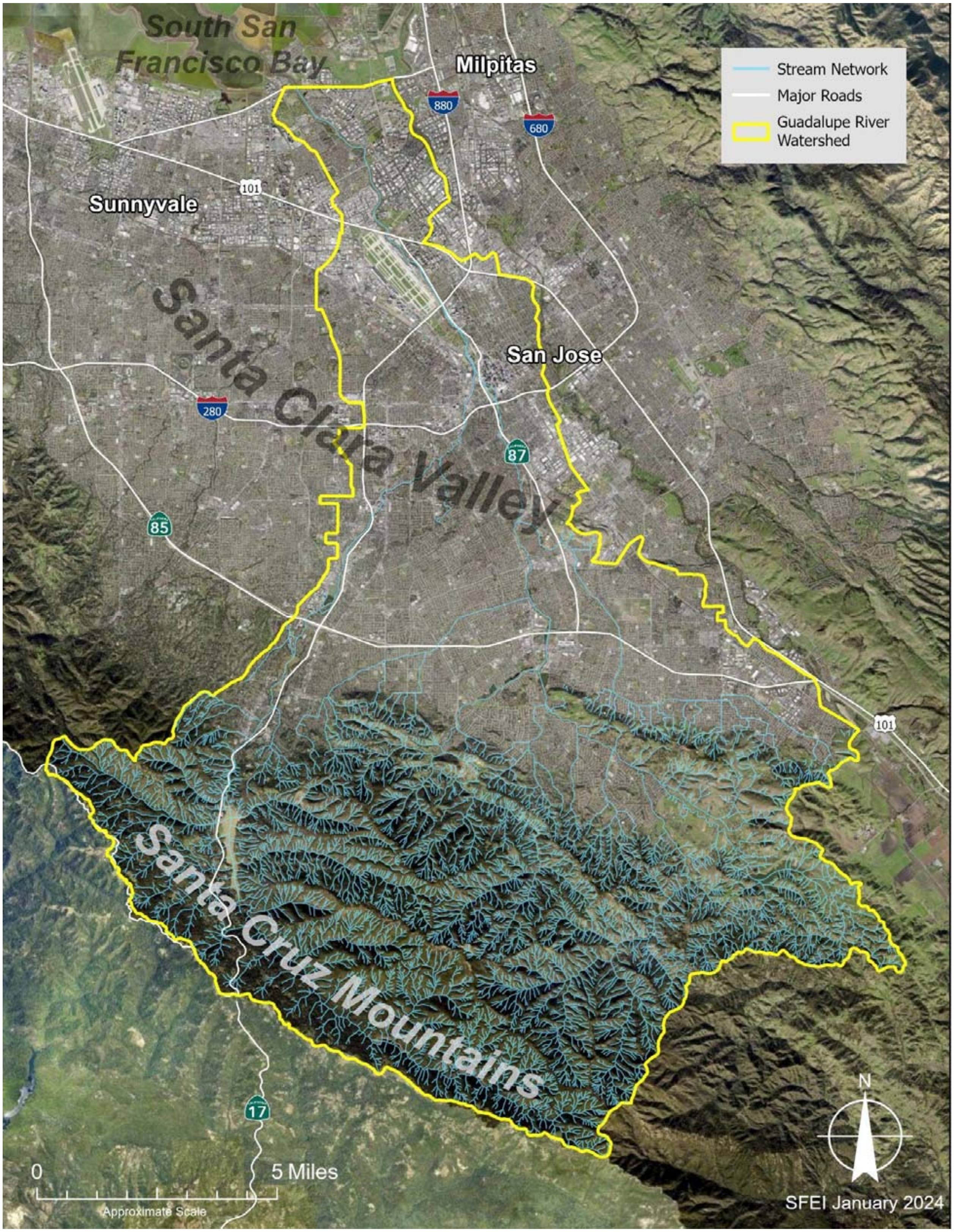


Figure 2. Aerial image of the Guadalupe River Watershed highlighting the topography and current urban land cover in the Santa Clara Valley versus the non-urban land cover in the Santa Cruz Mountains.

Geologically, the watershed is comprised of the high elevation Santa Cruz Mountains in the south, and the low elevation Santa Clara Valley in the north. The Santa Cruz Mountains consist of five unique fault-bounded blocks that have been complexly folded and faulted during tectonic accretion and uplift, and later by the right-lateral movement of the San Andreas fault zone. The upper Guadalupe River watershed is underlain by Cretaceous Franciscan Formation rocks overlaid by younger Miocene sedimentary rocks such as sandstones, shales and conglomerates. The Santa Clara Valley is underlain by a package of Quaternary alluvium that is greater than 1,500 feet thick.

Average annual precipitation across the watershed varies with elevation from the peaks of the Santa Cruz Mountains to the Santa Clara Valley near the Bay. The Wrights station (Western Regional Climate Center 049814) at the top of the ridgeline in the Santa Cruz Mountains has an average annual rainfall of 46.32 inches (1906-1986) (WRCC, 2023a), while the San Jose station (Western Regional Climate Center 047821) has an average annual precipitation of 14.58 inches (1893-2016) (WRCC, 2023b). However, rainfall in the Santa Cruz Mountains can be much higher; for example, the Mt. Umunhum Valley Water precipitation gauge (6069) recorded 76 inches of precipitation for the 2023 Water Year (Oct 1, 2022 to Sept 30, 2023). In response to the precipitation, the Guadalupe River has historically periodically flooded, including large flood events in 1940, 1955, 1958, 1986, 1995 (peak discharge of 11,000 cfs), 2003, and 2017 (USGS Streamflow gauges 11169000 and 11169025).

Historically, the Santa Clara Valley (circa 1850) was characterized almost entirely by discontinuous stream channels (Beller *et al.*, 2010). In the Guadalupe watershed, many diffused channels drained the upper watershed, spreading and sinking at the foothills, before coming back together as a single channel that we know now as the Guadalupe River near Willow Glen (Beller *et al.*, 2010). After European settlement many of the channels were straightened and connected for faster drainage primarily to increase the land area available for agriculture. A canal was built (completed by 1871) to connect the upstream and downstream single channel reaches of the Guadalupe River, bypassing the diffuse, multiple-channel willow grove area (Beller *et al.*, 2010). Channel changes in the baylands also affected the drainage network. For example, in the late nineteenth century, the Guadalupe River watershed was reduced in size due to anthropogenic rerouting of the river from Guadalupe Slough into Alviso Slough, which disconnected the Guadalupe River from the San Tomas Aquino and Calabazas Creek watersheds.

As compared to the historical regime, the present day flow regime of the Guadalupe River is significantly different. European settlement, agriculture and later urban development modified the flow regime of the channel network by straightening reaches, increasing channel connection, and increasing the volume of discharge due to changes in land use. Beginning in approximately the 1930s, the water supply and flood protection needs for the growing urban population spurred the construction of seven reservoirs in the upper portion of the watershed totaling 954 acres and with a storage capacity of 40,838 acre feet. Five reservoirs (Almaden Reservoir located on Alamitos Creek, Calero Reservoir on Calero Creek, Guadalupe Reservoir on Guadalupe Creek, and Lexington and Vasona Reservoirs on Los Gatos Creek) are operated and managed by Valley Water, while two (Lake Elsman and Williams Reservoir) are owned and operated by the public utility San Jose Water. These reservoirs contribute towards decreased discharge downstream and dampened peak flows for the smaller, more frequent flood events, as well as the decreased downstream transport of coarse sediment.

2.1 Non-urban watershed area

Almost 49% of the watershed lies within unincorporated parts of Santa Clara County (SCVWD, 2007) and consists of the largely undeveloped mountains and hills in the upper watershed. Large portions are publicly-owned and protected lands, including areas owned by Santa Clara County Parks, Mid-Peninsula Open Space District, San Jose Water District, and Valley Water. Other land is privately-held parcels that include a mix of open space, rural residential, horse property, and other various land uses (e.g. Christmas tree farms). The steep topography, thick forest cover, and protections for downstream reservoirs have kept the Non-urban area of the watershed relatively natural, including large portions without human alteration.

The Non-urban area includes steep mountainous slopes and headwater streams within the Santa Cruz Mountains. The watershed supports a variety of vegetation types and communities based upon the location within the watershed, aspect, and elevation. The variety of communities include those that are dominated by annual non-native grasslands, oak woodlands, chaparral, redwood forest, mixed evergreen/hardwood forests, as well as riparian areas along stream channels. The majority of the headwaters have good stream buffers and little to no modified hydrology due to the largely protected lands and low amounts of development. The hillslopes are steep, which causes the smaller-order channels to be narrow and steep, sometimes with low complexity overall. However, portions of the Non-urban area that have redwood trees or other large coniferous trees commonly have debris jams within the streams caused by trees that have fallen. The high amount of annual rainfall causes small landslides and slope failures to be common, episodically delivering slugs of sediment to the channels. The streams are sized to be able to convey large amounts of flow caused by relatively frequent wintertime storms, with evidence of cobble and boulder-sized sediment transport.

The Non-urban area has a strong precipitation gradient from the high elevation Santa Cruz Mountains to the interface with the valley floor, as well as from the western side to the eastern side of the watershed. This gradient has a significant control on the vegetation community as well as the size and complexity of the channels. For instance, the higher elevation and the western portion of the region receives much larger annual precipitation totals, and thus is dominated by redwood and coniferous forests and chaparral. The channels must convey the large volumes of runoff that are produced from the relatively frequent wintertime storms, which means that the channels tend to have high complexity, with cobbles, boulders and logs contributed from the adjacent hillslopes. Despite the relatively high annual precipitation, many of these channels, especially the low-order channels, are ephemeral or intermittent. However, the lower elevation foothills and the eastern side of the watershed tend to have lower overall precipitation totals, more often supporting an oak forest and annual grassland community. The channels here tend to be narrower and generally lower in complexity, with lesser contributions of sediment from hillslope mass movements and smaller diameter trees contributed from the hillslopes.

While wildfire risk in the region has been increasing largely due to climate change that is altering the timing and amount of annual precipitation, increasing summer/fall temperatures, and altering wind patterns that affect evapotranspiration, each intensifying the periods of drought, the upper portion of the Guadalupe River watershed only has eight fires recorded between 1950 and 2022 (see Appendix G FRAP; https://frap.fire.ca.gov/frap-projects/fire-perimeters/).

2.2 Urban watershed area

The lower portion of the Guadalupe River watershed includes the densely developed Silicon Valley municipalities of San Jose, Los Gatos, Monte Sereno, Campbell, and Santa Clara. San Jose is the twelfth most populous city in the United States (U. S. Census Bureau, 2022) and covers just over 40% of the Guadalupe River watershed. In total, parts of these five cities cover just over 50% of the watershed (SCVWD, 2007). This area includes the lowest portion of the watershed, not counting the tidal baylands, and drains northward into Alviso Slough and South San Francisco Bay. Land cover within the Urban area consists of dense urban and suburban development. To protect the urban development, a number of large flood control projects have been completed, modifying channel morphology or connections within the channel network. Currently some reaches of the Guadalupe River mainstem have unhoused populations that contribute to ecological disturbance of riparian vegetation, an increase in trash in the river corridor, and an increased incidence of fire along the channel corridor. The lowest portion of the Urban area includes the tidal reach of the Guadalupe River, where the muted tidal prism causes twice-daily fluctuations in river stage and dictates the type of vegetation that is present within the channel corridor.

The Urban watershed area has limited remaining areas of native vegetation community due to the level of development that has occurred across the landscape. The riparian corridor along the River and its tributaries offer the most significant areas of native vegetation. The widest riparian corridor exists within the mainstem River reaches that have been modified for flood control purposes. Many of the tributaries have very narrow or even no natural woody riparian corridor, or that corridor has been replaced largely by non-natives and exotics.

The channel network within the Urban area has a wide variety of channel types and morphologies. The downstream-most reach includes the wide tidal channel and adjacent tidal marsh plain located within the flood control channel levees and floodwalls. Here the channel is very low gradient, turbid, and dominated by emergent monocots such as tule and cattail. Above the head of tide, the channel maintains its wide, deep, and low gradient character, as it continues through the flood control levees. The channel is characterized by a relatively wide and diverse woody riparian corridor that is periodically flooded during large flow events. Between Interstate 880 and Coleman Avenue, the channel flows through the Guadalupe River Parkway project area, where the main channel is relatively straight and confined by levees, but with a created secondary channel and floodplain area that is designed to be engaged during flood flows. Further upstream, the channel enters the downtown area, where it is tightly confined by bridges, gabions and concrete walls. The channel here is highly incised and very simplified, but with a narrow, mixed native and non-native woody riparian corridor. This reach includes the Downtown Guadalupe River Flood Protection Project, where an underground bypass channel was constructed to carry large flood flows under downtown San Jose. Upstream of downtown, the mainstem channel is tightly confined by urban development, with essentially no lateral migration space. Continuing upstream, the mainstem channel continues to flow through the urban environment, but with a slightly wider, and more natural corridor, with sparse woody riparian canopy. The channel continues through a leveed portion adjacent to percolation ponds, until the confluence with Guadalupe Creek, immediately downstream from Lake Almaden.

The Urban watershed area also includes a number of tributaries to the mainstem, each with a slightly different character. Los Gatos Creek is the largest tributary watershed, consisting of a highly incised urban reach flowing from the Vasona Reservoir downstream to the confluence with the Guadalupe River. This reach has a number of grade control structures and diversions for adjacent percolation ponds. Upstream of Vasona Reservoir, the reach remains incised, and includes a straightened and concrete-lined section. The Lexington Reservoir is the largest reservoir in the watershed, constructed in 1952, with a capacity of 19,000 acre feet. Upstream of the reservoir, the channel network drains the relatively steep and rugged watershed, consisting of rural residential and open space land uses. Moving upstream, Canoas Creek drains a portion of the east side of the watershed. The mainstem consists of an engineered, trapezoidal flood control channel with adjacent maintenance road(s), that is maintained for efficient routing of flood waters. Many small sub-watersheds that drain northward from the Santa Teresa Hills are routed via underground stormdrains to the mainstem channel, creating a disconnect between the natural upstream reaches and the mainstem. The next tributary is Ross Creek, which is an engineered trapezoidal channel with highly managed banks for most of its length, lacking any significant woody riparian canopy until the natural bed and bank reach near the foothills. Further upstream is Guadalupe Creek, a natural channel throughout its length, with the Guadalupe Reservoir in its headwaters. Coming together with Guadalupe Creek just downstream of Lake Almaden is Alamitos Creek, which also drains a portion of the eastern side of the region. Its lower reach is a wide and natural channel, with a relatively healthy and diverse riparian corridor. However, Alamitos Creek does have a network of smaller tributaries consisting of engineered trapezoidal drainages through suburban neighborhoods including Greystone Creek, Golf Creek and Randol Creek. Further upstream, Alamitos Creek, which drains the rugged, steep Santa Cruz Mountain slopes including Loma Prieta peak, joins another tributary, Calero Creek, which drains the lower elevation eastern foothills within the watershed. Both creek branches have a reservoir: Almaden Reservoir on Alamitos Creek, and Calero Reservoir on Calero Creek. Perennial flow occurs in Calero Creek due to prescribed flow augmentation for fish from releases of Calero Reservoir.

Valley Water has conducted many flood control, restoration, and mitigation project in the Guadalupe River watershed, primarily in the urban area, through time. Many of these projects were implemented to address flooding hazards, protect water supplies, and/or improve stream ecosystem conditions at reach scales. These projects have both short-term and long-term effects upon stream condition in the watershed. For a more complete description of Valley Water projects, see the Guadalupe Watershed One Water Plan at: https://beheard.valleywater.org/guadalupe-creek-watershed-one-water-plan.

3. Methods

Methods for this study largely follow methods utilized in the 2012 Baseline Guadalupe River Assessment (SFEI, 2013). As such, this section simply summarizes the monitoring parameters, the specific monitoring questions, and the datasets that were utilized for the 2022 reassessment.

The Guadalupe River Watershed Reassessment survey employed the same watershed extent previously described in the Five Watershed Synthesis Report (Lowe *et al.,* 2020). Similar to the 2012 Baseline Guadalupe River assessment (SFEI, 2013), Project D5 employs six monitoring parameters (Table 1). Parameters A-D have been assessed for the Guadalupe River watershed using the best available digital maps of surface waters and riparian areas. The BAARI (v2.1, SFEI ASC, 2017) was employed to determine the values for Parameters A-D. Values for Parameter E used CALVEG (2014), digital elevation models (DEM), and RipZET. Parameter F was evaluated by conducting probabilistic ambient field surveys of stream condition using the CRAM Riverine Field Book v6.1 (CWMW, 2013b).

Table 1. Monitoring parameters to evaluate the amount, diversity, and condition of streams, riparian and wetland habitats for Project D5.

<table>
<tr><th colspan="2">Parameters</th><th>Framework Level</th><th>Data or Method</th></tr>
<tr><td>A</td><td>Stream abundance (miles of stream channels)</td><td>1</td><td rowspan="4">Bay Area Aquatic Resources Inventory (BAARI) or Valley Water’s “Creeks” GIS-layers</td></tr>
<tr><td>B</td><td>Stream distribution (miles of stream channel by stream order)</td><td>1</td></tr>
<tr><td>C</td><td>Non-stream wetland diversity</td><td>1</td></tr>
<tr><td>D</td><td>Non-stream wetland abundance by type</td><td>1</td></tr>
<tr><td>E</td><td>Stream riparian abundance (miles of streams by functional riparian width class)</td><td>1</td><td>CALVEG, DEM & RipZET</td></tr>
<tr><td>F</td><td>Proportion of streams by condition class</td><td>2</td><td>CRAM ambient stream condition surveys for the whole watershed</td></tr>
</table>

3.1 Geospatial Analysis of Streams and Wetlands

The geospatial data sources and analyses presented in this report are the same as the Five Watershed Synthesis Report (Lowe *et al*., 2020) subset specifically for the Guadalupe River watershed, because no new Level 1 data for vegetation or aquatic resources have been developed as of the time of reporting. In other words, these questions below were not reanalyzed in 2022. However, this report still includes the full suite of watershed monitoring parameters linked to Project D5’s core management questions, summarizing the original analyses. It includes information about the amount and distribution of streams and wetlands, with an update about Valley Water’s ownership of them. It also includes estimates of functional stream riparian extents based on the Riparian Zone Estimator Tool (RipZET, SFEI 2015a) developed and reported in the Five Watershed Synthesis Report (Lowe *et al.* 2020), but re-run using the same data sources and same RipZET version so as to include first order channels, which were not included in the Synthesis Report.

The resource management questions include:

1. What is the amount, distribution, and diversity of aquatic resources in the watershed and in its Primary Areas of Interest (PAIs)?
    a. How many miles of streams exist (including natural and unnatural stream lengths, if possible to identify within the GIS dataset)?
    b. What is the extent and distribution of non-riverine wetlands?
    c. What is the extent and distribution of stream-associated riparian areas?
2. How do the modern-day aquatic resources compare to historical extents within the low-lying, valley floor areas for which there is historical habitat GIS data?

3. Other landscape-level questions about streams and stream ownership:
    a. What amount and proportion of the streams are Valley Water-owned or have management easements (designated as Valley Water fee title and easement GIS data)? What proportion of the streams are protected areas based on the California Protected Areas and Easement Databases (CPAD and CCED: https://www.calands.org/) and other information sources?

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3.1.1 List of Level-1 Datasets

The following GIS datasets and tools were used in the geospatial analyses that are reported in the Results section.

- Bay Area Aquatic Resources Inventory (BAARI *streams* & *wetlands* layers v.2.1, SFEI ASC, 2017): BAARI mapping methods (SFEI, 2011) and GIS data available at: https://www.sfei.org/baari
- Santa Clara County line GIS layer (SCVWD, 2007)
- Valley Water's Stream Maintenance Program (SMP) 1,000-foot elevation boundary is based on a 2006 LiDAR contour dataset (SCVWD, 2006)
- Valley Water-owned and easement lands from Valley Water's fee title and easement GIS layers (an unpublished Valley Water dataset, updated on an ongoing basis). The data were provided to SFEI in March 2023.
- Valley Water's 'SCVWD Major Watersheds' GIS-layer (2011)[3]
- California Protected Areas Database version 2022 (CPAD, GreenInfo Network, December 2022)
- California Conservation Easement Database version 2022 (CCED, GreenInfo Network, December 2022)
- Santa Clara County Historical GIS Data, (SFEI, 2015b). "Santa Clara Valley Historical Ecology GIS Data version 2". Data are available to download[4]. The final Historical Ecology study report was completed by SFEI in 2010 and is available online[5]: *Historical Vegetation and Drainage Patterns of Western Santa Clara Valley: A technical memorandum describing landscape ecology in Lower Peninsula, West Valley, and Guadalupe Watershed Management Areas* (Beller *et al.*, 2010).
- The United States Department of Agriculture (USDA) Forest Service CALVEG 2014 (Zone 6 - Central Coast) data was used by RipZET to assign tree heights to estimate stream riparian extents using the Vegetation Processes module.
- USGS National Elevation Dataset (10-meter digital elevation model or DEM). Available at: https://lta.cr.usgs.gov/products_overview/

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[3] Publication Date: 09/01/2011 (internal draft)

[4] http://www.sfei.org/content/santa-clara-valley-historical-ecology-gis-data

[5] https://www.sfei.org/coyotecreek

- US and Canada Major Roads dataset, Tele Atlas North America (ESRI, 2010)
- Aerial imagery from Sanborn Map Company (Santa Clara County, 2021). Imagery captured on November 21, 2021.
- Riparian Zone Estimation Tool v2.0 (RipZET, SFEI, 2015a).

3.2 CRAM Surveys

To address monitoring parameter F (proportion of streams by condition class), probabilistic ambient field surveys of stream condition were conducted in the Guadalupe River Watershed using CRAM. Here, the resource management questions include:

1. What are the overall stream ecosystem conditions based on CRAM and have they been maintained or improved?
2. What are the likely ecological stressors influencing stream conditions?

3.2.1 CRAM Overview

CRAM is a standardized, statewide Level-2 field method used to characterize the ecological conditions of streams and other wetland types. CRAM provides numerical scores that estimate the overall potential of a wetland and its adjacent riparian area to provide levels of the ecological services expected of the area given its type, condition, and environmental setting. CRAM scores are based on visible indicators of physical and biological form and structure relative to statewide reference conditions. CRAM scores can be grouped into three standard ecological health classes (also called condition classes) to characterize stream condition as 1) Poor, 2) Fair, or 3) Good (CRAM Technical Bulletin CWMW, 2019). These condition classes are defined as tertiles of the maximum range of possible CRAM Index or Attribute scores, with Poor condition scores ranging from 25 to 50, Fair condition scores from 51 to 75, and Good condition scores from 76 to 100. Results can be reported using these condition classes as a way to bin the CRAM scores to facilitate comparison and evaluation.

CRAM assessments are comprised of a number of individual metrics, which are organized into four Attributes of condition: 1) Buffer and Landscape Context, 2) Hydrology, 3) Physical Structure, and 4) Biotic Structure. Each Attribute captures unique components of a stream's health or condition.

Buffer and Landscape Context: CRAM Manual (CWMW, 2013): "A buffer is a zone of transition between the immediate margins of a stream (or wetland) and its surrounding environment that is likely to help protect the wetland from anthropogenic stress. Areas adjoining wetlands that probably do not provide protection are not considered buffers. Buffers can protect wetlands by filtering pollutants, providing refuge for wetland wildlife during times of high water levels, acting as barriers to disruptive incursions by people and pets into wetlands, and moderating predation by ground-dwelling terrestrial predators. Buffers can also reduce the risk of invasion by non-native plants and animals, by either obstructing terrestrial corridors of invasion or by helping to maintain the integrity and therefore, the resistance of wetland communities to invasions. The presence of buffer is important both extending laterally from the stream and longitudinally along the stream corridor."

Because regulation and protection of streams and wetlands historically did not extend to adjacent uplands, these areas in some cases have been converted to recreational, agricultural, urban or other human land uses and may no longer provide functional ecological buffers. CRAM includes two metrics to assess the

Buffer and Landscape Context Attribute: the Stream Corridor Continuity Metric and the Buffer Metric. The Buffer Metric is composed of three submetrics: (1) percentage of the AA perimeter that has a buffer; (2) the average buffer width; and (3) the condition or quality of the buffer.

Hydrology: CRAM Manual (CWMW, 2013): "Hydrology includes the sources, quantities, and movements of water, plus the quantities, transport, and fates of water-borne materials, particularly sediment as bed load and suspended load. Hydrology is the most important direct determinant of wetland functions (Mitsch and Gosselink, 2007). The physical structure of a stream or wetland is largely determined by the magnitude, duration, and intensity of water movement. The hydrology of a wetland directly affects many physical processes, including nutrient cycling, sediment entrapment, and pollution filtration. The hydrology of a wetland constitutes a dynamic habitat template for wetland plants and animals. For example, Richards *et al.*, 2002 concluded that meandering and braiding in riverine systems control habitat patch dynamics and ecosystem turnover. Additionally, the spatial distribution of plants and animals in a tidal marsh closely correspond to patterns of tidal inundation or exposure (Sanderson *et al.*, 2000). CRAM includes three metrics to assess the hydrologic condition of streams: Water Source, Channel Stability, and Hydrologic Connectivity."

Physical Structure: CRAM Manual (CWMW, 2013): "Physical structure is defined as the spatial organization of living and non-living surfaces that provide habitat for biota (Maddock, 1999). For example, the distribution and abundance of organisms in riverine systems are largely controlled by physical processes and the resulting physical characteristics of habitats (e.g., Frissell *et al.*, 1986). Metrics of the Physical Structure attribute in CRAM therefore focus on physical conditions that are indicative of the capacity of a wetland to support characteristic flora and fauna. CRAM includes two metrics to assess the Physical Structure of streams: Structural Patch Richness and Topographic Complexity."

Biotic Structure: CRAM Manual (CWMW, 2013): "The biotic structure of a wetland includes all of its organic matter that contributes to its material structure and architecture. Living vegetation and coarse detritus are examples of biotic structure. Plants strongly influence the quantity, quality, and spatial distribution of water and sediment within wetlands. For example, in many wetlands, including bogs and tidal marshes, much of the sediment pile is organic. Vascular plants in estuarine and riverine wetlands entrap suspended sediment. Plants reduce wave energies and decrease the velocity of water flowing through wetlands. Plant detritus is a main source of essential nutrients, while vascular plants and large patches of macroalgae function as habitat for wetland wildlife. CRAM includes three metrics to assess the Biotic Structure of streams: Plant Community Composition, which includes three sub-metrics (Number of Plant Layers, Number of Co-dominant Species, and Percent Invasion), Horizontal Interspersion, and Vertical Biotic Structure."

Stressor Checklist: CRAM also includes a checklist of 47 different stressors (grouped by CRAM Attribute), where field teams answer two questions for each stressor:

1. Is the stressor visibly present?
2. Is the stressor significantly and adversely influencing the AA, based on a list of standard indicators and sets of considerations?

A CRAM stressor is defined as an anthropogenic perturbation within the AA or its immediate environmental setting that is likely to negatively influence condition and function of the wetland or stream (CWMW, 2013a). Stressors for Hydrology, Physical Structure, and Biotic Structure must be evident within 50 meters of the AA, while Buffer and Landscape Context stressors must be present within 500 meters of the AA in order for the field team to record them.

The stressor checklist is a highly subjective field observation that is based on practitioners' judgment, and there is no specific standardized guidance as to when a stressor should be flagged as observed or significantly impacting the AA. In addition, the relative ecological importance of different individual stressors and their impact on the stream is not taken into account by these CRAM observations: the field practitioner is not asked to rank stressors, nor provide any additional information about the frequency, duration, or extent of the stress. The checklist simply records the presence or absence of the stressor, and then adds a subjective determination about whether the stressor is causing a significant negative effect upon the AA. Practitioners are taught that stressors should be considered significant if they are directly affecting the score of any given CRAM Metric within the AA, or if the activity is clearly affecting morphology, function, or other natural processes within the stream.

Project D5 employed the CRAM Riverine module (version 6.1) and the U.S. EPA's GRTS sample draw (described below) to assess the overall conditions of streams in the D5 watersheds. For field books and more information about the methods, see the CRAM website at: https://www.cramwetlands.org/documents#field+books+and+sops.

3.2.2 Site Selection

This study focused on streams within the Guadalupe River watershed above the region of tidal influence, as delimited by the Bay Area Aquatic Resource Inventory (upstream limit of tidal waters is assumed to correspond to the upstream side of Montague Expressway; BAARI v2.1, SFEI ASC, 2017). The 2022 Guadalupe River watershed reassessment ambient stream condition survey design maintained the original 2012 baseline survey's two Urban and Non-urban PAIs (Figure 3) (SFEI, 2013). The extent of the Urban PAI is defined by urban, residential, and agricultural land uses mapped in the National Landcover Database (NLCD, 2016) and adjusted slightly based on visual evaluations of developed areas using aerial imagery (see Appendix B of Lowe *et al.*, 2020 for additional details). The Non-urban PAI includes the remainder of the watershed, including the Foothills (the area between the urban boundary and the 1,000-foot elevation contour) and the Hills area (between the 1,000-foot elevation contour and the watershed boundary).

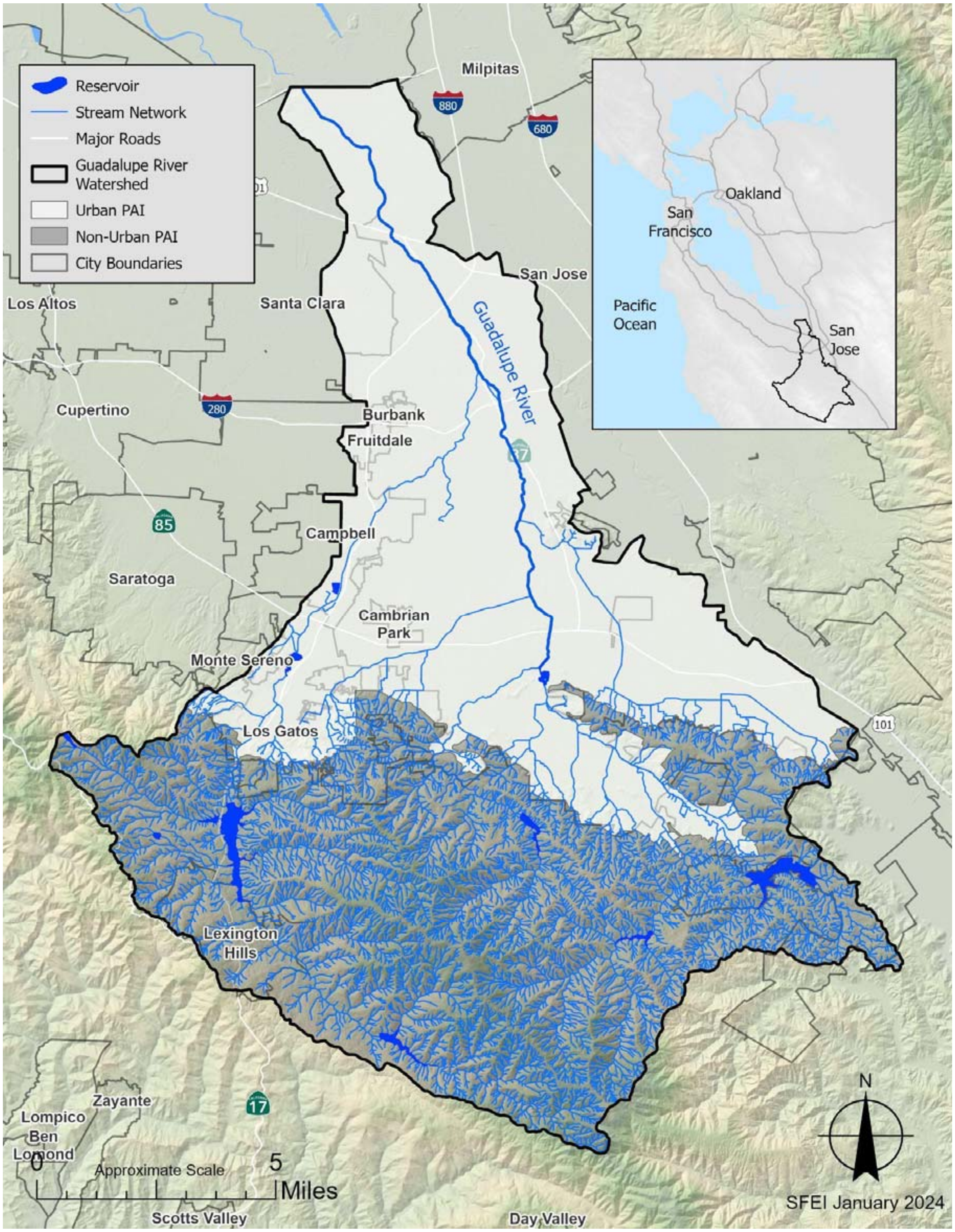

Figure 3. Map of the Guadalupe River Watershed and primary areas of interest (PAIs): Urban (Valley) and Non-urban (Hills, consisting of the regions also known as the Foothills and Headwaters).

The Urban and Non-urban PAIs divide the watershed primarily based upon differing land use, vegetation communities, and landscape ecologies. However, the Non-urban PAI includes portions of the watershed that are both above and below the 1,000-foot elevation contour, which demarcates the upper limit of

Valley Water's Stream Maintenance Program (SMP[6]) within Santa Clara County. Below the 1,000 foot elevation contour, Valley Water is most active in their stream management and maintenance activities. As the part of the watershed where Valley Water works most for reservoir operations and SMP, streams and land below 1,000 feet mark an important monitoring and assessment boundary for tracking status and trends of stream conditions in a long-term monitoring program.

The reassessment survey in 2022 employed the same Generalized Random Tessellation Stratified (GRTS) sample draw developed by the U.S. EPA for the National Rivers and Streams Assessment[7], and initially implemented in the 2004 National Wadeable Stream Assessment (Diaz-Ramos *et al.* 1995; Stevens and Olsen, 2004; USEPA, 2006). GRTS designs and data analyses are implemented using the *spsurvey* package in R (Kincaid, 2020; Kincaid and Olsen, 2020; Dumelle *et al.*, 2023). *Spsurvey* requires a digital geospatial dataset of the ecological resource to be sampled or a sample frame; a modified BAARI stream GIS layer served as the sample frame for the CRAM surveys. The stream network includes streams and connecting storm drains (which link the drainage of the upper and lower watershed), and open water (e.g., reservoirs and groundwater recharge ponds). In a probability survey, Assessment Areas are randomly selected from the sample frame, while accounting for the proportion of the resource that each area represents. Results can be analyzed to estimate the proportion of the total resource in the sample frame that is likely to have any particular condition as assessed using CRAM.

The extent of the study area included Strahler stream orders 2-7 (as mapped in BAARI) extending from above the region of tidal influence in the north, to the upper, eastern slopes of the Santa Cruz Mountains in the south. Stream order denotes the position of a stream within a stream network (Strahler, 1957). First-order streams have no tributaries. The confluence of two or more 1st-order streams mark the upstream beginning of a 2nd-order stream; the confluence of two or more 2nd-order streams mark the upstream beginning of a 3rd-order stream; and so on. The order of a network is based on its highest order stream. Most 1st-order streams occur in the headwater regions (uppermost or highest elevations) of natural drainage systems and their importance is well recognized. These streams represent the greatest amount of hydrological connection of the stream network to its contributing drainage basin and contribute a substantial amount of sediment and nutrients to downstream higher-order channels (USEPA, 2015). Headwater stream reaches (Strahler stream order 1) were not included in the sample frame because they are ecologically very simple and the CRAM Riverine Module is not currently calibrated to accurately assess the ecological condition of headwater streams. CRAM scores tend to be artificially low for 1st-order channels, and these low scores can create misleading profiles of overall stream condition.

The Guadalupe River watershed sample draw was an unstratified draw of 1,000 sites that were equally weighted, and proportionally allocated throughout the watershed based on stream length (areas with more stream miles have higher numbers of sites than areas with fewer stream miles). To maintain spatial balance across the whole watershed, the GRTS sample draw sites must be sampled in sequential order whenever possible. The large sample size allowed flexibility in setting the target number of sample sites per survey, while providing adequate oversample (or replacement) sites. Oversample sites replaced target sites that could not be sampled for any reason (e.g., landowner denied access, inaccessible or dangerous terrain, or the site did not meet the CRAM requirements). After the sample draw was completed, the study

[6] Valley Water's SMP works to improve the environment, reduce the risk of flooding and keep communities safe. The SMP actively manages streams below the 1,000-foot elevation contour and within the Baylands throughout the County.

[7] https://www.epa.gov/national-aquatic-resource-surveys/nrsa

area was divided into Urban and Non-urban PAIs and the project team set the target number of sites per PAI.

The 2012 and 2022 Guadalupe River watershed assessments allocated CRAM AAs differently among the two PAIs as follows:

- The original 2012 baseline survey design targeted 53 total CRAM AAs, with 30 AAs in the Urban PAI and 23 AAs in the Non-urban PAI. The first 30 AAs were selected in sequential order from the sample draw, resulting in 7 Urban and 23 Non-urban AAs; an addition 23 AAs (in sequential order within the sample draw) were then added to reach a total of 30 Urban AAs. A few of the selected AAs were dropped due to landowner permissions, and were replaced by oversample sites from the same PAI in sequential order. The 2012 CRAM assessments were conducted with CRAM Riverine module v6.0 (CWMW, 2012). For more specific information about the 2012 baseline survey, please refer to the SFEI (2013) technical report.
- The 2022 reassessment survey design aimed to reassess all 53 baseline survey AAs and add 22 new AAs for a total of 75 target AAs. The 22 new target AAs were visually selected from a map of the sample draw sites (by someone not familiar with the streams in the Guadalupe River watershed) to 1) add 15 AAs in the Urban PAI, in stream reaches that were under-represented in 2012, and 2) add 7 AAs in the Non-urban, uppermost headwaters region of the watershed where low numbers of assessments were completed in 2012. The final list of AAs that comprised the 2022 survey results included 44 Urban AAs, and 31 Non-urban AAs. The 2022 CRAM assessments were conducted with CRAM Riverine Module v.6.1 (CWMW, 2013b).

Logistical planning and implementation of the CRAM stream condition field assessments involved evaluating each initially targeted AA to make sure it was accessible and that field teams had permission from landowners to conduct the site assessments. Oversample sites replaced target sites that were dropped because they were inaccessible or not able to be assessed for any reason.

A total of 75 AAs in the Guadalupe River watershed were initially targeted, requiring 81 candidate AAs to be evaluated for access. Of the evaluated AAs, only three of the newly added Non-urban AAs were dropped and replaced with oversample AAs[8]. In the end, field teams successfully assessed (or completed) 75 AAs, of which 53 were revisit sites from the 2012 baseline ambient survey. Revisit sites were used in the GRTS *spsurvey* change analysis to evaluate change in overall stream conditions between survey periods. Table 2 summarizes the final number of AAs that were initially targeted, evaluated, dropped, and successfully assessed within the Urban PAI, Non-urban PAI, and the watershed as a whole for the 2012 and 2022 stream condition surveys employing CRAM.

[8] Dropped (or rejected) AAs were not assessed because of the following reasons: permission to enter was denied, site was inaccessible (e.g., steep terrain, excessive distance from road, or inundated with impenetrable noxious vegetation [e.g., blackberries, poison oak]), or the site turned out to be non-target meaning that the location was either in a reservoir, culvert, or other non-riverine habitat that did not fit the definition of a viable CRAM Riverine assessment site.

Table 2. Summary evaluated CRAM AAs including the number that were initially targeted, evaluated, dropped, and successfully assessed for the 2012 and 2022 Guadalupe River watershed stream condition surveys.

Primary Area of Interest (PAI)	*2012*				*2022*			
	Targeted AAs	*Evaluated AAs*	*Dropped AAs*	*Assessed AAs*	*Targeted AAs*	*Evaluated AAs*	*Dropped AAs*	*Assessed AAs (revisited)*
Urban	30	35	5	30	44	44	0	44 (30)
Non-urban	23	86	63	23	31	37	6	31 (23)
Total (whole watershed)	53	121	68	53	75	81	6	75 (53)

Figure 4 shows maps of the final distribution of all candidate CRAM AAs that were evaluated for assessment and their final outcomes (sites were either assessed or dropped) for both the 2012 and 2022 stream condition surveys employing CRAM. There was a noticeable gap in successfully sampled sites in the middle portion of the upper headwaters region of the watershed in the Non-urban PAI in 2012 in large part due to difficult access, safety issues, and the landowners not replying to requests for access. To address this gap, a number of new sites were added in 2022 to increase the total number of AAs in the upper headwater region of the watershed. In addition, the added sites in the Urban PAI improved the overall spatial distribution of AAs among the mainstem and tributaries in the urban valley region.

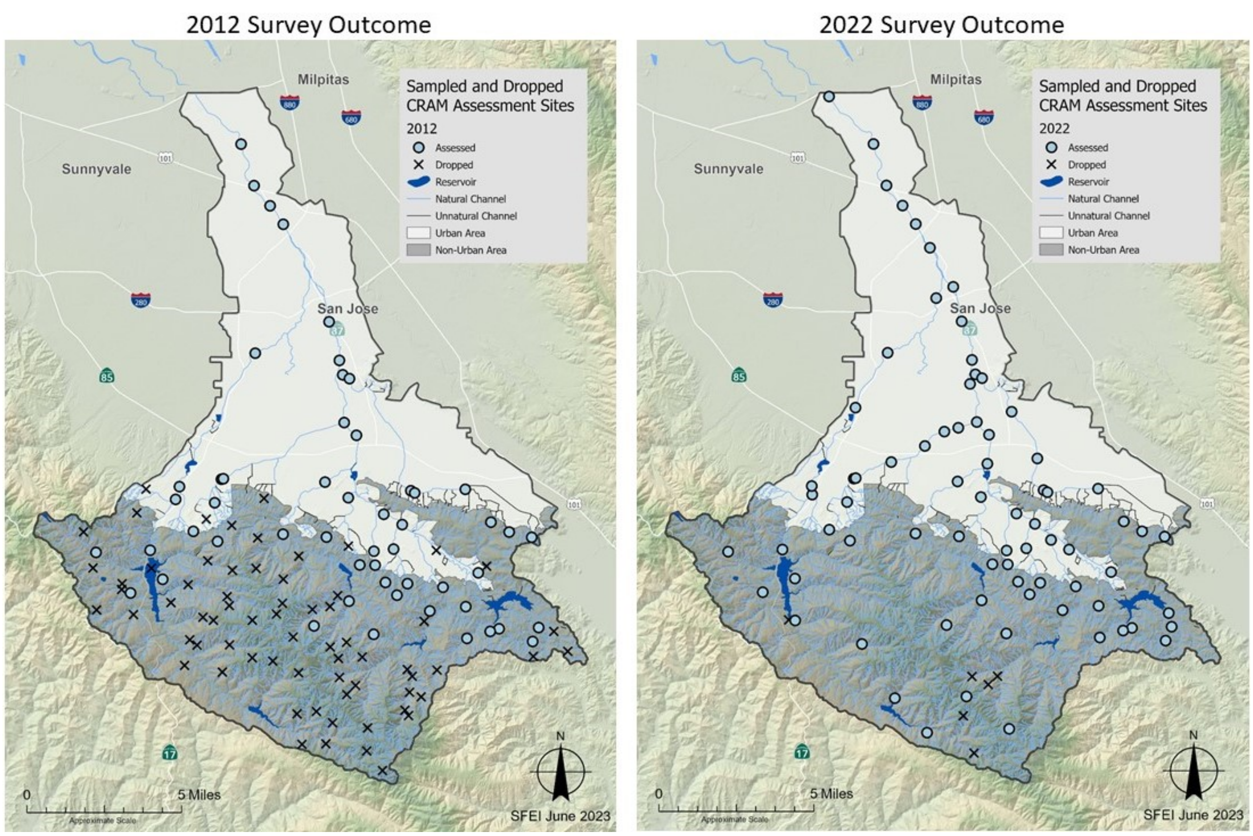

Figure 4. Guadalupe River watershed field assessment outcomes of the 2012 (n=53) and 2022 (n=75) ambient stream condition surveys showing successfully assessed CRAM sites and dropped sites.

The analysis assumes inaccessible AAs that are dropped are sufficiently similar to accessible AAs within the watershed and therefore, stream condition estimates in this and its other ambient surveys that employ GRTS are representative of the whole watershed. The assumption that areas not sampled are similar to areas sampled is common for probability-based ambient surveys. More specifically, it is assumed that: 1) CRAM AAs are dropped due to random or unforeseen circumstances (e.g., physically inaccessible, permission to enter is denied by the property owner, site is not actually located on a stream that can be assessed using CRAM (culvert, reservoir), site does not meet the CRAM Riverine requirements); and 2) replacement AAs drawn from the oversample list maintain the spatial balance of assessments across the watershed (i.e., surficial stream network). To assure the second assumption holds, oversample AAs were selected in sequential order whenever possible. However (in practice), the final distribution of assessed AAs often results in some areas being underrepresented. Sizable geographic gaps can occur when large landowners deny access, and this is when the analysis assumes that those areas are similar to other sampled areas to warrant including them in the sample frame.

3.2.3 FIELD SURVEYS

The CRAM field assessments were conducted by trained CRAM practitioners from Michael Baker International (MBI), Valley Water, and SFEI, who completed 75 AAs between July and September 2022. CRAM scores were recorded on paper field sheets and entered into the online CRAM data management system (eCRAM[9]). Through the eCRAM data entry forms, CRAM assessment scores were verified for accuracy in data entry and completeness, and became publicly accessible online through EcoAtlas[10].

Three field intercalibration exercises were completed for the 2022 CRAM field season to document and compare consistency among the CRAM field practitioners (CWMW, 2018). The first intercalibration exercise was held on July 11th and 12th and completed the first three AAs of the season. The second intercalibration occurred on August 11th, after 30 AAs were completed. The final intercalibration occurred on September 13th, completing the last two AAs of the season. Intercalibration exercises, for large surveys that employ multiple field teams, help evaluate and document inter-team variation. They also are important opportunities for additional CRAM training to help align practitioners in field methods for scoring Metrics and reduce practitioner-introduced variation, which is unavoidable in large surveys where many field teams are involved in data collection. The results of the CRAM intercalibration exercises were summarized and submitted to Valley Water in a separate memorandum.

3.2.4 DATA QUALITY ASSURANCE REVIEW

To have confidence in the 2012 and 2022 CRAM survey results, Sarah Pearce (Project D5's lead CRAM practitioner from SFEI, a Level-2 Committee Member, and a lead CRAM Trainer for the state), conducted a thorough review of the two CRAM datasets. To standardize the data and ensure comparability, the 2012 CRAM data were updated from the older CRAM Riverine module version 6.0 to the most recent version (6.1) employed in the 2022 reassessment survey. The methods and results of this effort are reported in Appendix B.

In addition to CRAM module version updates, all CRAM Metric scores were reviewed for practitioner or data entry errors by carefully inspecting field datasheets and field photographs at sites where a suspected

9 http://www.cramwetlands.org/

10 Project Name = 'SCVWD D5 Project_Guadalupe River 2022 Ambient 10-year Resurvey'. (Note: CRAM assessments where the landowner requested results be kept private are not visible on EcoAtlas, however, results are calculated into EcoAtlas summary measures.)

metric error was identified (by comparing the 2012 original scores to the 2022 reassessment scores). In some cases, conversations with the original field practitioners about particular scores, and rationale for their initial decisions were discussed in order to arrive at a final score. In other cases, Project D5 lead CRAM practitioners discussed the scores and made a final decision. Only scores that were obvious errors and that had clear supporting documentation (e.g., sketches, field photographs, discussion with practitioners) were updated. Nine Metric scores had eCRAM data entry errors between the paper datasheets and the eCRAM database, and were corrected. In the end, 71 Metric scores from the 2012 survey (9.5% of the 2012 Metric scores), and 11 Metric scores from the 2022 survey (1.0% of the 2022 Metric scores) were updated.

3.2.5 DATA ANALYSES

When analyzed, CRAM stream condition field results from a GRTS design estimate the proportion of stream resources (miles of stream) that are likely to have a particular ecological condition score with a known level of confidence across the surveyed area (i.e., watershed as a whole and each PAI). Analyzed results are reported as CDFs that are either tabular or visual plots (described below). Analysis of the Guadalupe River watershed CRAM data evaluated Index and Attribute scores, applying the updated Metric scores noted above. Sample weights were adjusted employing the original 2012 sample draw weights to account for new survey design and replacement sites. Statistical analyses were conducted with the *spsurvey* statistical library[11] (Dumelle *et al.*, 2023) and R programming language (version 4.2.1), which is a software environment for statistical computing and graphics specific for GRTS survey design and analyses. The basic *spsurvey* analysis outputs consisted of CDF estimates, plots, and percentile tables of CRAM Index and Attribute scores. To compare differences in CDF estimates between regions, and over time, *spsurvey* includes 2 statistical tests: 1) Wald and Rao-Scott statistical test or Wald F test (Dumelle *et al.*, 2023); and 2) *change analysis* test:

- The Wald and Rao-Scott statistical test (or Wald F test) is a function in the GRTS *spsurvey* data analysis package. It is used to identify significant differences between the mean CDF estimates and was run to evaluate if the 2012 baseline and the 2022 reassessment surveys were statistically different for the whole watershed and its PAIs (Urban and Non-urban).
- The *change analysis* test can be applied to both the categorical (e.g. Good, Fair, Poor condition class data) and continuous data (the actual CRAM Index and Attribute Scores). *Spsurvey's change analysis* function takes into account any paired revisit sites in effectively a paired t-test. The 2022 Guadalupe River reassessment survey included 53 revisit sites.

An ambient survey CDF enables a user to characterize and compare the percent of the resource (in this case – stream miles within a watershed or PAI) that has a specific CRAM condition score (or less) with a known level of confidence. Figure 5 presents *example* CDF estimates for a watershed stream condition survey employing CRAM. The solid black and blue lines indicate the estimated percentage of stream miles in the watershed (y-axis) that have specific CRAM Index or Attribute Scores (x-axis) or less - because the estimates are cumulative. The dashed and dotted lines indicate the upper and lower 95% confidence limits around the CDF estimates. Reading the horizontal and vertical arrows for the black CDF example, one would say that 50% of the streams in the watershed have a CRAM Score of 78 or lower. Interpreting the red confidence intervals in the example CDF, one would say (with 95% confidence) that half of the streams in the watershed have a CRAM Score estimated to be between 76 and 80. Confidence intervals are generally

[11] https://cran.r-project.org/web/packages/spsurvey/index.html

wider when there is a lot of variation in condition within a surveyed area or when only a few sites (AAs) represent a large proportion of the surveyed area.

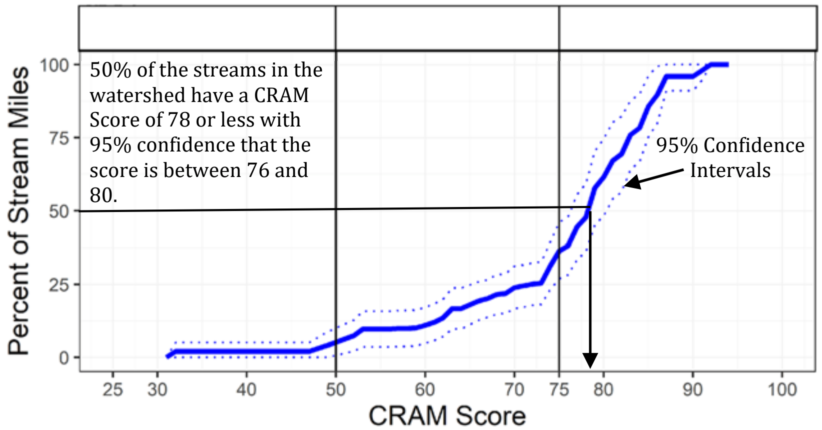

Figure 5. Example CDF estimate curve for a watershed-based stream condition assessment employing CRAM.

A CDF curve that is shifted toward the right (towards higher CRAM Scores on the x-axis) reflects relatively better ecological conditions and conversely a curve that is shifted to the left reflects relatively poorer ecological conditions (lower CRAM Scores). A convex downward curve (one that starts with a steep slope upward that decreases - not shown in Figure 5) would indicate a higher proportion of stream miles with low CRAM condition scores, compared to a convex upward curve (one that starts with a gradual upward slope that increases - as shown in Figure 5) indicates a higher proportion of stream miles with high condition scores. In this example, over 60 percent of the streams in the watershed are in Good ecological condition.

4. Results and Discussion

4.1 Distribution and Abundance of Aquatic Resources

The geospatial results presented here are the same as the Five Watershed Synthesis Report (Lowe *et al.*, 2020); the core management questions were not reanalyzed in 2022 because no new Level 1 data for vegetation or aquatic resources have been developed as of the time of reporting. The following sections summarize the results; see (Lowe *et al.*, 2020) for additional description of the results.

4.1.1 Miles of Streams

The Guadalupe River watershed is the third largest of the County's five major watersheds at 170 mi^2 (440 km^2), and is less than half the size of the County's largest watersheds: Coyote Creek and the upper Pajaro River. The Guadalupe River watershed area is drained by about 1,022 total miles (1,645 km) of surficial streams including Strahler stream orders 1 through 7 (Strahler 1952, 1957) (Table 3) and comprises about 13% of all stream length in Valley Water's five major watersheds. Approximately 57% of the total channel network length consists of first order channels (Lowe *et al.*, 2020). The Guadalupe River watershed has a greater length of first order channels as compared to higher order channels due to the significant proportion of the watershed that drains headwater areas. Proportions of the channel network by stream order are as follows: 2nd order 45%; 3rd order 22%; 4th order 13%; 5th order 8%; 6th order 7%;

7th order 5%; and 8th order <1%. Most of the stream network is in the Non-urban upper watershed (922 miles/1,484 km; 88%) and only 128 miles/206 km (12%) are in the Urban PAI.

In addition to surficial channels, the watershed has 251 miles (404 km) of underground storm drains, all of which occur in the Urban PAI and are not included in Table 3, but can be seen in the aquatic resources map in Figure 6. The watershed also has 29.3 miles (47.2 km) of channel connectors, which are artificial underground drainages that connect upstream natural surficial channel segments with downstream surficial channel segments (natural or engineered stream reaches), occurring primarily on the south side of the Urban/Non-urban interface at the base of the foothills.

Table 3. Guadalupe River watershed stream summary. Data includes the watershed area, and surficial stream lengths separated by 1st-order and 2nd-order and higher. Does not include subsurface drainage.

Watershed Size		***Stream Length***		
Square Miles (square km)	***Acres (hectares)***	***Length of first order streams in miles (km)***	***Length of second order and higher streams in miles (km)***	***Total length of all stream orders in miles (km)***
170 (440)	108,694 (43,987)	581 (935)	441 (710)	1,022 (1,645)

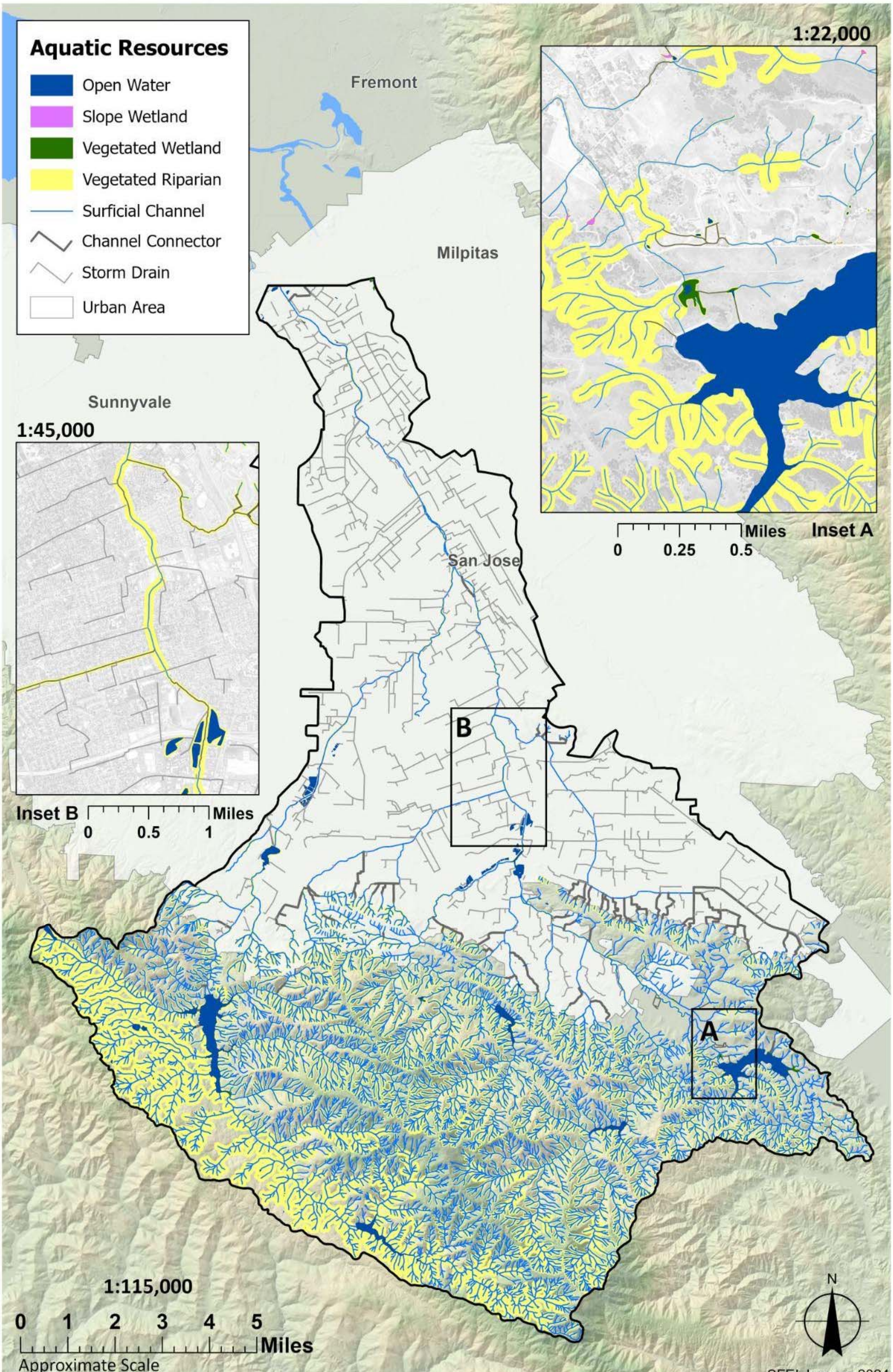

Figure 6. Distribution of aquatic resources in the Guadalupe River watershed including streams and non-riverine wetlands (slopes, seeps, ponds, vegetated portions of lakes and reservoirs, and open water portions of lakes and reservoirs) based upon BAARI (v2.1, SFEI ASC, 2017).

4.1.2 Non-riverine Wetlands

The Guadalupe River watershed also supports 231 acres (93 ha) of vegetated wetlands including slopes, seeps, ponds, and vegetated portions of lakes and reservoirs, and 1,005 acres (407 ha) of deep, open water areas within lakes and reservoirs. The proportion of open water wetland is large in this watershed because it contains seven reservoirs in addition to Lake Almaden and a number of groundwater recharge or percolation ponds. The majority of the pond, lake and reservoir wetlands are anthropogenically created. Figure 6 illustrates the spatial distribution of non-riverine wetlands, while Table 4 summarizes the total acres of non-riverine wetlands in the watershed by type.

Table 4. Total amount in acres (hectares) of non-riverine wetlands and open water area within the Guadalupe River watershed based on BAARI (v2.1, SFEI ASC, 2017). The vegetated wetland acres are likely an underestimate, as the abundance of slope wetlands (i.e., springs, seeps, and other wetlands caused by the emergence of groundwater) is underestimated in BAARI across the watersheds due to the difficulty in detecting and mapping them.

Watershed	*Vegetated Slope and Seep Wetlands*	*Vegetated Ponds*	*Vegetated portions of Lake and Reservoir Wetlands*	*Open Water portions of Lake and Reservoir Wetlands*	*Total Vegetated Wetland Area*	*Total Wetland Area (Vegetated and Open Water)*
Guadalupe River	5 (2)	211 (85)	15 (6)	1,005 (407)	231 (93)	1,236 (500)

4.1.3 Riparian Areas

Riparian areas are where surface and subsurface hydrology connect water bodies and waterways, including rivers, creeks, wetlands, and lakes with their adjacent uplands (Brinson *et al.*, 2002) and supports (or can support) vegetation that is dependent on surface or subsurface water. Riparian areas include portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems (SWRCB TAT, 2016).

Riparian areas vary in function or value (i.e., ecological services or benefits riparian habitat provides) primarily depending on their width, such as wildlife support, runoff filtration, input of leaf litter and large woody debris, shading, flood hazard reduction, groundwater recharge, and bank stabilization (Collins *et al.*, 2006). Riparian width classes reflect natural demarcations in the lateral extent of major riparian functions, where wider areas tend to provide higher levels of more functions. A riparian function is assigned to a width class, if the class is likely to support a high level of the function.

The Riparian Zone Estimator Tool, or RipZET, models and outputs estimated riparian habitat extents as GIS shapefiles and as tables estimating acres of riparian area by riparian width class. Areas modeled for "vegetation riparian" functions are based on vegetation height (CALVEG, 2014) and steepness of topographic slopes. Areas modeled as "hillslope riparian" functions are based on the steepness of topographic slopes. Thus, steepness of topographic slopes applies to both. Table 5 lists the estimated miles[12] of stream riparian habitat in the Guadalupe River watershed by functional riparian width class

[12] Note: Stream lengths associated with each riparian width class were calculated for the left and right banks separately. Therefore, the estimated riparian stream miles are the sum of both banks divided by 2. Total miles in Table 5 will not sum to the total stream network length (flow-line down the thalweg of channels), partly because the

(Collins *et al.*, 2006). The estimated stream miles and acres of riparian area listed in Table 5 are based on the output from the RipZET vegetation module. The Guadalupe watershed has more stream miles with adjacent buffer width in the 30-50m width class, followed by 0-10 m, 50-100 m, 10-30 m, and the least miles in the >100 m width class. Figure 7 shows a map of the modeled distribution of riparian areas adjacent to streams within the Guadalupe River watershed determined using RipZET.

Table 5. Estimated miles of streams with adjacent riparian areas, acres of riparian habitat, and ecological services provided for each of the five riparian width classes in the Guadalupe River watershed.

Riparian Width Class (m)	*Stream Miles (Km)*	*Acres (Ha)*	*% Total Length*	*Shading*	*Bank Stabilization*	*Allochthonous Input*	*Runoff Filtration*	*Flood Dissipation*	*Groundwater Recharge*	*Wildlife Support*
0 - 10	297 (478)	684 (277)	29							
10 - 30	99 (160)	2,783 (1,126)	10							
30 - 50	310 (500)	17,275 (6,991)	30							
50 - 100	189 (303)	17,559 (7,106)	19							
>100	123 (198)	37,151 (15,035)	12							

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shape of the stream network is slightly altered by buffering the GIS-based thalweg flow-line to estimated left and right stream banks, and partly because subsurface drainage features are not included in the estimate of riparian extents.

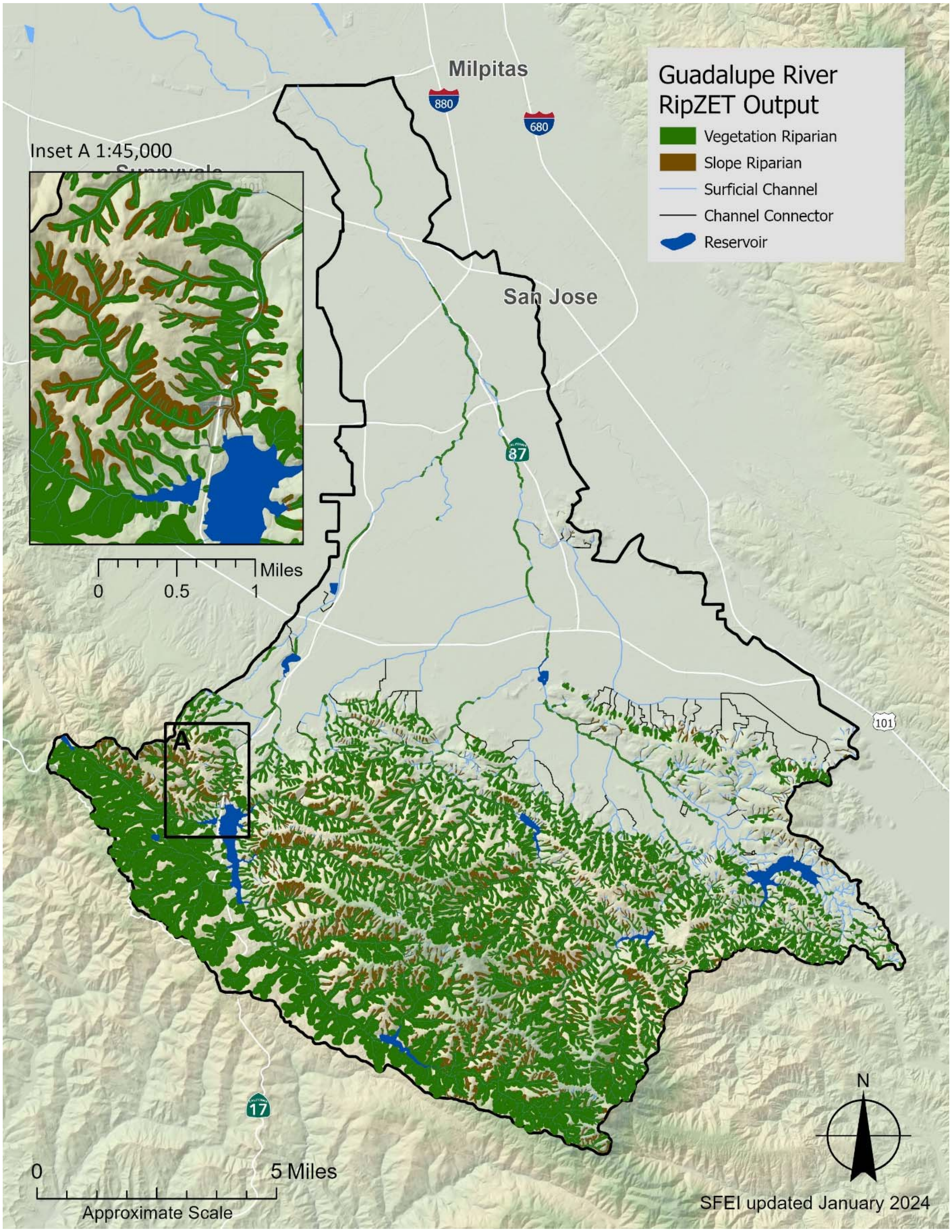

Figure 7. Modeled distribution of riparian areas adjacent to streams within the Guadalupe River watershed determined using RipZET. Areas of hillslope functions (brown) are largely encompassed by vegetation functions (green, overlaid on the hillslope layer), except in steep terrain dominated by short vegetation (chaparral or grasslands). Riparian width is generally constrained in the Urban PAI by urban or suburban development.

4.1.4 COMPARISON TO HISTORICAL EXTENTS

The modern-day distribution, abundance, and diversity of streams and wetlands are very different from historical conditions prior to European contact (circa 1850). The Guadalupe River historically had many more willow sausals, wet meadows, slope wetlands, and ponds (depressional wetlands), which acted to dissipate and store floodwaters, and supported resident and migratory wildlife (Lowe *et al.*, 2020). As mentioned in section 4, surface flow in the river historically diffused into multiple channels and infiltrated into the coarse valley fill, and re-emerged further downslope near Willow Glen (Beller *et al.*, 2010). Figure 8 shows the historical (circa 1850) and modern aquatic resources in the Guadalupe River watershed within the valley area for which there are overlapping mapped historical ecology data from the *Historical Vegetation and Drainage Patterns of Western Santa Clara Valley* report (Beller *et al.*, 2010) and BAARI v.0.2 (SFEI, 2011). Figure 9 quantifies the difference in channel length between the historical and modern time periods.

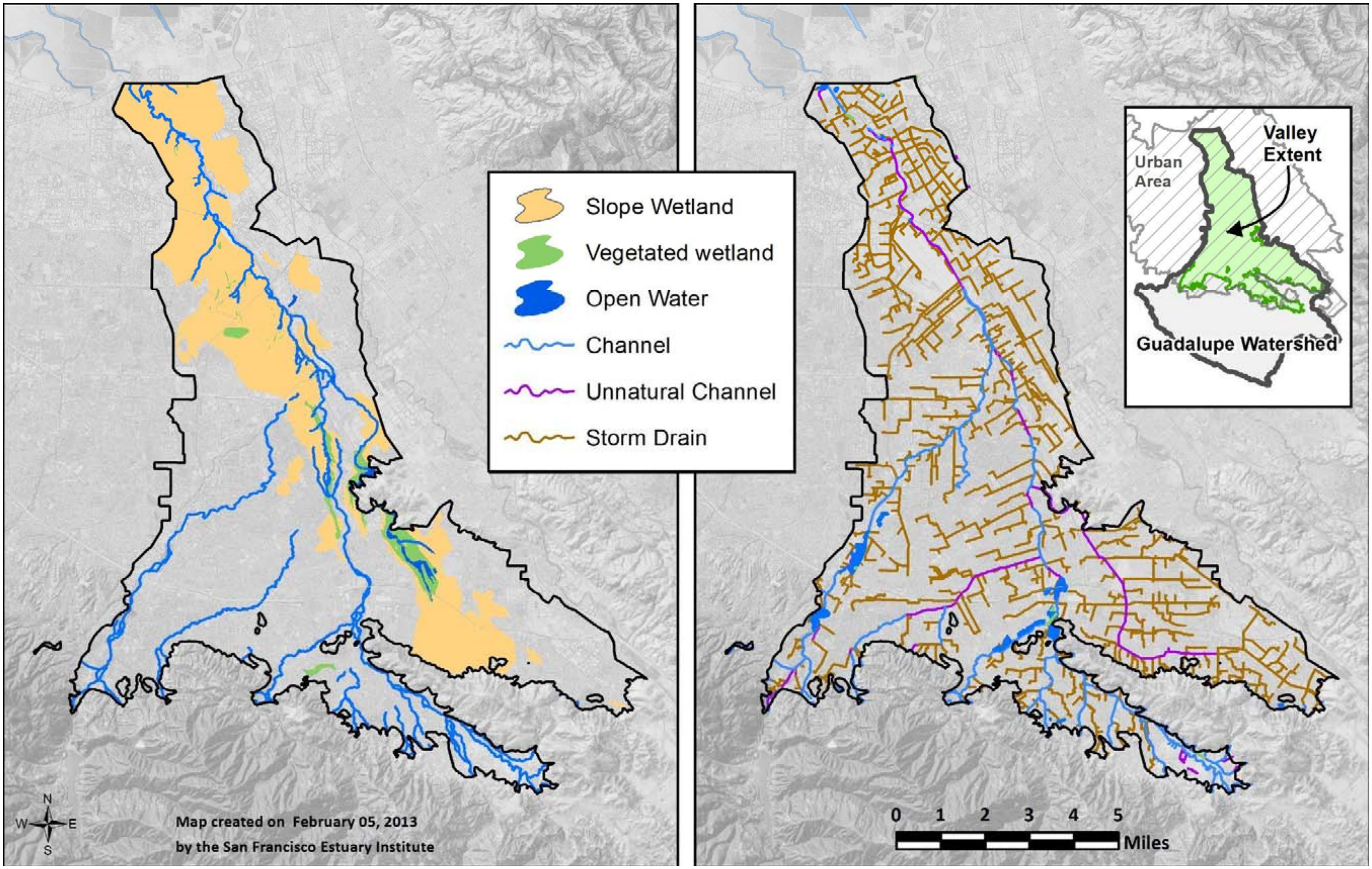

Figure 8. Maps of historical (circa 1850) and modern aquatic resources in the Guadalupe River watershed valley floor, where there are overlapping historical ecology spatial data from the Historical Vegetation and Drainage Patterns of Western Santa Clara Valley (Beller *et al.*, 2010) and BAARI v.0.2 (SFEI, 2011).

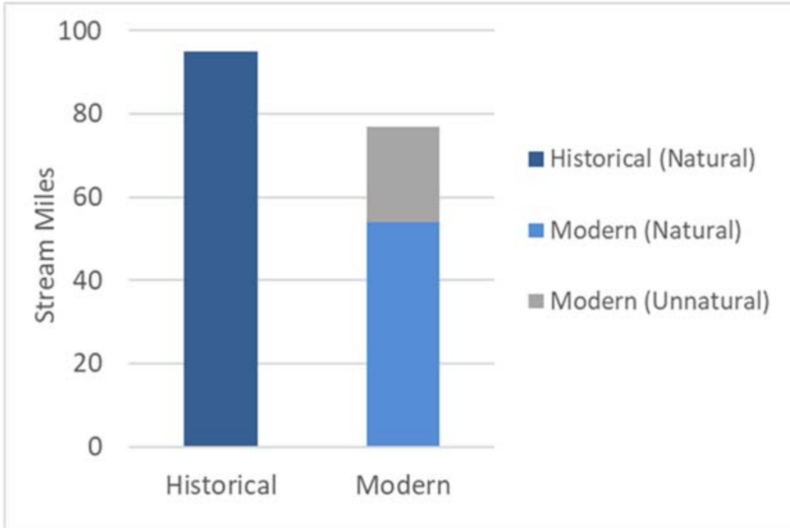

Figure 9. Comparison of historical (circa 1850) and modern (circa 2008) stream length in the valley portion of the Guadalupe River watershed based on data provided by the *Historical Vegetation and Drainage Patterns of the Western Santa Clara Valley* (Beller *et al.*, 2010) and BAARI v.0.2 (SFEI, 2011).

Within the overlapping mapped extents in the valley region, the historical 95 mi (153 km) of natural channels has been reduced to 54 mi (87 km) of natural channels (shown in blue in the map on the right of Figure 8). A total of 23 mi (37 km) of unnatural channels were built to connect mainstem tributaries and improve drainage along with 251 mi (404 km) of storm drains (shown in purple and brown, respectively in the map on the right of Figure 8). This illustrates the degree to which the watershed has been artificially plumbed to increase drainage efficiency in the valley. The historical watershed also contained many more individual wetlands, including depressional wetlands (approximately 1,100 acres/445 ha) and slope wetlands (e.g. alkali meadow, wet meadow, wild rose thickets, willow groves, and freshwater marsh) (approximately 12,900 acres/5,220 ha). These wetland areas provided off-channel water detention and retention in addition to groundwater recharge. Presently, many of the ponds in the valley are artificially created percolation ponds or ponds created for aesthetic purposes (e.g. golf course ponds). These types of ponds do not necessarily provide the same kinds of ecological functions or provide the same habitat value as the historical ponds and wetlands.

4.1.5 Ownership and Protected Areas

In addition to the abundance, distribution, and diversity of stream and wetland resources in the watershed, it is helpful to know who owns and manages them, within the context of identifying and prioritizing areas for future restoration or mitigation. Figure 10 shows a map of Valley Water-owned and easement lands (Valley Water's fee title and easement GIS datasets, accessed in March 2023), protected lands and conservation easements (based on CPAD and CCED, version December 2022) within the Guadalupe River watershed.

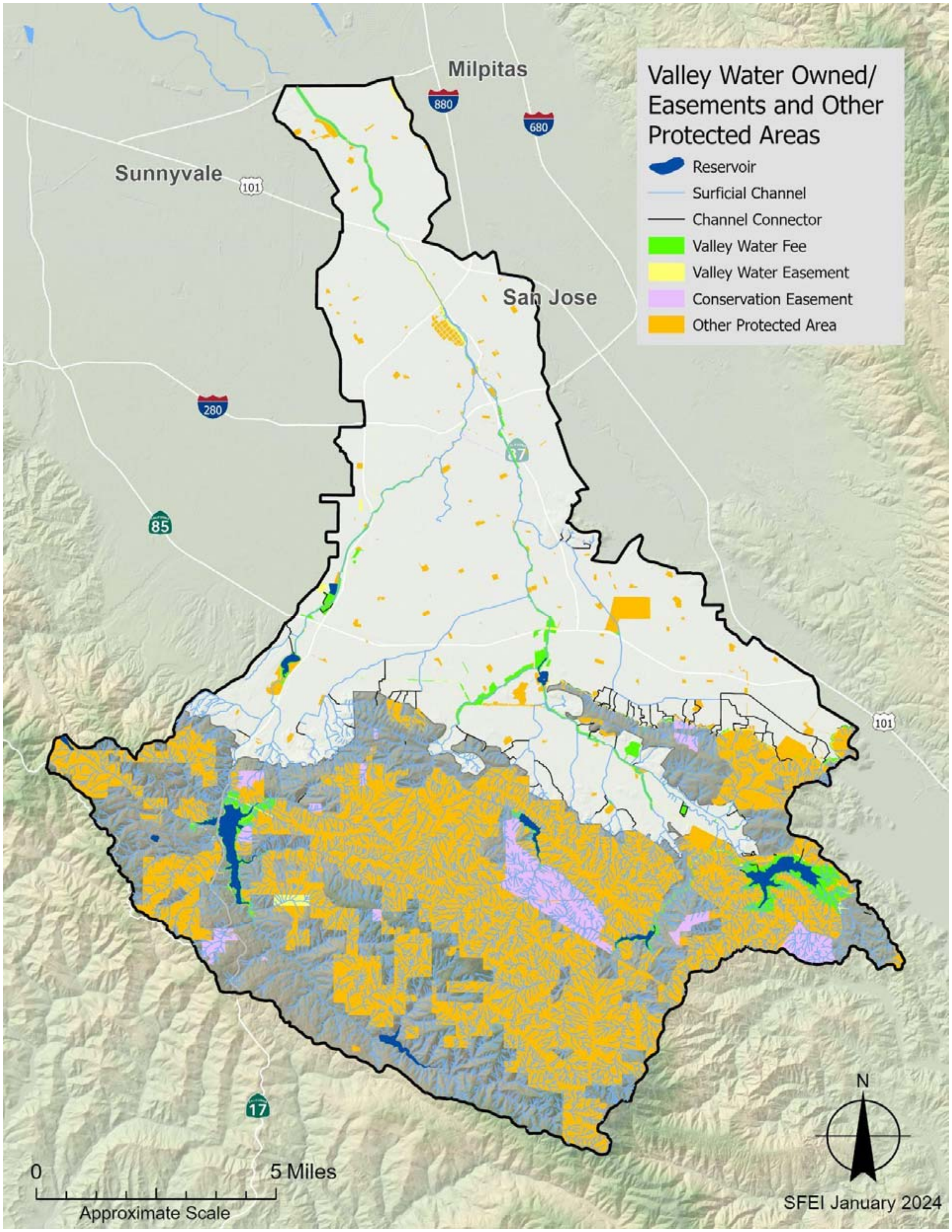

Figure 10. Map of Valley Water owned and easement lands, other protected areas, and conservation easements based on Valley Water's fee title and easements GIS datasets (accessed March 2023), CPAD and CCED (December 2022a and 2022b) data. The underlying map shows BAARI v2.1 streams and wetlands (SFEI ASC, 2017).

Valley Water owns only about 7 percent of the steams (about 78 miles/126 km), and has easement access to another 2 percent (20 miles/32 km) in the watershed (second order and higher, and not including any of the storm drain network), located mostly along channels in the Urban PAI (Figure 10 and Table 6). Most (71%) of the streams that Valley Water owns are located within protected areas documented by CPAD.

Table 6. Amount (miles) [km] and proportion (parentheses) of streams within the Guadalupe River watershed and its two PAIs that are Valley Water-owned or under easement, or are in protected lands or under conservation easements based on CPAD and CCED (respectively). Note: lengths do not include 1st-order streams as mapped in BAARI.

Primary Area of Interest (PAI)	*Total Stream Miles**	*Valley Water Owned*	*Valley Water Easement*	*Protected Lands*	*Conservation Easements*
Urban	128 [206]	40 [64]	15 [24]	31 [50]	0.1 [0.2]
Non-urban	922 [1,484]	38 [61]	5 [8]	598 [962]	46 [74]
Total Watershed	1,050 [1,690]	78 (7%) [126]	20 (2%) [32]	629 (60%) [1,012]	46 (4%) [74]

* This table includes 29 miles of subsurface channel connectors between the upper and lower watershed.

Approximately 64% of the stream network (675 miles/1,086 km) are on protected lands and conservation easements, the majority of which are located in the higher elevation headwaters of the watershed. Much of the watershed area draining to each of the reservoirs in the watershed is protected, to help protect and maintain water quality entering the reservoir. Future effective and sustainable natural resource and watershed management will require Valley Water, other agencies (e.g. Santa Clara County Parks, San Jose Water, Mid-Peninsula Open Space) and private landowners to collaborate in order to have a meaningful effect on the watershed.

4.2 CRAM Survey Results

Within this section, the CRAM survey results are first summarized to provide a high level overview of findings. The technical details then follow this summary, to provide a greater and more in-depth understanding of the results.

The 2022 Guadalupe River CRAM reassessment survey showed that the majority of the stream reaches in the watershed (about 80%) are in Fair overall ecological condition based on Index Scores, and that roughly 10% of stream reaches are in either Poor or Good ecological condition as defined by CRAM's condition classes[13]. This distribution of condition has not changed since the 2012 baseline survey, as was expected, because significant drivers of change, such as large restoration projects, significant wildfires, or large areas of new development have not occurred in the watershed in the past 10 years.

[13] Poor condition includes CRAM scores ranging from 25-50, Fair condition includes scores ranging from 51-75, and Good condition includes scores ranging from 76-100.

There are clear differences in stream conditions between the Urban PAI and Non-urban PAI. About one-third (34%) of the Urban stream reaches are in Poor condition, while none of the Non-urban stream reaches are in Poor condition. The differences are most pronounced at the Attribute Level and follow expected trends. For example, almost all of the Non-urban stream reaches are in Good condition for the Buffer and Landscape Context Attribute (90%), while only 14% of Urban stream reaches are in Good condition for that Attribute. The reassessment's Biotic Structure Attribute scores may indicate small changes due to extended drought conditions over the past decade including 2012-2016 and 2020-2022 (DWR, 2023), with small but noticeable declines in the vegetation community condition scores. Proportions of Urban stream reaches with Poor Biotic Structure scores increased from 26% to 41% between survey periods.

The lack of significant ecological change in stream conditions over the last 10 years indicates relative stability, meaning that current resource management actions are at least maintaining stream conditions. However, because the majority of streams in the Guadalupe River watershed are in Fair condition, there is plenty of opportunity for targeted improvement. The maps showing the spatial distribution of stream conditions at the Index and Attribute score levels are helpful visual planning tools for deciding where to focus resources and how to improve ecological conditions. Drilling down to site specific Metrics and stressor checklists can provide tangible monitoring information that can further inform restoration/mitigation plans and actions.

Following from the summary above, this section next describes the technical details of the results. The 2022 reassessment survey assessed 75 AAs (for details see Appendix A) including revisiting all 53 of the 2012 survey AAs and adding 22 new AAs: 14 new Urban AAs in previously under-represented stream reaches such as Ross and Canoas Creeks, and eight new Non-urban AAs located in the under-represented upper headwater reaches of the watershed (Figure 11). Adding the new AAs improved the spatial coverage and representativeness across the watershed and partly contributed to the observed shifts in the analysis results as explained in the Attribute level sections below. As mentioned in the methods section, the 2012 Metric Scores were carefully reviewed and updated to CRAM version 6.1 to make them comparable to the 2022 assessments. Therefore, the 2012 CDF estimates and the proportions of streams in each condition class will be different than previously reported.

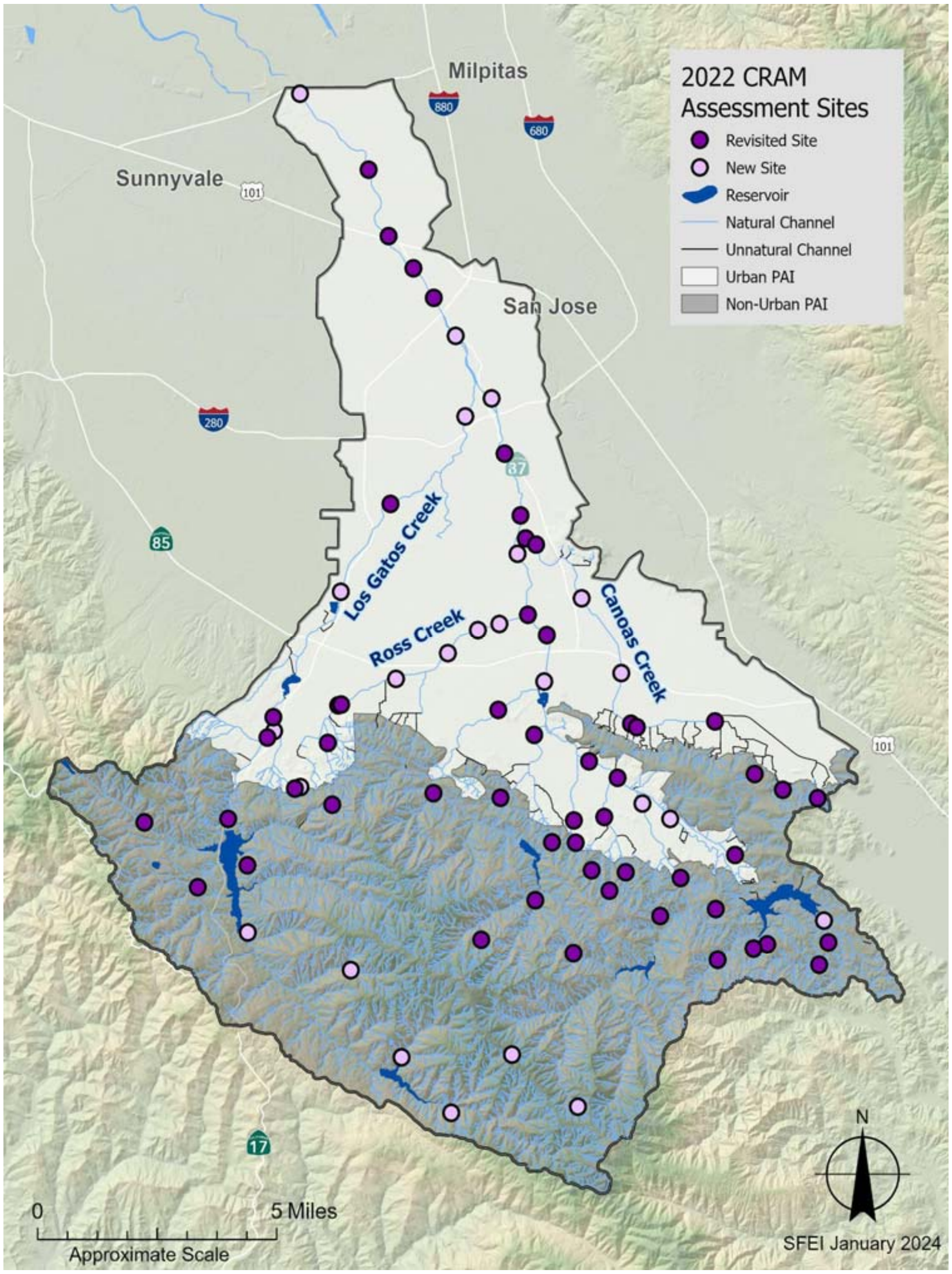

Figure 11. Map of the 2022 survey sites showing the distribution of the 53 revisit sites (dark purple) and 22 new AAs (light purple) in areas previously under-represented stream reaches including Ross, Canoas, and Los Gatos Creeks in the Urban PAI and upper headwater reaches in the Non-urban PAI.

To test for statistically significant temporal changes in stream conditions at the watershed and PAI scales, *spsurvey's* Wald F test (*cdf_test*) and *change_analysis* tests were run on the mean CDF results, and the categorical condition classes of Good, Fair, and Poor. The Wald F test results are presented in Table 7, and compared changes in the mean CDF conditions between the baseline (2012) and reassessment (2022) surveys at the Index and Attribute Score levels, and the watershed and PAI scales. The results indicated no significant change in conditions between surveys, except in the Urban PAI at the Index Score level.

Table 7. Wald F test statistics comparing change in the mean CDF conditions between the baseline (2012) and reassessment (2022) surveys at the Index and Attribute Score levels, and the watershed and PAI scales. * indicates the significance value was <0.05.

Subpopulation_1	*Subpopulation_2*	*CRAM Indicator*	*Adjusted Wald Statistic*	*Degrees of Freedom 1*	*Degrees of Freedom 2*	*p Value*
Survey2012	Survey2022	Index Score	0.02	2	126	0.98
Survey2012	Survey2022	Buffer	0.20	2	126	0.82
Survey2012	Survey2022	Hydrology	1.17	2	126	0.31
Survey2012	Survey2022	Physical	0.18	2	126	0.83
Survey2012	Survey2022	Biotic	0.41	2	126	0.67
Nonurban_Survey2012	Nonurban_Survey2022	Index Score	0.06	2	126	0.94
Urban_Survey2012	Urban_Survey2022	Index Score	3.67	2	126	0.03*
Nonurban_Survey2012	Nonurban_Survey2022	Buffer	0.15	1	127	0.70
Urban_Survey2012	Urban_Survey2022	Buffer	0.14	1	127	0.70
Nonurban_Survey2012	Nonurban_Survey2022	Hydrology	1.30	2	126	0.28
Urban_Survey2012	Urban_Survey2022	Hydrology	0.09	2	126	0.91
Nonurban_Survey2012	Nonurban_Survey2022	Physical	0.24	2	126	0.79
Urban_Survey2012	Urban_Survey2022	Physical	0.75	2	126	0.48
Nonurban_Survey2012	Nonurban_Survey2022	Biotic	0.15	2	126	0.86
Urban_Survey2012	Urban_Survey2022	Biotic	1.64	2	126	0.20

The *change analysis* test was applied to both the continuous data (the actual CRAM Index and Attribute mean CDFs) and the categorical (e.g. Good, Fair, Poor condition class data) and is effectively a statistical t-test. The results tables are fairly large and therefore included in Appendix C (Tables C.6 and C.7). The main takeaways from these statistical tests is that they confirmed the observed differences described above:

- No statistically significant differences could be discerned in stream conditions between the two survey periods at the watershed scale.
- A small decline in overall ecological conditions in the Urban PAI (Index Score DiffEst = -2.9 with a StdError of 1.0) and a more pronounced decline in Biotic Structure conditions in the Urban PAI (Biotic Score DiffEst = -7.4 with a StdError of 1.4).
- A small increase in Buffer and Landscape Context conditions in the Non-urban PAI (Buffer Score DiffEst = 2.9 with a StdError of 1.0).

The detailed tabular results from the GRTS *spsurvey* analysis outputs from R can be found in Appendix C.

More detailed descriptions of the CRAM survey results and comparisons are presented below using three kinds of graphical formats and summary tables:

1. Maps show the spatial distribution of the CRAM stream condition Index and Attribute Scores color-coded for their ecological condition class of Good, Fair, and Poor.
2. Bar charts show the proportions of stream reaches in Good, Fair, and Poor condition employing CRAM's standard ecological condition classes (or health classes as described in the Methods section) based on the GRTS survey analysis CDFs.
3. CDF plots, with 95% upper and lower confidence levels, are presented to show the most detailed, visual output of the GRTS survey analysis. CRAM Index and component Attribute Score CDF curves are overlaid to support a visual comparison of the relative amounts of stream resources by CRAM condition scores.

4.2.1 CONDITION OF STREAMS AT THE CRAM ATTRIBUTE LEVEL

CRAM includes four Attribute Scores each composed of two to three underlying Metric Scores. The Attribute Scores are averaged into an overall Index Score. The Attributes include: Buffer and Landscape Context, Hydrology, Physical Structure, and Biotic Structure. Characterizing Attribute scores, and even the component Metric scores, provides detailed information about aspects of stream form and function to directly assist in management action decisions.

The change in the spatial distributions of AAs between surveys is best seen in the maps in Figure 12. Each map shows the Attribute level spatial distribution of stream conditions, color-coded by condition class, across the watershed including: (1) differences among the Urban and Non-urban PAIs, (2) differences between the mainstem and individual tributaries, and (3) temporal differences among survey periods (between the left and right sets of maps).

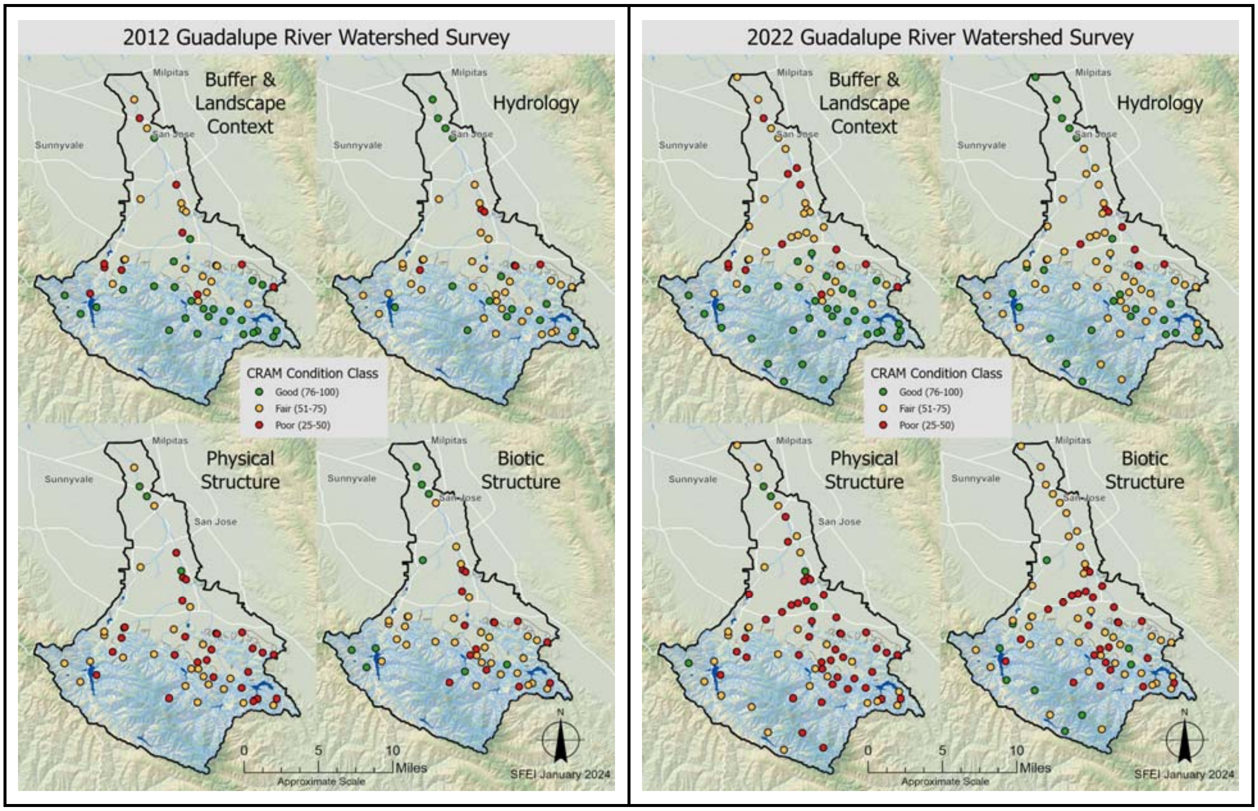

Figure 12. Stream condition survey sites (AAs) in 2012 (left) and 2022 (right) for the Guadalupe River watershed, color-coded for their CRAM Attribute condition class of Good, Fair, and Poor.

Adding the 22 new AAs to the reassessment survey in 2022 improved the spatial coverage and representativeness across the watershed and partly contributed to the shifts in the analysis results. For example, the new Urban AAs in Ross Creek, Canoas Creek and Los Gatos Creek indicated that those reaches have poorer Physical and Biotic Structure compared to other Urban stream reaches, and therefore the shifts to the left on the CDFs curves.

The bar charts in Figures 13 and 14 show the proportions of stream reaches in Good, Fair, and Poor condition (categorical condition class estimates), indicating (1) mostly small differences between survey periods for all four of the CRAM Attributes with the exception of Biotic Structure, and (2) clear differences among the Urban and Non-urban PAIs for two of the four Attributes.

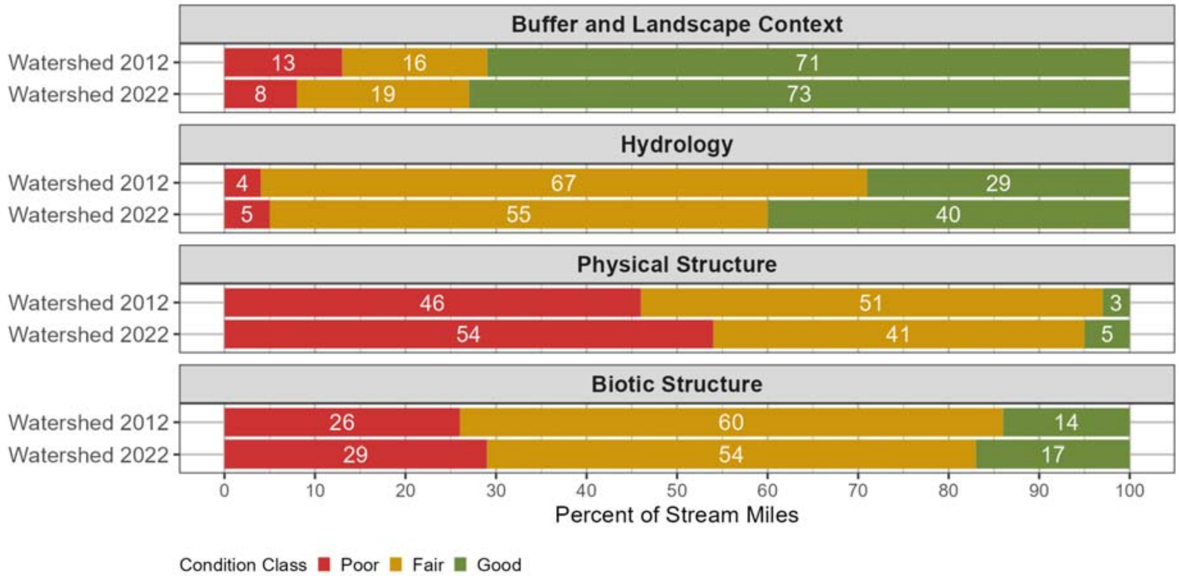

Figure 13. Percent of stream miles in Poor, Fair, and Good ecological condition for the Guadalupe River watershed as a whole for the 2012 and 2022 ambient surveys based on CDF estimates of the four CRAM Attributes. Ecological condition classes are based on three CRAM equal-interval health classes of Poor 25-50, Fair 51-75, and Good 76-100. The number of AAs differed between surveys: 2012 Watershed = 53; 2022 Watershed = 75 (consisting of 53 revisit AAs and 22 new AAs).

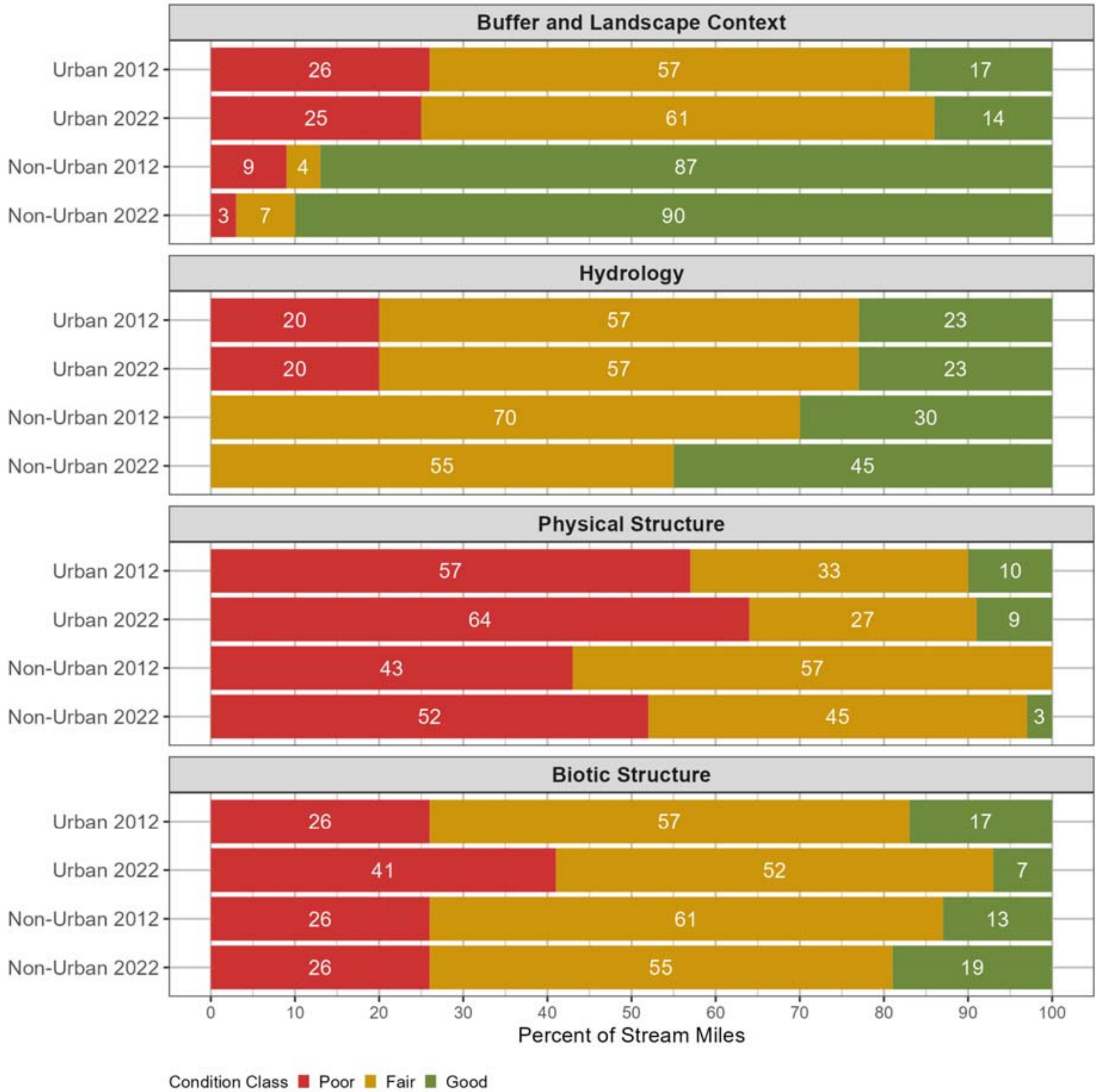

Figure 14. Percent of stream miles in Poor, Fair, and Good ecological condition for the Urban and Non-urban PAIs within the Guadalupe River watershed for the 2012 and 2022 ambient surveys based on CDF estimates of the four CRAM Attributes. Ecological Condition Classes are based on three CRAM equal-interval health classes of Poor 25-50, Fair 51-75, and Good 76-100. The number of AAs differed between surveys: 2012 Urban = 30, 2012 Non-urban = 23, 2022 Urban = 44, 2022 Non-urban = 31.

The CDF plots show the Attribute level survey results for the whole watershed (Figure 15) and the Urban and Non-urban PAIs (Figure 16) for both survey periods. Each curve represents the proportion of stream miles (on the y-axis) for any specific CRAM score (on the x-axis) as a cumulative distribution function estimate, with dashed lines to indicate the upper and lower 95% confidence intervals. The overlaid 2012 and 2022 curves allow one to visually compare shifts left or right indicating lower or higher ecological conditions, respectively.

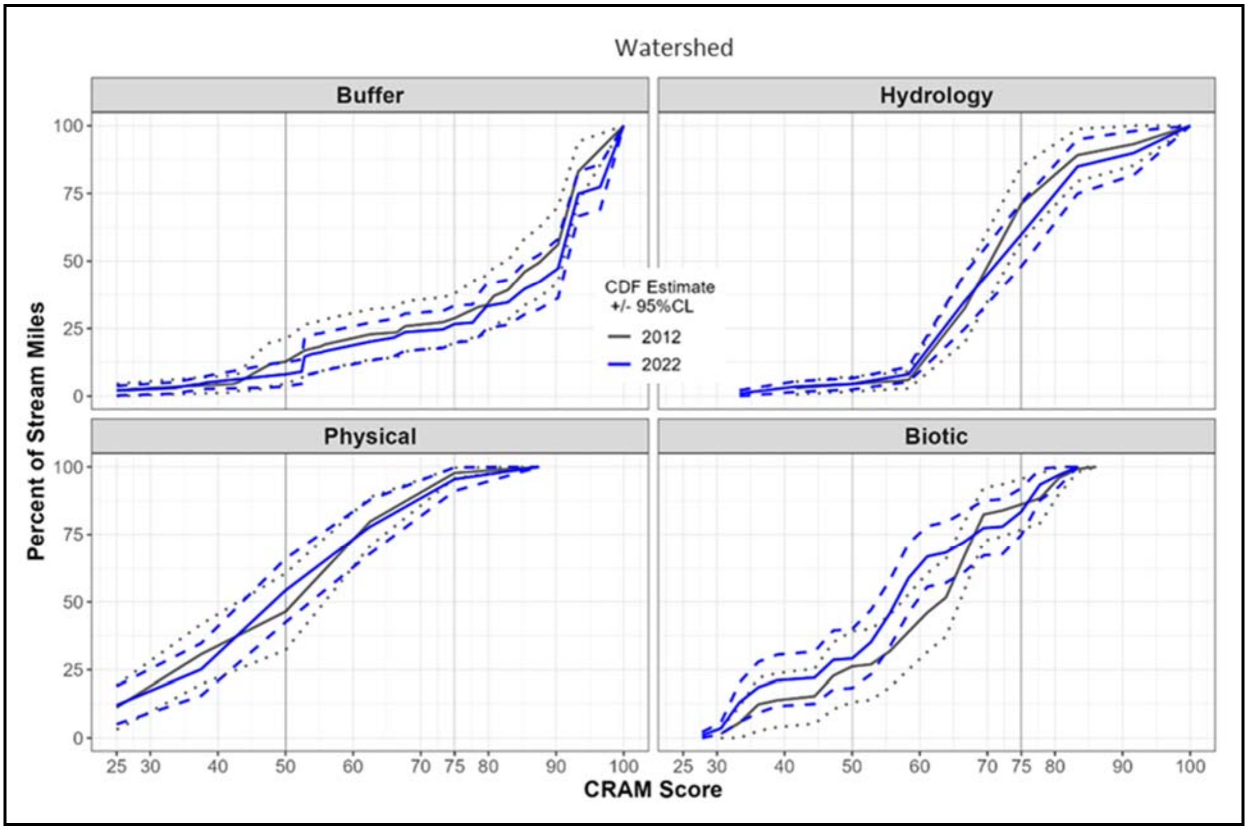

Figure 15. CDF estimates comparing CRAM Attribute Scores for the 2012 and 2022 Guadalupe River Watershed ambient stream condition surveys for the whole watershed. Curves visually compare the relative conditions of streams within each PAI and between survey periods.

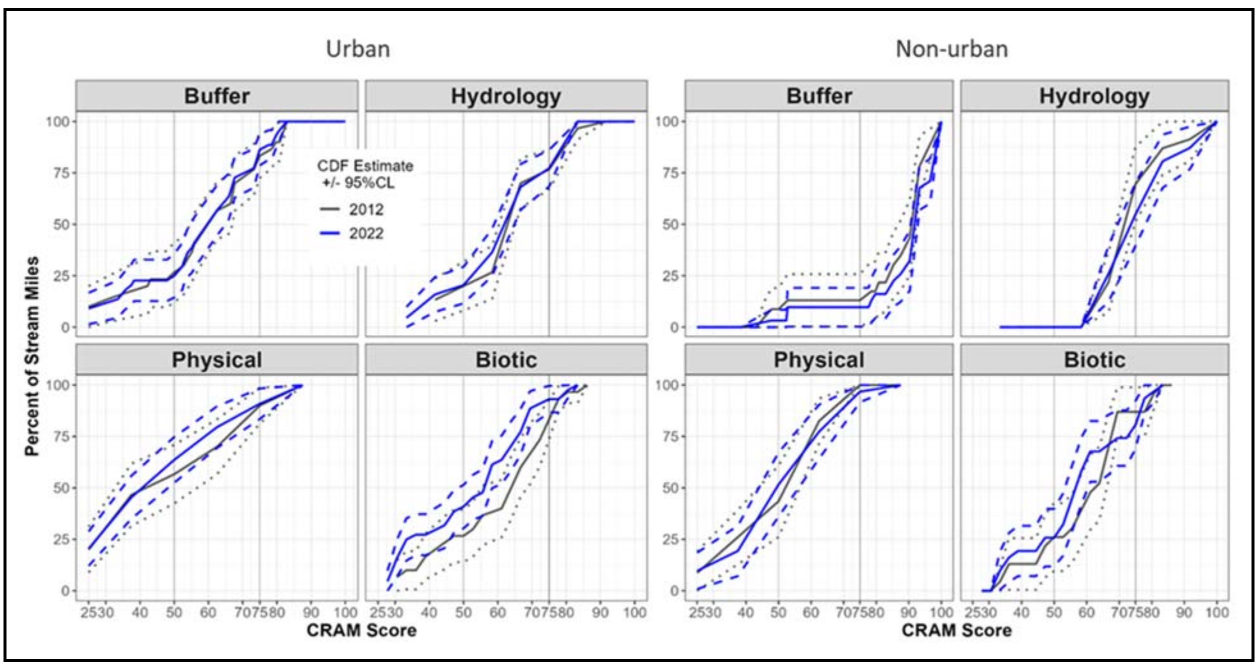

Figure 16. CDF estimates comparing CRAM Attribute Scores for the 2012 and 2022 Guadalupe River watershed ambient stream condition surveys for the Urban PAI (left), and the Non-urban PAI (right). Curves visually compare the relative conditions of streams within each PAI and between survey periods.

The following sections present each CRAM Attribute in more detail to further explore possible ecological drivers and explanations behind the differences (or lack of) observed between survey periods, and among PAIs.

Buffer and Landscape Context Attribute

In 2022, at the watershed scale, the Buffer and Landscape Context Attribute is primarily in Good condition (73% of the stream reaches). The results indicate that no significant change in condition has occurred between survey periods. Comparing 2012 and 2022, only a slight increase in condition is observed at the watershed scale, which is evident in a shift to the right in the CDF estimate (Figure 15). This change is mimicked by the Non-urban PAI CDF estimate (Figure 16) because the improvement at the watershed scale is likely (in part) a result of having added eight new AAs in the Non-urban upper watershed where most streams have Good buffer condition due to the region largely being comprised by natural open space (see the condition class maps in Figure 12).

Differences between the Urban and the Non-urban PAIs are clear. Most of the Urban PAI is characterized by Fair and Poor condition scores (with only 14% of the stream reaches in Good condition), while most of the Non-urban PAI is characterized by Good condition scores (90% of stream reaches in Good condition). This finding illustrates the effect of adjacent land use upon stream conditions. Most of the Urban streams are affected by breaks in the riparian corridor, and they either have no buffer or only a narrow buffer that is in Fair to Poor condition. Improvement of buffer scores in the Urban PAI will require purchasing and ecologically improving areas adjacent to stream channels whenever they become available. In contrast, most of the Non-urban streams have a continuous riparian corridor and adjacent buffer that is most often wide and in Good condition. Maintenance of Good condition scores within the Non-urban PAI will require protecting existing buffer areas.

Hydrology Attribute

For the Hydrology Attribute, scores at the watershed scale indicate that more than half the stream reaches are in Fair condition, but with 40% in Good condition. Good conditions are observed in both the Urban and the Non-urban PAIs. Intuitively, the Non-urban PAI might be expected to have all of the Good condition reaches, however the 23% of channel length in Good condition within the Urban PAI is mostly located in the mainstem reaches at the bottom of the watershed (see the 2022 Hydrology Attribute map in Figure 12). Those reaches have stable channel bed elevations, multiple topographic surfaces (“benches”), and the channel has space to spill laterally during times of flood. This illustrates the importance of a wide, dedicated channel corridor, which can contribute to channel stability and lower flood risks in densely urban environments. Alternatively, the 45% of channel length in Good condition within the Non-urban PAI is driven by slightly different metrics; these upper watershed reaches typically have little to no upstream development and stable channel bed elevations. They generally do not have the ability for floodwaters to spill laterally as the channels are confined by steep adjacent hillslopes.

At the watershed scale, the Hydrology Attribute shows an increase in the proportion of stream reaches in Good condition between 2012 and 2022. However, the CDFs show some of the nuance in the data. No significant change in the amount of stream reaches in each condition class was observed between survey periods for the Urban PAI. The addition of new AAs in the Urban PAI, which are in Poor condition, did slightly shift the lower portion of the Urban CDF to the left, in addition to extending the curve to cover lower CRAM scores (Figure 16). However, the addition of new AAs in the Non-urban PAI, where many AAs are in Good condition, has shifted the upper portion of the Non-urban CDF to the right. The addition of these AAs better characterizes the headwater portion of the watershed, and caused the small improvement at the watershed scale. The maps show two areas of Good condition for this Attribute; intuitively the upper watershed has many AAs in Good condition, but perhaps surprisingly, the lowest reach of the Guadalupe River mainstem is also in Good condition (Figure 12).

Physical Structure Attribute

In 2022, at the watershed scale, 54% of the stream reaches are in Poor condition for the Physical Structure Attribute. This proportion has increased since the 2012 survey (Figure 13), likely driven by the addition of new AAs in the 2022 survey.

At the PAI scale, 64% of the stream reaches in the Urban PAI and 52% of the stream reaches in the Non-urban PAI are in Poor condition. The proportion of stream reaches in Poor condition has increased since the 2012 survey (Figure 14). The change is visible in the CDF estimates as a shift to the left in the middle portion of the curve in the Urban PAI (Figure 16). Overall, the Non-urban PAI curve has slight variations from the 2012 curve, but noticeably shows a slight shift to the right for scores greater than 60, indicating slightly better scores for any given percentile of channel length. These changes appear to be driven by the addition of new AAs in the 2022 survey; six new Non-urban AAs had improved Structural Patch Richness scores as compared to 2012, likely reflecting the presence of an extra structural patch type or two. Although the scores are largely poor in both PAIs, the scores represent two different channel morphologies. These scores reflect two very different dominant channel morphologies. In the Urban PAI, many of the tributaries (not the mainstem) are modified or created engineered channels that have very simple morphology, lacking any “benches” or floodplain surfaces, and are purposefully maintained for maximum flow capacity. These channels lack the physical complexity of natural channels. However, in the Non-urban PAI, much of the channel length is comprised of low-order headwater channels that are naturally simple, lacking “benches” and lacking a large number of structural patches, due to the narrow channel width and steep channel slope. Similarly to the Hydrology Attribute, the small proportion of Good Physical Structure conditions within the Urban PAI is found along the Guadalupe River mainstem, in the wide reaches that have multiple “benches” and a relatively complex channel and floodplain corridor.

Biotic Structure Attribute

And finally, at the watershed scale the Biotic Structure Attribute has a predominance of Fair and Poor condition scores. Most of the stream reaches with Good condition scores are located in the Non-urban upper watershed. As compared to the 2012 survey, there has been a decrease in the proportion of stream reaches in Fair condition, with slight increases in both Poor and Good condition (Figure 13). At the watershed scale, the CDF curve shifts to the left, indicating a decline in condition, with the exception of scores in approximately the 70-75 range, that shift to the right.

These watershed scale changes are driven by differences in each PAI; the watershed scale bar charts (Figure 14) indicate different responses among the Urban and Non-urban PAIs between survey periods. The Urban PAI has a substantial increase in the proportion of stream reaches in Poor condition, likely due to both the new AAs in Ross Creek and Canoas Creek and declines in condition at revisit AAs (Figure 14). This is visible as a significant shift to the left for the entire Urban PAI CDF curve. The Non-urban PAI has a small increase in the proportion of stream reaches in Good condition, again likely due to the addition of the new AAs in the upper watershed. These patterns are also visible within the CDF curves (Figures 15 and 16).

The decline in Urban Biotic Structure conditions between survey periods is significant (as reflected in the *change analysis*) and is likely due to two causes. First, the 2022 survey better characterized urban channels by adding 14 new AAs in a number of previously under-represented tributaries including Ross and Canoas Creeks, which are managed and maintained to have a simple vegetation community. And secondly, the condition scores may be capturing the effects of many years of drought between survey periods as evidenced by declines at the Attribute level for 17 of the 30 Urban revisit AAs. Closer inspection of the Metric Scores for the 17 AAs does not reveal a consistent pattern in which Metric declined; number of plant layers, number of co-dominant species, and vertical biotic structure were the most common Metrics with decreased scores. These declines most often represent the absence of short or medium height class annual plant species that weren't present in 2022 due to less precipitation in the wet season and/or years prior.

The Non-urban PAI bar chart and CDF plot results (Figures 14 and 16, respectively) show an increase in the proportions of stream reaches in Good condition, which is likely due to better characterization of channels in the upper watershed as a result of the added AAs in 2022. Interestingly, the proportion of channel length in each condition class did not visibly change in the bar charts, but there is a visible decline (shift left) in the 2022 CDF curve in the Poor and Fair condition range. Of the 23 Non-urban revisit AAs, 18 had a decline in score at the Attribute level in 2022. Similarly to the Urban PAI, many of the AAs in the Non-urban PAI showed reductions in the number of plant layers present, the number of co-dominant plant species, or the vertical overlap of plant layers as compared to 2012. These changes likely reflect small biotic structure effects of the extended years of drought between survey periods, but were not deemed statistically significant at the PAI level because of the opposing effects of adding new AAs in the upper headwater reaches of the watershed that had better Biotic Structure conditions compared to the AAs surveyed in 2012.

4.2.3 OVERALL CONDITION OF STREAMS AT THE CRAM INDEX SCORE LEVEL

Streams in the Guadalupe River watershed as a whole are in Fair ecological condition based on CRAM Index Scores, and have not changed significantly since 2012. Not surprisingly, the streams in the Urban PAI are in Fair to Poor condition, while the streams in the Non-urban PAI are dominantly in Fair condition, with 13% of the channel length in Good condition. Figure 17 illustrates the spatial distribution and patterns of CRAM Index Scores across the watershed, and within the two PAIs. Figure 18 shows the relative percent of stream miles in Good, Fair, or Poor ecological condition from CRAM Index Scores for the whole watershed and its Urban and Non-urban PAIs between survey periods.

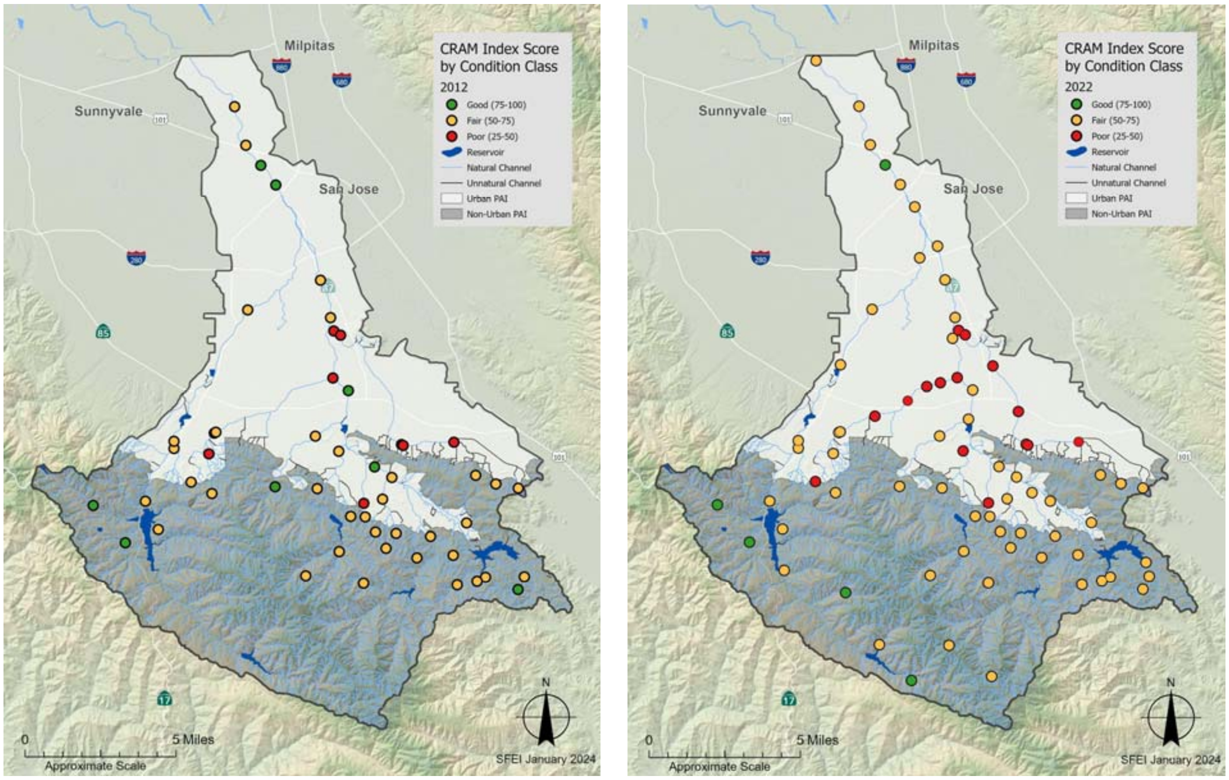

Figure 17. Guadalupe River watershed, Urban and Non-urban PAIs stream condition survey sites (AAs) color-coded by Poor, Fair, and Good ecological condition (CRAM Index Scores ≤50, 51-75,>75, respectively). 2012 survey results are shown on the left, and 2022 survey results are shown on the right.

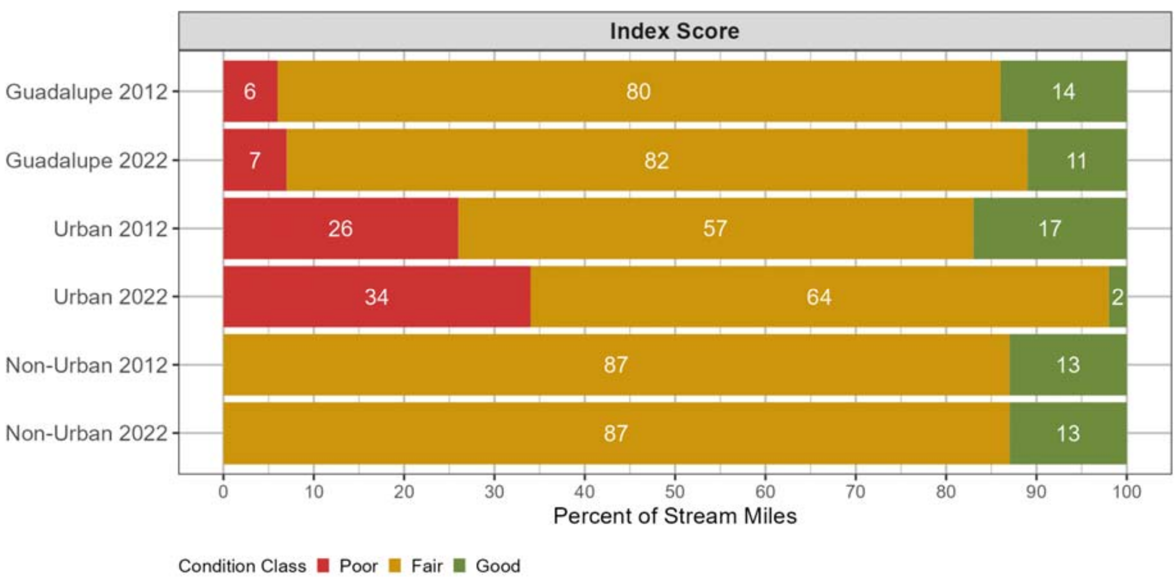

Figure 18. Percent of stream miles in Poor, Fair, and Good ecological condition throughout the Guadalupe River watershed, Urban and Non-urban PAIs in 2012 and 2022.

Table 8, lists the relative proportions of stream resources in Good, Fair, and Poor condition with the lower and upper 95% confidence limits in parentheses to show the amount of overlap among condition classes. For example, at the watershed scale, between 5-22% of stream reaches were in Good condition in 2012, and 3-18% were in Good condition in 2022. The narrower confidence bounds by condition class (as seen in Table 8) are potentially due (in part) to the increased number of AAs in 2022 that added 22 new AAs (14 Urban and 8 Non-urban). The larger sample size increased the statistical power to characterize overall condition of streams in each PAI. Overlapping confidence bounds (as seen in Table 8 and in the CDF plots in Figures 19 and 20) intuitively indicate that the difference between the two survey periods may not be significant; *spsurvey's* statistical Wald F and *change analysis* tests confirmed this at the Index Score level for the whole watershed and PAI scales.

Table 8. Percent of stream miles in Poor, Fair, and Good condition* throughout the Guadalupe River watershed, Urban and Non-urban PAIs in 2012 and 2022 based on the CRAM Index Score CDFs. Values shown in parentheses are the lower and upper 95% confidence limits.

PAI (Survey Year)	*Poor*	*Fair*	*Good*	*Number of AAs (n)*
Guadalupe River Watershed (2012)	6 (3-9)	80 (71-90)	14 (5-22)	53
Guadalupe River Watershed (2022)	7 (5-10)	82 (74-90)	11 (3-18)	75
Urban (2012)	26 (13-40)	57 (42-72)	17 (5-28)	30
Urban (2022)	34 (24-44)	64 (53-75)	2 (0-6)	44
Non-urban (2012)	0 (0-0)	87 (76-98)	13 (2-24)	23
Non-urban (2022)	0 (0-0)	87 (78-96)	13 (4-22)	31

* Stream ecological condition classes correspond to the following CRAM Index Score ranges: Poor 25-50, Fair 51-75, and Good 76-100.

Overlapping confidence bounds (as presented in Table 8 and in the CDF plots in Figures 19 and 20) initially indicate that the differences between the two survey periods may not be statistically significant. S*psurvey's* statistical Wald F test confirmed this at the Index Score level for the whole watershed and the PAI scales. However, at a more detailed level, the *change analysis* tests (Appendix C) indicate that the Urban Index Scores showed a discernible 14% decline in the proportion of stream reaches in Good condition (DiffEst = -14%, StdError = 5%), an increase in the proportion of stream reaches in Poor condition (though this was less pronounced, DiffEst = 7%, StdError = 5%). And, to a lesser degree, the mean CDF change analysis test agreed with those results (DiffEst = -2.9%, StdError = 1%).

The CDF plots in Figures 19 and 20 show the overlaid Index Score curves and 95% confidence limits for both the 2012 and 2022 surveys at the watershed and PAI scales. The shapes of the curves help to further interpret the overall conditions of streams in the watershed compared to the condition class bar charts. For example, the watershed scale CDF (Figure 19) has the shape of the letter "S" with a longer, flatter tail to the left than at the top right. The majority of the curve falls within the Fair condition class with the steepest part of the curve with CRAM Index Scores between 65 and 75. In addition, the steepest part of the curve makes up over 50% of the total stream miles on the y-axis, indicating that more than half of the total stream miles in the watershed have Index Scores within this narrow range of condition. This 10-point span in condition scores means that the range of stream conditions is fairly narrow at the watershed scale, and therefore much of the stream length is providing similar levels of functions and services. Because the watershed has such a large length of stream miles in the Fair condition class, stream enhancement projects to improve watershed scale conditions should occur over extended lengths of the channel network.

The CDF estimate plots for the Urban and Non-urban PAIs (Figure 20) are very different from each other. The Non-urban PAI is strongly "S" shaped, and similar to the watershed scale CDF, though the left side of the curve is shifted right, indicating that none of the channel length is in Poor condition. The majority of the stream reaches are in Fair condition. Similarly to the watershed scale, most of the channel length has an Index Score between 65 and 75, indicating how homogenous stream conditions are across this PAI. The extended range of CRAM condition scores at the top right side of the curve in 2022 likely reflect better characterization of the headwater reaches in the upper watershed with the newly added AAs, although the proportion of stream reaches in Good condition did not change between survey periods.

The CDF for the Urban PAI has a very different linear shape as compared to the watershed and Non-urban PAIs. It is almost a straight 45 degree line extending upward to the right. This indicates that the Urban streams have a diverse and wide range of conditions (Index Scores ranging between 31 and 80). Approximately 30% of the channel length is in Poor condition, highlighting opportunities for targeting future stream enhancement projects. Because the highest condition score in this PAI is 80, it illustrates the dearth of truly high-condition reaches. Interestingly, four of the 30 Urban AAs were in Good condition in 2012 (Index Scores ranging between 76 and 80), while only one AA (out of 44) was in Good condition with a score of 78 in 2022.

For the Urban PAI, there was a statistically significant downward shift in stream conditions based on the Index Score CDF and *change analysis* tests (Table 8 and Appendix C). Reviewing the overlaid Urban CDF curves in Figure 20, one can see that not much change occurred in the lower condition scores between survey periods. However, for reaches with Index Scores between about 55 and 75, the 2022 CDF curve is clearly shifted left compared to the 2012 curve. The shift largely reflects reductions in the Physical Structure and Biotic Structure Attributes that is partly due to the 14 added new AAs in reaches that were previously under-represented, and is partly due to a decline in Biotic Structure that may be a result of extended drought between survey periods.

The range of scores across the watershed are visually evident based upon photographic examples of the full range of CRAM condition scores (Figure 21).

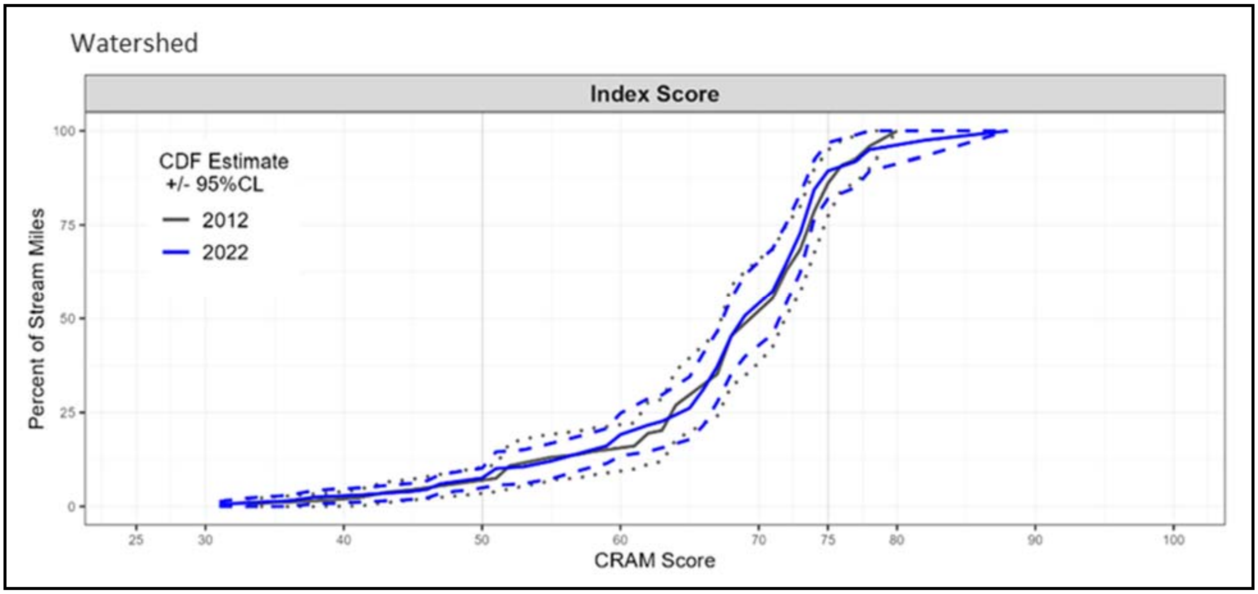

Figure 22. CDF estimates comparing CRAM Index Scores for the 2012 and 2022 Guadalupe River Watershed ambient stream condition surveys at the watershed scale.

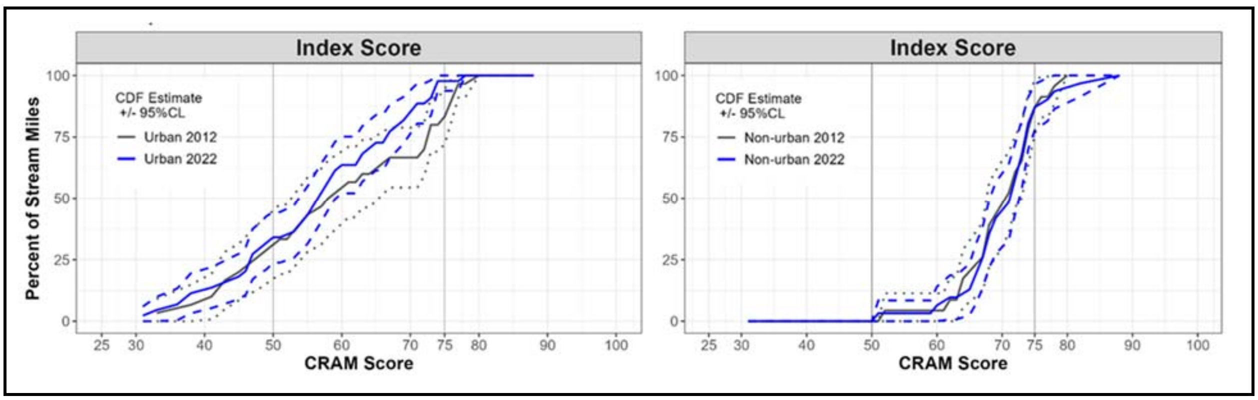

Figure 23. CDF estimates comparing CRAM Index Scores for the 2012 and 2022 Guadalupe River watershed ambient stream condition surveys at the Urban and the Non-urban PAI scales.

Figure 21. Examples of different stream reaches within Guadalupe River watershed show a range of ecological conditions (from Poor to Good) based on CRAM. Upper left: GR-0128 (2022 Index Score = 31) Upper right: GR-0112 (2022 Index Score = 55) Lower left: GR-0052 (2022 Index Score = 71) Lower right: GR-0701 (2022 Index Score = 88).

4.2.4 STRESSORS IMPACTING STREAM CONDITIONS

For the purposes of summarizing the 2022 survey results for this report, stressors that were thought to directly affect the Metric Scores in at least 25% of the AAs in either the Urban or Non-urban PAIs are listed in Table 9. Many of the same stressors (but not all) were also thought to have a negative impact on at least 25% of the AAs in the 2012 baseline survey. A direct comparison between survey periods was not completed since the data are subjective observations and could not be appropriately standardized between periods. Some stressors were not observed in the Non-urban PAI – those stressors are listed in the table as 0%.

Table 9. List of CRAM stressors that indicate potential negative impacts in at least 25% of the 2022 field assessments in one or both of the Urban (n=44) and Non-urban (n=31) PAIs within the Guadalupe River Watershed. For each PAI the table includes two measures: (1) the percent of AAs where the stressor was observed (% Observed), and (2) the percent of AAs where the stressor was thought to negatively impact the AAs (% Neg. Impact).

Attribute	*Potential Negative Impact in ≥ 25% of AAs in one or both PAIs*	*Urban*		*Non-urban*	
		% Observed	*% Neg. Impact*	*% Observed*	*% Neg. Impact*
Buffer and Landscape Context	Urban residential	91	80	45	3
	Transportation corridor	77	48	29	13
	Industrial/commercial	73	45	6	0
Hydrology	Non-point Source (Nonpoint Source) discharges (urban runoff, farm drainage)	93	64	10	0
	Engineered channel (riprap, armored channel bank, bed)	59	36	6	0
Physical Structure	Grading/compaction	73	50	29	6
	Vegetation management	70	30	13	0
	Bacteria and pathogens impaired (Point or Nonpoint Source)	39	30	0	0
	Pesticides or trace organics impaired (Point or Nonpoint Source)	68	27	0	0
	Heavy metal impaired (Point or Nonpoint Source)	55	25	0	0
Biotic Structure	Mowing, grazing, excessive herbivory (within AA)	55	27	3	0

The most commonly observed stressors that were also thought to have a significant negative impact on stream conditions within the Guadalupe River watershed include:

- Urban residential, commercial, and industrial land uses that often reduce the amount of buffer present, provide urban runoff, and often dictate the management that occurs within the channel (e.g. vegetation management) so as to reduce flood risks to the adjacent development.
- Transportation corridors that can reduce the stream corridor connectivity, reduce the amount of buffer present, can contribute to hydromodification, and can sometimes reduce the amount of vegetation present adjacent to the road/railway.
- Nonpoint source runoff that was likely contributing to reduced water quality, and increased stream power, which can cause incision and reduced hydrologic connectivity.

- Excessive mowing, grazing, or herbivory within the AAs that often reduce the number of plant layers present, the number of co-dominant species present, the complexity of the horizontal interspersion, and reduce the vertical biotic structure of the AA.

Stressors such as transportation corridors, urban residential land use, and nonpoint source discharges are common and ubiquitous in urban areas, and are difficult to remediate or eliminate. Nonetheless, many stressor impacts respond to management efforts, and can be mitigated through the presence of riparian buffers, and changes in-stream and riparian management.

Other stressors were less commonly observed, and were sometimes identified as having a significant negative impact upon stream conditions within the surveyed AAs. Those stressors included: excessive human visitation, lack of treatment of invasive plants, mowing/grazing, dike/levees, engineered channel, bacteria/pathogens impaired, heavy metal impaired, nutrient impaired, pesticides impaired, trash or refuse, and vegetation management. Appendix A Table A.2 includes the full list of stressors observed in the watershed including (1) the percent of AAs where the stressor was observed (% Observed), and (2) the percent of AAs where the stressor was thought to negatively impact the AAs (% Neg. Impact).

5. Benefits of Project D5

The renewed Project D5 continues to build and update watershed data to track stream ecosystem conditions, helping Valley Water and other county agencies and organizations make informed watershed, asset management and natural resource decisions. The new and updated environmental information will be used to develop or modernize integrated watershed plans (such as watershed profiles, One Water Plan, and Stream Corridor Priority Plans) that identify potential restoration/enhancement opportunities, mitigation opportunities for projects, support grant applications, environmental analyses and permits, and are shared with land use agencies, environmental groups, and the public to make efficient and coordinated resource management decisions throughout the county. These data and plans help integrate and enhance Valley Water’s programs, projects, maintenance and stewardship actions by using standardized, repeatable and defensible measurements that guide, organize and integrate information on stream and habitat conditions. Measuring changes in ecological conditions through time allows Valley Water, resource agencies, land managers and the public to understand and respond to climate change effects, and evolving creek and habitat conditions.

The Valley Water Project D5’s 3-level monitoring and assessment framework, data collection and analysis efforts are linked to the needs of water resource decision-makers through management questions (or core ecological concerns) that the data are designed to address. Management questions can be general and overarching, or very specific. They can evolve over time based on monitoring findings and management needs. The purpose is to link watershed monitoring and assessment to trackable management questions that support an adaptive management strategy to protect aquatic resources and their beneficial uses.

The Project D5 monitoring and assessment framework can support the following uses:

Regulatory Support - The watershed and subwatershed (primary areas of interest) approach and monitoring methods that Project D5 employs to develop watershed profiles that characterize and track the abundance, diversity, and condition of aquatic resources in its five major watersheds within Santa Clara County are consistent with a number of federal and state monitoring recommendations and regulations for resource management and compensatory mitigation planning and tracking. The Project D5's monitoring results can be used as the technical basis for mitigation proposals under the Dredge and Fill Procedures, and wetland abundance and condition assessments (employing CRAM) can serve as mitigation performance tracking measures in required mitigation monitoring plans, putting project performance tracking into a watershed context based on the Project D5 ambient surveys.

- USEPA: Project D5's 3-Level framework for monitoring and assessing its aquatic resources follows the USEPA's recommended methods for regional and statewide wetlands monitoring and assessment programs as described in Section 1.1 above.
- California State Water Resources Control Board: The Project D5's aquatic abundance summaries and stream condition assessments (CDF estimates employing CRAM) are aspects of watershed profiles that provide context for a watershed approach to compensatory mitigation as described in the California State Water Resources Control Board's State Policy for Water Quality Control: State Wetland Definition and Procedures for Discharges of Dredged or Fill Material to Waters of the State (SWRCB, 2021). Guidance for developing a watershed approach to compensatory mitigation is described in Appendix A, subpart J of this document. It describes using watershed profiles to support the goal of maintaining and improving the abundance, diversity, and condition of aquatic resources within watersheds through strategic selection of compensatory mitigation sites. This is a goal that is consistent with the Project D5 goals. It also describes how the Water Boards will implement the U.S. EPA's 404(b)(1) Guidelines under the Dredge and Fill Procedures.
- US Army Corp of Engineers: The USACE South Pacific Division issued guidance in 2015 allowing the application of CRAM for impact and mitigation credit assessments for both the San Francisco and Sacramento Districts, covering Santa Clara County.

Enhancement Planning - The Priority D5 Project collects and analyzes ecological data, providing an empirical scientific basis to support the development of the One Water Plan's stream stewardship goals, and to monitor progress towards those goals at watershed and subwatershed scales. Project D5's monitoring data and reports are being used to develop or modernize integrated watershed plans that identify potential projects, support grant applications, environmental analyses and permits, and are shared with land use agencies, environmental groups, and the public to make efficient and coordinated environmental decisions. This information will support and integrate Valley Water's programs, projects, maintenance and stewardship actions through standardized, repeatable and defensible measurements that guide, organize and integrate information on stream and habitat conditions.

For the Guadalupe River watershed, Project D5 data provided much of the technical basis for the ecological elements of Valley Water's One Water Plan. This included reach characterizations for an ecological enhancement workshop (see Appendix F); characterization of current watershed conditions; identification of reaches for preservation or enhancement by land ownership; and quantification of metrics and objectives for tracking the outcomes of the One Water Plan. For details on the countywide framework and individual watershed plan components within the One Water Plan, visit the website at: https://www.valleywater.org/project-updates/one-water-plan.

Project D5 results for Coyote Creek provided much of the technical landscape context for identifying management actions and opportunity areas in the Coyote Creek Native Ecosystem Enhancement Tool (CCNEET) (https://neet.ecoatlas.org) (SFEI, 2020). CCNEET is a detailed planning tool stemming from the One Water Plan, and that satisfies Valley Water requirements for a Stream Corridor Priority Plan, that aims to facilitate restoration and enhancement on Coyote Creek using a watershed approach.

Development of a new Upper Pajaro River Native Ecosystem Enhancement Tool (UPNEET) that will also utilize Project D5 data is beginning in 2024.

Change Detection- By reassessing the ecological conditions of streams over decades, Valley Water is assembling a standardized environmental dataset that supports both a short and long-term vision for coordinated resource planning and management at a watershed or subwatershed scale. These stream condition assessments could be augmented with additional aquatic resource and riparian vegetation mapping and monitoring to help plan, assess, and report the efforts by Valley Water to improve watershed stewardship in the context of climate change and population growth.

6. Recommendations

This final section highlights key programmatic messages, makes recommendations specific to the findings within the Guadalupe River watershed, describes the lessons learned from conducting this and the six previous Project D5 watershed scale assessments, and makes recommendations for future Project D5 data collection, analysis, and applications.

Key messages:

- Project D5 surveys provide an understanding of stream conditions across the watershed. This is important for Valley Water because it only owns a small portion of streams in the watershed, and most of their stream management work occurs only in reaches that they own or have easement access to. These ambient watershed-wide assessments, that include stream reaches owned by Valley Water, other agencies and organizations, and private landowners, provide important context for site- or project-specific management decisions and the data necessary for partners across the watershed to work collaboratively.
- The stream reaches in the Guadalupe River watershed are currently primarily in Fair condition. The lack of significant change in condition between the 2012 and 2022 surveys illustrates that current management is maintaining that condition, but also that there is room for future improvement in condition. Improvement at the watershed scale will require restoration and enhancement projects to occur over extended lengths of the channel network. A lesser scale of effort will not “move the needle”, or affect meaningful improvement, at the watershed scale.
- The 2022 results provide information on which stream reaches could be targeted for restoration or enhancement to improve ecological conditions, as well as site specific details on the aspects of stream form and function that could be improved. Because Valley Water owns the majority of the highly altered channels in the Urban area, conducting enhancement projects on these channels is the best way for Valley Water to improve watershed ecological conditions.
- The results also provide data to support planning and management that increases stream and habitat resiliency for future climate conditions: increased periods of drought, warmer air temperatures, more intense precipitation events, flashier flows, increased wildfire risk, and sea level rise, among others. The metric-level data can be used to identify patterns of change, such as channel incision or aggradation due to more intense storms, or gain/loss of plant layers or co-dominant species due to drought or temperature. The spatial scale of data will also allow change detection across elevation, precipitation, and development gradients within the County.

Guadalupe River Watershed recommendations:

- The overall result that most stream reaches are in Fair condition highlight opportunities that Valley Water and other partners can implement to improve stream condition, given the challenges of this highly urbanized watershed. For example, some of the most effective enhancements could include:
    - In non-developed lands adjacent to streams, improve the ecological condition of the buffer, by removing invasive plant species and replacing with natives, and reduce the amount (or impact) of human visitation and use of the buffer area.
    - Maintain and protect wide channel corridors wherever they exist. These corridors provide buffer, riparian habitat, promote channel stability, and provide space for floodplain development and lateral movement of flood waters.
    - When channel reconfiguration and restoration is planned, prioritize the inclusion of a low-elevation floodplain bench surface in the design. These surfaces promote channel stability, provide space for lateral inundation by high flows, provide topographic complexity, and can provide the cross-sectional space necessary for habitat complexity to develop.
    - Where appropriate, add complexity elements into the channel or on the floodplain during other project or maintenance-related actions. For example, boulders, large woody debris, floodplain pannes, snags, and swales are patch types that create localized complexity and provide unique habitat elements.
    - Focus on improving the vegetation community in reaches owned by Valley Water, especially the smaller tributaries and simple mainstem reaches. Remove invasive plants, and plant natives with the goal of increasing plant layers, diversity, and community complexity. Heterogeneous vegetation communities can increase habitat resilience during future drought periods.
    - And finally, provide additional buffer (in length and/or a width) for streams in the urban reaches when the opportunity arises. This will likely require working with partner agencies on their properties, or purchasing property along the streams.

- The geomorphic zones (Appendix F) that have been developed for the watershed should be utilized for developing future restoration opportunities in tandem with the CRAM results. These zones are based upon a suite of geomorphic characteristics creating watershed sub-units that are distinct in their morphology, functioning and condition. These zones can be valuable tools for evaluating potential for ecological enhancement and identifying effective and feasible actions for doing so. Similar geomorphic zones proved very useful in the development of ecological enhancement opportunity areas in CCNEET.

Upcoming Project D5 watershed survey recommendations:

- Future Project D5 watershed surveys (e.g. Upper Pajaro River watershed in 2025) should evaluate the sample draw locations in advance of the survey. Revisiting the same assessment sites provides the most direct analysis of change in the watershed. This Guadalupe River assessment highlighted the need for adding new assessment sites in areas of the watershed that were not previously well sampled. Adding new sites improves our confidence in condition estimates, but it also can confound our ability to track change. For example, previous surveys have made the assumption that areas that were unable to be assessed have the same distribution of condition as areas that were successfully assessed. The addition of new sites in this watershed illustrates that this assumption is not necessarily always accurate. Project D5 should use this second round of assessments as an opportunity to improve the distribution of sample locations within the watershed, understanding that change detection might be slightly confounded for this round, but ultimately will be improved in the longer term.

- Future surveys should continue to use consultant teams with trained and refreshed practitioners, to condense the fieldwork season as much as possible, given access permissions. Team intercalibration events at the beginning, middle, and end of the season are essential for correcting erroneous interpretations and practices, and ensuring the highest quality data possible.

Programmatic recommendations:

- Project D5 should continue to employ the USEPA's 3-level monitoring and assessment framework for future watershed-scale assessment of stream resources. This framework and Project D5 data collection supports regional resource management and restoration planning within Santa Clara County, and helps Valley Water track the performance of projects, maintenance activities, and on-the-ground stewardship actions, including protecting and restoring healthy riparian areas, floodplains, managing invasive plants, improving fish passage and spawning habitat, and stabilizing stream channels.
- Project D5 should continue to collect and analyze the Level 1 and Level 2 data described above in future surveys because it provides the foundation for a long-term dataset to track change in stream ecosystem conditions.
- Current and future Valley Water projects should utilize CRAM for tracking project condition. Project D5's watershed-based ambient stream condition assessments are not designed to track changes in condition at specific restoration or mitigation project locations. But instead, these ambient survey results are intended to provide the watershed-scale context and overall ecological condition comparison for project evaluation and tracking. Therefore, individual projects should utilize CRAM to quantify improvements in conditions from a specific implementation project, and compare those improvements with the watershed-scale ambient condition. Restoration and enhancement projects will be the driver for improvement in stream condition; watershed-scale improvement will require large scale projects to be implemented. Project-based use of CRAM in the time periods between ambient surveys is especially important, as it will show progress towards watershed goals.
- Increased use of the EcoAtlas toolset will support Valley Water staff in tracking projects and their condition, and will support future project planning and coordination with outside agencies and partners.
- Valley Water should continue to use Project D5 data to support a 50-year planning horizon for each watershed.

Potential future management questions:

The Project D5 surveys were designed, and have been implemented to answer a specific set of current management questions for each watershed. However, as management concerns and questions change in the future, these watershed scale surveys will likely be able to address some of those questions. For example, Project D5 data could be used in the future to explore the following type of questions.

- Using the Level 1 data, what type of wetland habitats are rare, where are they located, and how might projects create or recreate these wetlands within the watershed?
- Are Valley Water projects contributing to the protection of area and condition of streams and wetlands in the watershed?
- What is the condition of the stream riparian zone, and is it providing the services and functions that are needed to support wildlife in the watershed? Can riparian zone restoration or enhancement projects also improve stream condition and achieve other benefits for communities and the environment?
- Is climate change (drought, wildfire, temperatures) having an observable effect upon overall ecological condition of streams in Santa Clara County?

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Appendix A: 2022 CRAM Results and Assessment Area Maps

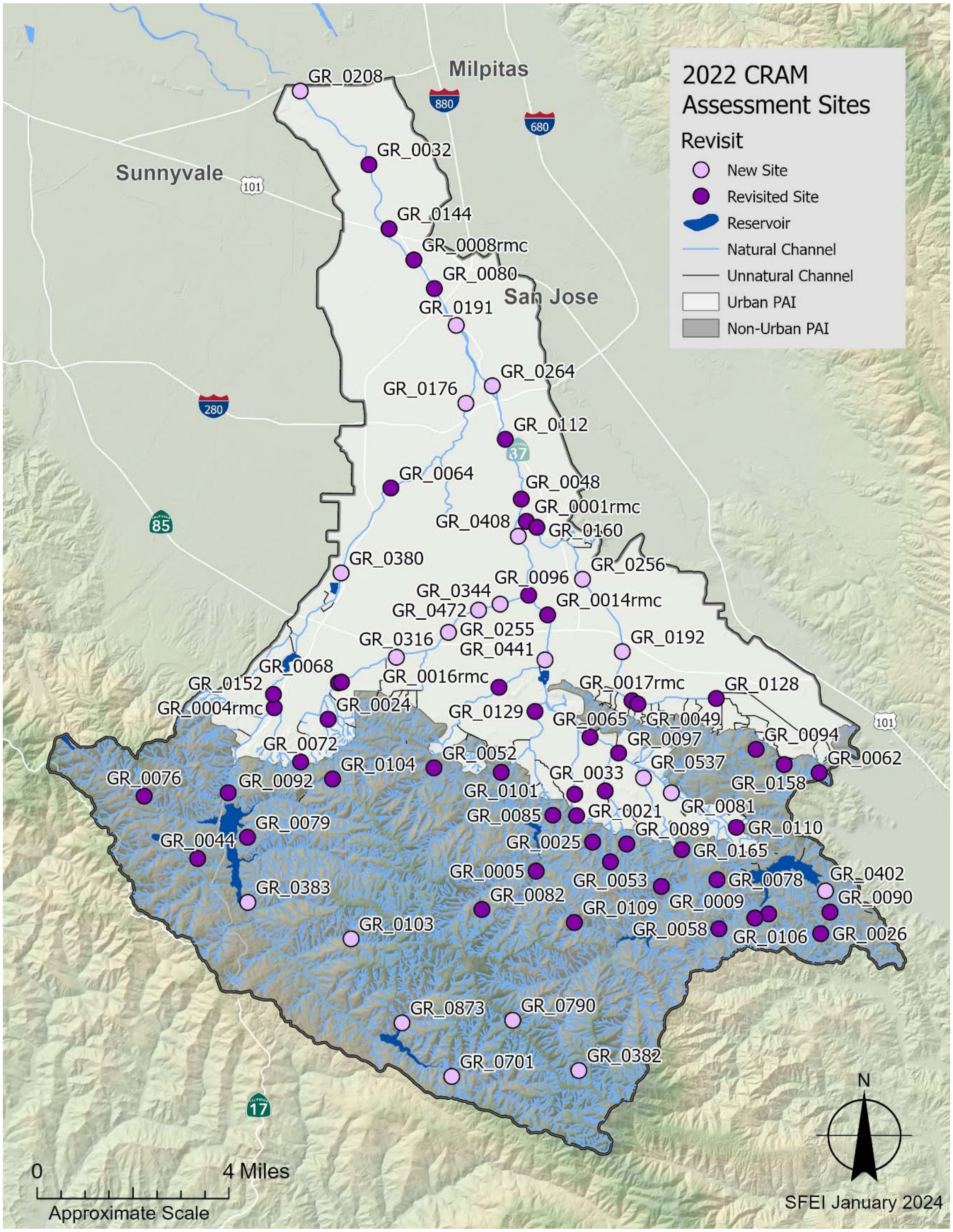

Figure A.1. Map of the 2022 Guadalupe River watershed CRAM Survey AAs with SiteIDs (n= 75; 44 Urban; 31 Non-urban)

Table A.1. 2022 Guadalupe River watershed CRAM reassessment survey condition scores. The table includes assessment area (AA) site IDs, AA Name, eCRAM's unique AARowIDs, visit date, basic wetland site information, and CRAM Index and Attribute Scores. See Methods section for more information about the scores.

Site ID	*AA Name*	*eCRAM AARowID*	*Visit Date*	*Urban or Non-urban*	*Riverine Sub-class*	*Longitude (centroid)*	*Latitude (centroid)*	*Index Score*	*Buffer and Landscape Context Score*	*Hydrology Score*	*Physical Structure Score*	*Biotic Structure Score*
GR_0001 rmc	GR_0001 Canoas Cr 250 m DS Nightingale Dr	8766	7/14/2022	Urban	confined	-121.8785	37.2880	38	53.95	41.67	25.00	30.56
GR_0004 rmc	GR_0004 Los Gatos Creek 500 m DS Saratoga Creek - Los Gatos Rd	8801	8/1/2022	Urban	non-confined	-121.9736	37.2302	69	38.25	83.33	75.00	80.56
GR_0005	Guadalupe Creek D/S Hicks Rd	8807	8/3/2022	Non-urban	non-confined	-121.8734	37.1817	74	78.49	66.67	75.00	75.00
GR_0008 rmc	GR_0008 Guadalupe River at Airport between Airport/Skyport	8813	8/23/2022	Urban	non-confined	-121.9241	37.3669	78	73.27	83.33	87.50	69.44
GR_0009	Unnamed Tributary to Alamedos Cr. (Almaden Quicksilver County Park)	8816	8/24/2022	Non-urban	non-confined	-121.8268	37.1793	66	87.50	75.00	50.00	52.78
GR_0014 rmc	GR_0014 Guadalupe River 300m US of Branham Ln	8793	8/19/2022	Urban	non-confined	-121.8696	37.2594	73	75.00	83.33	87.50	47.22
GR_0016 rmc	GR_0016 Guadalupe Creek Upstream of Meridian	9010	7/11/2022	Urban	non-confined	-121.8889	37.2371	74	79.73	66.67	75.00	75.00
GR_0017 rmc	GR_0017 Canoas Creek, 300 m DS of Tillamook Dr	8877	7/20/2022	Urban	confined	-121.8370	37.2338	45	67.68	41.67	25.00	47.22
GR_0021	Greystone Creek west of Glenview Dr	8885	8/12/2022	Non-urban	non-confined	-121.8582	37.1987	60	52.80	75.00	50.00	61.11

Site ID	*AA Name*	*eCRAM AARowID*	*Visit Date*	*Urban or Non-urban*	*Riverine Sub-class*	*Longitude (centroid)*	*Latitude (centroid)*	*Index Score*	*Buffer and Landscape Context Score*	*Hydrology Score*	*Physical Structure Score*	*Biotic Structure Score*
GR_0024	East Ross Creek at Hillbrook School	8873	7/18/2022	Urban	non-confined	-121.9526	37.2279	53	25.00	83.33	50.00	55.56
GR_0025	West Branch of Randol Creek in Almaden Quicksilver Park	8900	8/31/2022	Non-urban	confined	-121.8518	37.1914	66	93.30	75.00	62.50	33.33
GR_0026	Calero Creek in Calero County Park US of Reservoir	8810	8/4/2022	Non-urban	non-confined	-121.7658	37.1647	73	93.30	66.67	75.00	58.33
GR_0030	Unnamed Creek in Calero County Park adj to Javalina Loop	8784	8/17/2022	Non-urban	non-confined	-121.7855	37.1703	73	93.30	100.00	37.50	61.11
GR_0032	Guadalupe River Upstream of Montague	8820	8/22/2022	Urban	non-confined	-121.9403	37.3949	71	66.45	83.33	62.50	72.22
GR_0033	Randol Cr. @ Serenity Way	8811	8/5/2022	Urban	confined	-121.8480	37.2073	55	55.18	66.67	50.00	50.00
GR_0044	Briggs Creek	8764	7/13/2022	Non-urban	non-confined	-122.0019	37.1845	77	90.30	75.00	75.00	66.67
GR_0048	Guadalupe River DS of Curtner Ave	8883	8/10/2022	Urban	confined	-121.8807	37.2942	67	62.50	58.33	87.50	58.33
GR_0049	Canoas Creek DS of Tillamook Dr	8876	7/20/2022	Urban	confined	-121.8360	37.2334	47	67.68	50.00	25.00	47.22
GR_0052	Pheasant Creek	8808	8/3/2022	Urban	non-confined	-121.9125	37.2125	71	82.90	66.67	75.00	58.33
GR_0053	Tributary to Randol Creek in Almaden Quicksilver Park	8902	8/31/2022	Non-urban	confined	-121.8454	37.1837	67	100.00	83.33	50.00	33.33
GR_0058	Cherry Canyon	8871	8/26/2022	Non-urban	confined	-121.8024	37.1666	69	93.30	83.33	62.50	36.11

Site ID	AA Name	eCRAM AARowID	Visit Date	Urban or Non-urban	Riverine Sub-class	Longitude (centroid)	Latitude (centroid)	Index Score	Buffer and Landscape Context Score	Hydrology Score	Physical Structure Score	Biotic Structure Score
GR_0062	Unnamed Creek above Coyote-Alamitos Canal	8850	8/25/2022	Non-urban	non-confined	-121.7666	37.2134	51	47.86	75.00	25.00	55.56
GR_0064	Los Gatos Creek D/S Bascom	8802	8/2/2022	Urban	confined	-121.9306	37.2975	68	62.50	66.67	62.50	80.56
GR_0065	Alamitos Creek DS of Greystone Rd	8783	8/16/2022	Urban	non-confined	-121.8531	37.2228	74	77.67	75.00	75.00	69.44
GR_0068	Ross Creek US of Linda Ave	8874	7/19/2022	Urban	non-confined	-121.9495	37.2380	57	62.50	50.00	50.00	63.89
GR_0072	Ross Creek off of Quarry Rd	8889	8/30/2022	Urban	non-confined	-121.9630	37.2142	45	52.80	58.33	37.50	33.33
GR_0076	Lyndon Canyon Creek	8846	8/24/2022	Non-urban	non-confined	-122.0214	37.2022	78	100.00	66.67	87.50	58.33
GR_0078	Tributary to Chilean Gulch	8812	8/22/2022	Non-urban	non-confined	-121.8050	37.1808	68	93.30	100.00	25.00	55.56
GR_0079	Unnamed trib to Los Gatos Crk (Lexington)	8763	7/13/2022	Non-urban	confined	-121.9822	37.1911	72	100.00	91.67	50.00	47.22
GR_0080	Guadalupe River Adj. to Airport Blvd	8814	8/23/2022	Urban	non-confined	-121.9148	37.3576	74	75.00	83.33	75.00	63.89
GR_0081	Calero Creek Upstream of Harry Road and Camden Avenue Intersection	8872	8/23/2022	Non-urban	non-confined	-121.8220	37.2065	75	79.73	66.67	75.00	77.78
GR_0082	Unnamed Tributary to Rincon Creek	8888	8/30/2022	Non-urban	confined	-121.8933	37.1698	71	100.00	100.00	50.00	33.33
GR_0085	Golf Creek in Almaden-Quicksilver Park	8887	8/29/2022	Non-urban	confined	-121.8668	37.1987	72	93.30	83.33	62.50	47.22
GR_0089	GR_0089 Tributary to Randol Creek in Almaden Quarry Park	8929	8/10/2022	Non-urban	confined	-121.8395	37.1909	72	93.30	83.33	50.00	61.11

Site ID	***AA Name***	***eCRAM AARowID***	***Visit Date***	***Urban or Non-urban***	***Riverine Sub-class***	***Longitude (centroid)***	***Latitude (centroid)***	***Index Score***	***Buffer and Landscape Context Score***	***Hydrology Score***	***Physical Structure Score***	***Biotic Structure Score***
GR_0090	Tributary to Calero Creek	8809	8/4/2022	Non-urban	non-confined	-121.7621	37.1709	62	85.36	100.00	25.00	36.11
GR_0092	Los Gatos Creek at Lexington Reservoir	8843	9/27/2022	Non-urban	non-confined	-121.9903	37.2045	69	52.80	83.33	62.50	77.78
GR_0094	GR_0094 Unnamed Tributary to Coyote-Alamitos Canal	8930	9/13/2022	Non-urban	confined	-121.7923	37.2195	67	93.30	66.67	50.00	58.33
GR_0096	GR_0096 Ross Creek at Briarglen	9011	7/12/2022	Urban	confined	-121.8789	37.2653	47	52.37	66.67	37.50	33.33
GR_0097	Alamitos Creek across from Leland HS	8780	8/16/2022	Urban	non-confined	-121.8425	37.2179	63	73.27	58.33	50.00	69.44
GR_0101	McAbee Creek	8792	8/19/2022	Non-urban	non-confined	-121.8870	37.2120	68	93.30	66.67	37.50	75.00
GR_0103	Hooker Gulch Tributary to Los Gatos Creek	8903	9/1/2022	Non-urban	confined	-121.9438	37.1610	82	100.00	83.33	62.50	80.56
GR_0104	Unnamed Trib of Limekiln Gulch along Blackberry Rd	8909	7/29/2022	Non-urban	confined	-121.9508	37.2091	68	93.30	75.00	50.00	55.56
GR_0106	Tributary to Cherry Canyon Creek	8787	8/17/2022	Non-urban	confined	-121.7905	37.1684	74	93.30	83.33	62.50	55.56
GR_0109	GR_0109 Jacques Gulch	9012	7/12/2022	Non-urban	non-confined	-121.8585	37.1667	65	96.53	75.00	50.00	38.89
GR_0110	SE Santa Teresa Creek US of San Vicente Ave	8789	8/18/2022	Urban	non-confined	-121.7973	37.1964	57	75.00	83.33	25.00	44.44
GR_0112	Guadalupe River adj to Lelong St and US of Willow St	8777	8/15/2022	Urban	confined	-121.8871	37.3122	55	35.77	58.33	62.50	63.89
GR_0128	Canoas D/S Cottle	8767	7/15/2022	Urban	confined	-121.8055	37.2352	31	25.00	41.67	25.00	33.33
GR_0129	Golf Cr. D/S Redmond	8803	8/4/2022	Urban	confined	-121.8747	37.2300	49	62.50	66.67	37.50	30.56

Site ID	AA Name	eCRAM AARowID	Visit Date	Urban or Non-urban	Riverine Sub-class	Longitude (centroid)	Latitude (centroid)	Index Score	Buffer and Landscape Context Score	Hydrology Score	Physical Structure Score	Biotic Structure Score
GR_0132	Ross Creek DS of Linda Ave	8875	7/19/2022	Urban	confined	-121.9485	37.2384	65	62.50	66.67	62.50	66.67
GR_0144	GR_0144 Guadalupe River downstream of 101	8931	8/11/2022	Urban	non-confined	-121.9333	37.3765	65	37.50	83.33	87.50	52.78
GR_0149	Greystone Creek US of Hampton Dr	8886	8/12/2022	Urban	non-confined	-121.8591	37.2052	47	25.00	83.33	37.50	41.67
GR_0152	GR_0152 Los Gatos Creek at Blossom Hill Rd	8932	9/13/2022	Urban	non-confined	-121.9737	37.2337	57	33.52	66.67	62.50	66.67
GR_0158	Trib to Canoas Cr above ST Golf Course	8819	8/26/2022	Urban	non-confined	-121.7800	37.2154	57	55.80	66.67	37.50	69.44
GR_0160	Canoas Cr U/S Nightingale	8768	7/15/2022	Urban	confined	-121.8745	37.2859	41	64.87	41.67	25.00	30.56
GR_0165	Alamitos Creek adj. to Almaden Rd.	8815	8/24/2022	Urban	non-confined	-121.8188	37.1896	71	82.90	66.67	50.00	83.33
GR_0176	Los Gatos Creek US of W. San Carlos Street Train Tracks	8923	9/2/2022	Urban	confined	-121.9025	37.3226	55	35.77	66.67	50.00	66.67
GR_0191	Guadalupe River Downstream of Taylor	8818	8/25/2022	Urban	non-confined	-121.9059	37.3470	63	75.00	66.67	50.00	58.33
GR_0192	Canoas Creek US of Blossom Hill	8881	7/22/2022	Urban	confined	-121.8419	37.2494	37	50.00	41.67	25.00	30.56
GR_0208	GR_0208 Guadalupe River Upstream of 237	9013	8/22/2022	Urban	non-confined	-121.9665	37.4165	67	62.50	83.33	62.50	58.33
GR_0255	Ross Creek DS of Ross Avenue	8880	7/21/2022	Urban	confined	-121.9084	37.2538	33	25.00	33.33	37.50	36.11
GR_0256	Canoas Creek DS of Albion Drive	8882	7/22/2022	Urban	confined	-121.8577	37.2711	36	52.37	33.33	25.00	33.33

Site ID	AA Name	eCRAM AARowID	Visit Date	Urban or Non-urban	Riverine Sub-class	Longitude (centroid)	Latitude (centroid)	Index Score	Buffer and Landscape Context Score	Hydrology Score	Physical Structure Score	Biotic Structure Score
GR_0264	Guadalupe River Upstream of San Carlos St.	8817	8/25/2022	Urban	confined	-121.8918	37.3283	60	33.52	75.00	62.50	69.44
GR_0316	Ross Creek Upstream of Sandy Lane	8805	8/2/2022	Urban	confined	-121.9280	37.2462	46	53.95	66.67	37.50	27.78
GR_0344	Ross Creek US of Cherry Avenue	8879	7/21/2022	Urban	confined	-121.8889	37.2627	48	64.87	58.33	37.50	30.56
GR_0380	Guadalupe River at Los Gatos Creek County Dog Park	8884	8/10/2022	Urban	confined	-121.9491	37.2706	59	65.99	58.33	50.00	61.11
GR_0382	Tributary to Herbert Creek off of Mt. Umunhum L Prieta Rd.	8924	9/12/2022	Non-urban	confined	-121.8557	37.1220	71	100.00	75.00	50.00	58.33
GR_0383	Lexington Reservoir Inlet	8821	7/28/2022	Non-urban	non-confined	-121.9809	37.1713	74	90.30	66.67	62.50	77.78
GR_0402	Calero Creek U/S of Calero reservoir at old horse stables	8890	8/23/2022	Non-urban	non-confined	-121.7642	37.1776	74	85.36	66.67	75.00	69.44
GR_0408	Guadalupe River 50 m DS Almaden Expy	8765	7/14/2022	Urban	non-confined	-121.8821	37.2842	58	62.50	75.00	37.50	58.33
GR_0441	Guad River Behind Campus	8791	8/18/2022	Urban	non-confined	-121.8718	37.2453	58	79.73	75.00	25.00	52.78
GR_0472	Ross Creek 225m US of Reedhurst Avenue	8878	7/21/2022	Urban	confined	-121.8972	37.2608	50	67.68	66.67	37.50	27.78
GR_0537	Section of Alamitos Creek Near Camden Avenue and Carrabelle Park	8790	8/18/2022	Urban	non-confined	-121.8331	37.2104	59	80.62	58.33	37.50	58.33

Site ID	AA Name	eCRAM AARowID	Visit Date	Urban or Non-urban	Riverine Sub-class	Longitude (centroid)	Latitude (centroid)	Index Score	Buffer and Landscape Context Score	Hydrology Score	Physical Structure Score	Biotic Structure Score
GR_0701	Los Gatos Creek Upstream of Lake Elsman	8891	8/25/2022	Non-urban	non-confined	-121.9036	37.1196	88	100.00	91.67	75.00	83.33
GR_0790	Tributary to Herbert Creek near Cathermola Road and Mt. Umunhum L Prieta Road	8925	9/12/2022	Non-urban	non-confined	-121.8814	37.1366	73	100.00	75.00	37.50	77.78
GR_0873	Austrian Gulch U/S Lake Elsman	8898	8/25/2022	Non-urban	confined	-121.9232	37.1364	75	100.00	83.33	62.50	52.78

Table A.2. List of CRAM Stressor Checklist measures observed in Urban and Non-urban AAs during the 2022 survey, including: (1) the percent of AAs where the stressor was observed (Percent Observed), and (2) the percent of AAs where the stressor was thought to negatively impact the AAs (Percent Neg. Impact).

			Urban				Non-urban			
Attribute	Measure	Neg. Impact ≥ 25%	Count All Observed	Count if Sig. Impact	Percent Observed	Percent Neg. Impact	Count All Observed	Count if Sig. Impact	Percent Observed	Percent Neg. Impact
Buffer	Active recreation (off-road vehicles, mountain biking, hunting, fishing)		18	0	41	0	21	1	68	3
Buffer	Dams (or other major flow regulation or disruption)		2	2	5	5	4	1	13	3
Buffer	Dryland farming		0	0	0	0	1	0	3	0
Buffer	Industrial/commercial	✓	32	20	73	45	2	0	6	0
Buffer	Military training/Air traffic		5	3	11	7	0	0	0	0
Buffer	Orchards/nurseries		4	0	9	0	4	0	13	0
Buffer	Passive recreation (bird-watching, hiking, etc.)		31	1	70	2	20	1	65	3

			Urban				Non-urban			
Attribute	*Measure*	*Neg. Impact ≥ 25%*	*Count All Observed*	*Count if Sig. Impact*	*Percent Observed*	*Percent Neg. Impact*	*Count All Observed*	*Count if Sig. Impact*	*Percent Observed*	*Percent Neg. Impact*
Buffer	Physical resource extraction (rock, sediment, oil/gas)		0	0	0	0	1	0	3	0
Buffer	Ranching (enclosed livestock grazing or horse paddock or feedlot)		3	1	7	2	2	0	6	0
Buffer	Rangeland (livestock rangeland also managed for native vegetation)		2	1	5	2	2	0	6	0
Buffer	Sports fields and urban parklands (golf courses, soccer fields, etc.)		33	6	75	14	1	0	3	0
Buffer	Transportation corridor	✓	34	21	77	48	9	4	29	13
Buffer	Urban residential	✓	40	35	91	80	14	1	45	3
Hydrology	Actively managed hydrology		9	3	20	7	2	1	6	3
Hydrology	Dams (reservoirs, detention basins, recharge basins)		1	0	2	0	3	1	10	3
Hydrology	Dike/levees		13	8	30	18	0	0	0	0
Hydrology	Ditches (borrow, agricultural drainage, mosquito control, etc.)		1	0	2	0	1	0	3	0
Hydrology	Dredged inlet/channel		2	0	5	0	0	0	0	0
Hydrology	Engineered channel (riprap, armored channel bank, bed)	✓	26	16	59	36	2	0	6	0
Hydrology	Flow diversions or unnatural inflows		8	2	18	5	2	1	6	3
Hydrology	Flow obstructions (culverts, paved stream crossings)		11	6	25	14	3	1	10	3
Hydrology	Groundwater extraction		1	1	2	2	0	0	0	0

			Urban				Non-urban			
Attribute	***Measure***	***Neg. Impact ≥ 25%***	***Count All Observed***	***Count if Sig. Impact***	***Percent Observed***	***Percent Neg. Impact***	***Count All Observed***	***Count if Sig. Impact***	***Percent Observed***	***Percent Neg. Impact***
Hydrology	Non-point Source (Non-PS) discharges (urban runoff, farm drainage)	✓	41	28	93	64	3	0	10	0
Hydrology	Point Source (PS) discharges (POTW, other non-stormwater discharge)		1	0	2	0	0	0	0	0
Hydrology	Weir/drop structure, tide gates		5	3	11	7	0	0	0	0
Physical	Bacteria and pathogens impaired (PS or Non-PS pollution)	✓	17	13	39	30	0	0	0	0
Physical	Excessive runoff from watershed		11	6	25	14	0	0	0	0
Physical	Excessive sediment or organic debris from watershed		1	1	2	2	0	0	0	0
Physical	Filling or dumping of sediment or soils		2	2	5	5	1	1	3	3
Physical	Grading/ compaction	✓	32	22	73	50	9	2	29	6
Physical	Heavy metal impaired (PS or Non-PS pollution)	✓	24	11	55	25	0	0	0	0
Physical	Nutrient impaired (PS or Non-PS pollution)		19	9	43	20	1	0	3	0
Physical	Pesticides or trace organics impaired (PS or Non-PS pollution)	✓	30	12	68	27	0	0	0	0
Physical	Plowing/Discing		2	1	5	2	1	0	3	0
Physical	Resource extraction (sediment, gravel, oil and/or gas)		1	0	2	0	0	0	0	0
Physical	Trash or refuse		39	10	89	23	17	0	55	0
Physical	Vegetation management	✓	31	13	70	30	4	0	13	0

			Urban				Non-urban			
Attribute	***Measure***	***Neg. Impact ≥ 25%***	***Count All Observed***	***Count if Sig. Impact***	***Percent Observed***	***Percent Neg. Impact***	***Count All Observed***	***Count if Sig. Impact***	***Percent Observed***	***Percent Neg. Impact***
Biotic	Biological resource extraction or stocking (fisheries, aquaculture)		1	1	2	2	0	0	0	0
Biotic	Excessive human visitation		19	9	43	20	3	0	10	0
Biotic	Lack of treatment of invasive plants adjacent to AA or buffer		18	8	41	18	11	5	35	16
Biotic	Lack of vegetation management to conserve natural resources		7	4	16	9	4	0	13	0
Biotic	Mowing, grazing, excessive herbivory (within AA)	✓	24	12	55	27	1	0	3	0
Biotic	Pesticide application or vector control		22	1	50	2	1	0	3	0
Biotic	Predation and habitat destruction by non-native vertebrates		36	5	82	11	1	0	3	0
Biotic	Removal of woody debris		5	0	11	0	1	0	3	0
Biotic	Treatment of non-native and nuisance plant species		12	0	27	0	0	0	0	0
Biotic	Tree cutting/sapling removal		18	2	41	5	4	0	13	0

Appendix B: 2012 CRAM Results and Assessment Area Maps

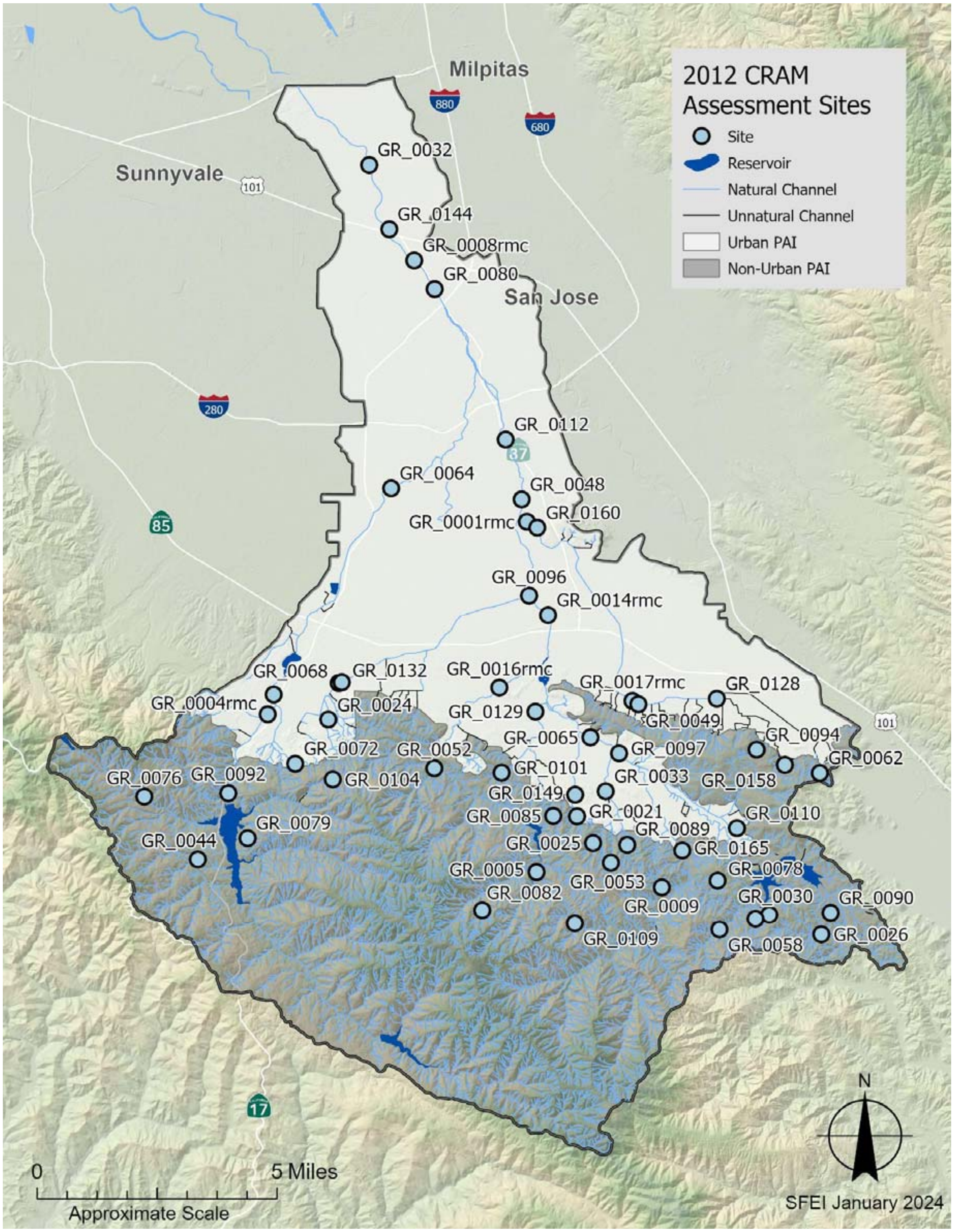

Figure B.1. Map of the 2012 Guadalupe River watershed CRAM survey AAs with SiteIDs (n= 53; 30 Urban; 23 Non-urban).

2012 CRAM Assessment Score Update

To have confidence in the standardization and comparability of the 2012 and 2022 CRAM survey results, and to update the 2012 results from the older CRAM Riverine module version 6.0 to the most recent version (6.1) employed in the 2022 reassessment survey, Sarah Pearce (Project D5's lead CRAM practitioner from SFEI, a Level-2 Committee Member, and a lead CRAM Trainer for the state), conducted a thorough review of the two CRAM datasets. Because of Sarah's expertise, and because she participated in both the 2012 baseline and the 2022 surveys, she was uniquely qualified to review the datasets for quality assurance and to update the 2012 results to Riverine module version 6.1.

Sarah conducted a thorough evaluation of all the CRAM Metric Scores for the 53 paired AAs that were assessed in both 2012 and 2022, and was aided by CRAM support documents (CWMW, 2013c). Based upon her experience reviewing the Coyote Creek baseline (2010) and reassessment (2020) CRAM survey results, she identified two types of inconsistencies that were both anticipated and observed in the Guadalupe datasets: 1) methodological and interpretive changes between CRAM Module versions 6.0 and 6.1; and 2) practitioner error in either measurement or interpretation.

First, two methodological updates were made in the Riverine Module between versions 6.0 and 6.1. A scoring change within the Topographic Complexity Metric (in the Physical Structure Attribute) occurred, updating the scoring of an AA that is characterized by a single bench with microtopographic complexity from a C to a B. As a result, updates were made to four 2012 scores, so that scores from AAs where no physical change had occurred would be standardized and comparable between survey periods. The second methodology change between CRAM module versions was the addition of large woody debris to the Structural Patch Richness Metric (also in the Physical Structure Attribute). A single 2012 AA was updated, because photographic evidence was available to evaluate the presence of woody debris in only one AA.

Other changes between versions 6.0 and 6.1 included interpretive changes. First, in the Stream Corridor Continuity Metric (in the Buffer and Landscape Context Attribute), the method of how practitioners assess continuity has been improved. The additional guidance resulted in updates to two 2012 AAs. Second, a few specific features (e.g. concrete walls, 3 ft tall chain link fences, one lane roads) within the Buffer Metric (in the Buffer and Landscape Context Attribute) have been clarified, resulting in updates to three 2012 AAs. And finally, in the Water Source Metric (in the Hydrology Attribute), the presence of some development (e.g. on the order of 1% of the watershed area) is currently interpreted as having some negative impact on the hydrology resulting in score updates to four 2012 AAs to reflect this interpretation.

The CRAM version updates were made conservatively, choosing to trust the data and decisions of the original field teams. Updates were made only for Metrics that had clear and obvious differences due to the methodological changes and were well-documented (e.g., sketches and notes, or field photographs). In total, 14 individual Metric scores from the 2012 survey were updated based on methodological and interpretation changes in CRAM versions (comprising only 1.9% of the total 2012 Metric scores).

In this report, the updated 2012 Guadalupe River CRAM Scores (version 6.1) were reanalyzed using the GRTS *spsurvey* analysis process. As a result, the 2012 condition summaries in this report do not match the CDF results and estimates of the proportion of stream miles in Good, Fair, and Poor condition previously reported (SFEI-ASC, 2013; Lowe *et al.*, 2020). For some Attributes, the percent change in updated proportions of streams by condition class is pronounced. Nonetheless, the Project Team believed it was appropriate to update the scores for this report, to ensure the results were standardized and consistent with the Riverine Module version 6.1 employed in 2022. Table B.1 compares the original 2012 survey estimates of the proportions of stream miles in each CRAM condition class (employing CRAM v.6.0) to the updated (CRAM v.6.1) estimates.

Table B.1. Comparison of the percent of stream miles in Poor, Fair, and Good ecological conditions based on the original 2012 CDF estimates (employing CRAM v.6.0) and the updated 2012 v.6.1 CDF estimates. Stream ecological condition classes correspond to the following CRAM Index and Attribute score ranges: Poor 25-50, Fair 51-75, and Good 76-100.

Dataset and CRAM Measure	*Poor*	*Fair*	*Good*
Original Index	7	64	29
Updated Index	6	80	14
Original Buffer and Landscape Attribute	6	21	73
Updated Buffer and Landscape Attribute	13	16	71
Original Hydrology Attribute	6	63	31
Updated Hydrology Attribute	4	67	29
Original Physical Structure Attribute	50	44	6
Updated Physical Structure Attribute	46	51	3
Original Biotic Structure Attribute	19	60	21
Updated Biotic Structure Attribute	26	60	14

References

California Wetland Monitoring Workgroup’s (CWMW). 2013c. California Rapid Assessment Method Summary of Changes to the CRAM Riverine Field Book version 6.0 to version 6.1. January 2013. https://www.cramwetlands.org/documents

Table B.1. 2012 Guadalupe River CRAM stream condition survey results updated to CRAM Field Book v.6.1. The table includes assessment area (AA) site IDs, AA Name, eCRAM's unique AARowIDs, visit date, basic wetland site information, and CRAM Index and Attribute Scores. Four of the 53 AAs are not listed here because the landowners did not want the specific field assessment results published. See Methods section for more information about the updated scores. The Site ID acronym "rmc" stands for regional monitoring coalition; see https://scvurppp.org/monitoring/ for more information.

Site ID	*AA Name*	*eCRAM AARowID*	*Visit Date*	*Urban or Non-urban*	*Riverine Sub-class*	*Longitude (centroid)*	*Latitude (centroid)*	*Index Score*	*Buffer and Landscape Context Score*	*Hydrology Score*	*Physical Structure Score*	*Biotic Structure Score*
GR_0001 rmc	Canoas Creek, 250m DS of Nightengale Dr	2486	7/18/2012	Urban	confined	-121.8786	37.2879	38	53.95	41.67	25.00	33.33
GR_0004 rmc	Los Gatos Cr, 500m DS of Saratoga-Los Gatos Rd	2482	7/25/2012	Urban	non-confined	-121.9736	37.2302	67	43.12	75.00	75.00	75.00
GR_0005	Guadalupe Creek, US of Guad Reservoir	2165	7/3/2012	Non-urban	non-confined	-121.8735	37.1817	72	78.49	66.67	62.50	80.56
GR_0008 rmc	Guadalupe River at airport, between Brokaw/Skyport	2484	7/24/2012	Urban	non-confined	-121.9241	37.3669	80	73.27	83.33	87.50	77.78
GR_0009	Unnamed Creek in Almaden Quicksilver County Park	2170	7/3/2012	Non-urban	confined	-121.8268	37.1793	74	87.50	75.00	62.50	69.44
GR_0014 rmc	Guadalupe River 300m US of Branham Ln	2485	7/18/2012	Urban	non-confined	-121.8693	37.2593	76	82.90	75.00	75.00	69.44
GR_0016 rmc	Guadalupe Creek, US Meridian near Perc pond	2460	7/16/2012	Urban	non-confined	-121.8888	37.2372	73	79.73	66.67	75.00	72.22
GR_0017 rmc	Canoas Creek, 300 m DS of Tillamook Dr	2483	7/19/2012	Urban	confined	-121.8370	37.2338	45	67.68	41.67	25.00	47.22
GR_0021	Greystone Creek west of Glenview Dr	2164	7/2/2012	Non-urban	non-confined	-121.8582	37.1986	64	52.80	75.00	62.50	66.67
GR_0025	West Branch of Randol Creek in Almaden Quicksilver Park	2168	7/2/2012	Non-urban	confined	-121.8518	37.1914	74	93.30	75.00	62.50	66.67

Site ID	AA Name	eCRAM AARowID	Visit Date	Urban or Non-urban	Riverine Sub-class	Longitude (centroid)	Latitude (centroid)	Index Score	Buffer and Landscape Context Score	Hydrology Score	Physical Structure Score	Biotic Structure Score
GR_0026	Calero Creek in Calero County Park US of reservoir	2166	7/3/2012	Non-urban	non-confined	-121.7658	37.1647	76	93.30	66.67	75.00	69.44
GR_0030	Unnamed Creek in Calero County Park adj to Javalina Loop	2167	7/3/2012	Non-urban	non-confined	-121.7854	37.1703	68	93.30	75.00	37.50	66.67
GR_0032	Guadalupe River US of Montague Expy	2253	6/27/2012	Urban	non-confined	-121.9403	37.3949	75	66.45	83.33	62.50	86.11
GR_0033	Randol Creek btw Serenity Way and Calcaterra Way	2163	6/26/2012	Urban	non-confined	-121.8480	37.2073	54	55.18	66.67	37.50	55.56
GR_0044	Briggs Creek	2256	8/8/2012	Non-urban	non-confined	-122.0018	37.1844	80	90.30	75.00	75.00	80.56
GR_0049	Canoas Creek DS of Tillamook Dr	2157	6/25/2012	Urban	confined	-121.8360	37.2333	43	67.68	50.00	25.00	30.56
GR_0052	Pheasant Creek	2246	7/23/2012	Urban	non-confined	-121.9125	37.2125	76	82.90	83.33	75.00	63.89
GR_0053	Tributary to Randol Creek in Almaden Quicksilver Park	2247	7/24/2012	Non-urban	confined	-121.8454	37.1837	75	100.00	100.00	62.50	36.11
GR_0058	Cherry Canyon	2290	8/21/2012	Non-urban	confined	-121.8024	37.1666	70	93.30	75.00	62.50	47.22
GR_0062	Unnamed Creek above Coyote- Alamitos Canal	2254	8/8/2012	Non-urban	confined	-121.7666	37.2135	52	47.86	75.00	37.50	47.22
GR_0064	Los Gatos Creek DS of Bascom Ave	2171	6/26/2012	Urban	confined	-121.9306	37.2974	67	62.50	66.67	62.50	77.78
GR_0065	Alamitos Creek DS of Greystone Rd	2160	7/26/2012	Urban	non-confined	-121.8530	37.2228	77	75.00	83.33	75.00	75.00

Site ID	AA Name	eCRAM AARowID	Visit Date	Urban or Non-urban	Riverine Sub-class	Longitude (centroid)	Latitude (centroid)	Index Score	Buffer and Landscape Context Score	Hydrology Score	Physical Structure Score	Biotic Structure Score
GR_0076	Lyndon Canyon Creek	2257	8/14/2012	Non-urban	non-confined	-122.0215	37.2022	78	100.00	66.67	75.00	69.44
GR_0078	Tributary to Chilean Gulch	2249	8/7/2012	Non-urban	non-confined	-121.8050	37.1807	68	93.30	91.67	25.00	61.11
GR_0079	Unnamed Tributary of Los Gatos Creek (Lexington Reservoir)	2293	8/20/2012	Non-urban	confined	-121.9823	37.1911	74	100.00	83.33	50.00	61.11
GR_0080	Guadalupe River adjacent to Airport Blvd	2180	7/16/2012	Urban	non-confined	-121.9148	37.3575	77	78.49	83.33	75.00	69.44
GR_0082	Unnamed Tributary to Rincon Creek	2258	8/15/2012	Non-urban	confined	-121.8933	37.1698	67	100.00	83.33	50.00	33.33
GR_0085	Golf Creek in Almaden-Quicksilver Park	2259	8/13/2012	Non-urban	confined	-121.8668	37.1988	72	93.30	83.33	62.50	50.00
GR_0089	Tributary to Randol Creek in Almaden Quicksilver Park	2255	8/8/2012	Non-urban	confined	-121.8395	37.1909	75	100.00	83.33	50.00	66.67
GR_0090	Tributary to Calero Creek	2251	8/7/2012	Non-urban	non-confined	-121.7621	37.1709	62	85.36	100.00	25.00	36.11
GR_0092	Los Gatos Creek at Lexington Reservoir	2260	8/13/2012	Non-urban	non-confined	-121.9903	37.2045	68	45.40	66.67	75.00	83.33
GR_0094	Unnamed Tributary to Coyote-Alamitos Canal	2296	8/21/2012	Non-urban	confined	-121.7923	37.2194	64	80.80	75.00	37.50	61.11
GR_0096	Ross Creek at Briarglen Ct	2181	7/18/2012	Urban	confined	-121.8788	37.2652	48	50.00	66.67	37.50	38.89
GR_0097	Alamitos Creek across from Leland HS	2161	6/26/2012	Urban	non-confined	-121.8425	37.2179	63	73.27	58.33	50.00	72.22
GR_0101	McAbee Creek	2291	8/21/2012	Non-urban	non-confined	-121.8872	37.2119	67	85.36	75.00	37.50	69.44

Site ID	AA Name	eCRAM AARowID	Visit Date	Urban or Non-urban	Riverine Sub-class	Longitude (centroid)	Latitude (centroid)	Index Score	Buffer and Landscape Context Score	Hydrology Score	Physical Structure Score	Biotic Structure Score
GR_0104	Tributary of Lime Kiln Gulch	2292	8/20/2012	Non-urban	non-confined	-121.9504	37.2087	73	93.30	75.00	62.50	61.11
GR_0106	Tributary to Cherry Canyon Creek	2261	8/20/2012	Non-urban	confined	-121.7904	37.1684	71	93.30	75.00	50.00	63.89
GR_0109	Jacques Gulch	2295	8/21/2012	Non-urban	confined	-121.8586	37.1668	69	90.30	66.67	62.50	55.56
GR_0110	SE Santa Teresa Creek US of San Vicente Ave	2153	7/2/2012	Urban	non-confined	-121.7973	37.1964	61	75.00	91.67	25.00	52.78
GR_0112	Guadalupe River adj to Lelong St and US of Willow St	2152	6/25/2012	Urban	confined	-121.8871	37.3122	51	35.77	66.67	37.50	63.89
GR_0128	Canoas Creek DS of Cottle Rd	2155	7/25/2012	Urban	confined	-121.8055	37.2352	33	25.00	41.67	25.00	41.67
GR_0129	Golf Creek DS of Redmond Ave	2154	6/25/2012	Urban	confined	-121.8747	37.2300	53	62.50	66.67	37.50	44.44
GR_0132	Ross Creek DS of Linda Ave	2183	7/17/2012	Urban	confined	-121.9485	37.2384	61	62.50	66.67	50.00	63.89
GR_0144	Guadalupe River at U.S. 101	2182	7/18/2012	Urban	non-confined	-121.9333	37.3765	73	42.23	83.33	87.50	80.56
GR_0149	Greystone Creek US of Hampton Dr	2162	7/2/2012	Urban	non-confined	-121.8591	37.2051	42	25.00	66.67	37.50	38.89
GR_0152	Los Gatos Creek US of Blossom Hill Rd	2250	7/23/2012	Urban	non-confined	-121.9737	37.2337	57	30.18	66.67	62.50	66.67
GR_0158	Tributary to Canoas Creek US of Santa Teresa Golf Course	2179	7/17/2012	Urban	non-confined	-121.7800	37.2154	55	55.80	66.67	37.50	61.11
GR_0160	Canoas Creek US of Nightingale Dr	2184	7/17/2012	Urban	confined	-121.8745	37.2859	41	67.68	41.67	25.00	30.56

Appendix C: CRAM Statistical Analysis Results

CDF Percentile Estimates (Summary Statistics)

The following tables present the CDF percentile and mean CDF estimates (Statistic) for the CRAM Index and Attribute Scores (CRAM Indicator) based on the 2012 baseline and the 2022 reassessment surveys in the Guadalupe River watershed and its Urban and Non-urban primary areas of interest (PAIs), using spsurvey. The 2012 survey results were reviewed and standardized to CRAM module v.6.1 to be comparable to the 2022 reassessment survey results.

Table C.1 CRAM Index Score CDF percentile estimates for the 2012 and 2022 surveys

			2012 baseline survey (updated to v.6.1)					*2022 reassessment survey (v.6.1)*				
PAI	***CRAM Indicator***	***Statistic***	***n AAs***	***CRAM Score Estimate***	***Std. Error***	***LCB95 Pct***	***UCB95 Pct***	***n AAs***	***CRAM Score Estimate***	***Std. Error***	***LCB95 Pct***	***UCB95 Pct***
Watershed	Index	5Pct	6	46	4	36	51	9	46	3	37	50
Watershed	Index	10Pct	10	52	3	46	59	15	51	3	47	57
Watershed	Index	25Pct	20	64	3	57	67	33	64	2	58	67
Watershed	Index	50Pct	30	69	2	66	73	46	69	1	67	72
Watershed	Index	75Pct	39	74	1	71	76	61	73	1	72	75
Watershed	Index	90Pct	45	76	1	74	80	70	75	3	74	87
Watershed	Index	95Pct	50	78	1	75	80	73	78	3	75	88
Watershed	Index	Mean	53	68	1	66	69	75	68	1	66	69
Urban	Index	5Pct	1	36	2	31	40	2	34	2	30	37
Urban	Index	10Pct	3	41	3	35	47	4	37	4	30	44
Urban	Index	25Pct	6	47	3	41	54	9	47	3	40	53
Urban	Index	50Pct	15	58	5	48	68	19	57	2	52	61
Urban	Index	75Pct	21	73	4	65	80	32	66	3	60	72
Urban	Index	90Pct	27	76	2	73	79	39	72	2	68	77
Urban	Index	95Pct	27	77	1	74	79	40	74	2	70	77

			2012 baseline survey (updated to v.6.1)					2022 reassessment survey (v.6.1)				
PAI	***CRAM Indicator***	***Statistic***	***n AAs***	***CRAM Score Estimate***	***Std. Error***	***LCB95 Pct***	***UCB95 Pct***	***n AAs***	***CRAM Score Estimate***	***Std. Error***	***LCB95 Pct***	***UCB95 Pct***
Urban	Index	Mean	30	60	2	56	63	44	57	1	54	59
Non-urban	Index	5Pct	1	54	3	48	59	1	56	3	50	62
Non-urban	Index	10Pct	2	62	3	56	69	3	62	4	55	70
Non-urban	Index	25Pct	4	67	2	63	70	6	67	1	64	70
Non-urban	Index	50Pct	11	71	2	68	73	15	71	1	69	74
Non-urban	Index	75Pct	15	74	2	71	77	21	74	1	71	76
Non-urban	Index	90Pct	20	76	2	73	79	27	77	3	70	84
Non-urban	Index	95Pct	21	78	1	75	80	29	80	3	73	86
Non-urban	Index	Mean	23	70	1	68	72	31	71	1	69	73

Table C.2 CRAM Buffer and Landscape Context Attribute Score CDF percentile estimates for the 2012 and 2022 Surveys.

			2012 baseline survey (updated to v.6.1)					*2022 reassessment survey (v.6.1)*				
PAI	***CRAM Indicator***	***Statistic***	***n AAs***	***CRAM Score Estimate***	***Std. Error***	***LCB95 Pct***	***UCB95 Pct***	***n AAs***	***CRAM Score Estimate***	***Std. Error***	***LCB95 Pct***	***UCB95 Pct***
Watershed	Buffer	5Pct	6	43	5	25	46	9	38	6	25	50
Watershed	Buffer	10Pct	8	46	7	25	54	14	52	5	35	55
Watershed	Buffer	25Pct	21	67	8	49	81	37	74	8	53	83
Watershed	Buffer	50Pct	38	88	3	79	91	54	91	2	83	92
Watershed	Buffer	75Pct	40	92	2	90	97	65	93	2	92	98
Watershed	Buffer	90Pct	48	96	2	93	100	66	98	1	96	100
Watershed	Buffer	95Pct	48	98	2	93	100	66	99	1	97	100
Watershed	Buffer	Mean	53	80	2	76	85	75	83	2	79	86
Urban	Buffer	5Pct	3	25	2	20	30	4	25	2	21	29
Urban	Buffer	10Pct	3	25	4	17	33	4	27	3	21	32
Urban	Buffer	25Pct	7	47	8	32	61	11	50	6	38	62
Urban	Buffer	50Pct	12	60	3	53	67	18	60	3	53	66
Urban	Buffer	75Pct	21	72	4	64	80	32	70	3	64	77
Urban	Buffer	90Pct	27	80	2	75	84	39	78	2	74	83
Urban	Buffer	95Pct	27	81	2	78	85	41	80	2	77	84
Urban	Buffer	Mean	30	59	3	54	65	44	58	2	54	63
Non-urban	Buffer	5Pct	1	46	3	40	52	1	49	5	40	59
Non-urban	Buffer	10Pct	2	49	9	32	66	3	55	9	38	73
Non-urban	Buffer	25Pct	5	83	10	62	103	7	87	9	69	105
Non-urban	Buffer	50Pct	10	91	2	87	95	10	92	1	90	93

			2012 baseline survey (updated to v.6.1)					2022 reassessment survey (v.6.1)				
PAI	***CRAM Indicator***	***Statistic***	***n AAs***	***CRAM Score Estimate***	***Std. Error***	***LCB95 Pct***	***UCB95 Pct***	***n AAs***	***CRAM Score Estimate***	***Std. Error***	***LCB95 Pct***	***UCB95 Pct***
Non-urban	Buffer	75Pct	10	93	2	89	97	22	97	2	94	100
Non-urban	Buffer	90Pct	18	97	2	93	100	22	99	1	97	100
Non-urban	Buffer	95Pct	18	98	2	95	102	22	99	1	98	101
Non-urban	Buffer	Mean	23	87	3	81	92	31	89	2	85	94

Table C.3 CRAM Hydrology Attribute Score CDF percentile estimates for the 2012 and 2022 Surveys.

			2012 baseline survey (updated to v.6.1)					*2022 reassessment survey (v.6.1)*				
PAI	***CRAM Indicator***	***Statistic***	***n AAs***	***CRAM Score Estimate***	***Std. Error***	***LCB95 Pct***	***UCB95 Pct***	***n AAs***	***CRAM Score Estimate***	***Std. Error***	***LCB95 Pct***	***UCB95 Pct***
Watershed	Hydrology	5Pct	6	53	4	42	59	9	51	6	36	58
Watershed	Hydrology	10Pct	8	60	1	56	61	16	59	2	53	60
Watershed	Hydrology	25Pct	8	64	1	63	66	16	64	1	62	65
Watershed	Hydrology	50Pct	26	70	2	67	74	38	72	2	67	76
Watershed	Hydrology	75Pct	39	77	3	72	86	51	80	4	75	91
Watershed	Hydrology	90Pct	49	85	5	79	100	71	92	4	82	100
Watershed	Hydrology	95Pct	51	94	5	82	100	71	96	4	84	100
Watershed	Hydrology	Mean	53	75	1	72	78	75	76	1	73	79
Urban	Hydrology	5Pct	4	42	1	39	44	2	34	1	31	36
Urban	Hydrology	10Pct	4	42	3	36	47	2	37	2	33	42
Urban	Hydrology	25Pct	6	56	5	47	65	9	52	5	43	62
Urban	Hydrology	50Pct	8	63	2	60	66	16	62	2	58	66
Urban	Hydrology	75Pct	21	73	4	65	81	30	73	4	66	80
Urban	Hydrology	90Pct	23	81	5	71	90	34	80	2	76	84
Urban	Hydrology	95Pct	23	83	4	75	90	34	81	2	78	85
Urban	Hydrology	Mean	30	66	2	63	70	44	65	2	62	68
Non-urban	Hydrology	5Pct	5	67	0	67	67	8	67	0	67	67
Non-urban	Hydrology	10Pct	5	67	0	66	67	8	67	0	67	67
Non-urban	Hydrology	25Pct	5	67	1	65	69	8	67	1	65	69
Non-urban	Hydrology	50Pct	5	72	2	69	75	8	74	2	69	78

			2012 baseline survey (updated to v.6.1)					2022 reassessment survey (v.6.1)				
PAI	***CRAM Indicator***	***Statistic***	***n AAs***	***CRAM Score Estimate***	***Std. Error***	***LCB95 Pct***	***UCB95 Pct***	***n AAs***	***CRAM Score Estimate***	***Std. Error***	***LCB95 Pct***	***UCB95 Pct***
Non-urban	Hydrology	75Pct	16	78	6	67	88	17	82	5	72	91
Non-urban	Hydrology	90Pct	20	89	5	79	100	27	94	4	85	102
Non-urban	Hydrology	95Pct	21	95	5	86	104	27	97	3	90	104
Non-urban	Hydrology	Mean	23	78	2	74	81	31	79	2	76	83

Table C.4 CRAM Physical Structure Attribute Score CDF percentile estimates for the 2012 and 2022 Surveys.

			2012 baseline survey (updated to v.6.1)					*2022 reassessment survey (v.6.1)*				
PAI	***CRAM Indicator***	***Statistic***	***n AAs***	***CRAM Score Estimate***	***Std. Error***	***LCB95 Pct***	***UCB95 Pct***	***n AAs***	***CRAM Score Estimate***	***Std. Error***	***LCB95 Pct***	***UCB95 Pct***
Watershed	Physical	5Pct	8	25	1	25	27	12	25	0	25	27
Watershed	Physical	10Pct	8	25	1	25	31	12	25	2	25	31
Watershed	Physical	25Pct	8	34	3	28	41	12	37	3	29	41
Watershed	Physical	50Pct	27	51	5	39	58	26	48	3	43	54
Watershed	Physical	75Pct	27	61	4	54	71	44	61	4	53	71
Watershed	Physical	90Pct	40	70	6	61	88	59	71	6	63	88
Watershed	Physical	95Pct	40	73	6	64	88	59	75	5	66	88
Watershed	Physical	Mean	53	54	2	50	58	75	54	2	51	58
Urban	Physical	5Pct	6	25	0	25	25	9	25	0	25	25
Urban	Physical	10Pct	6	25	1	24	26	9	25	0	25	25
Urban	Physical	25Pct	6	27	2	23	32	9	27	2	23	31
Urban	Physical	50Pct	14	42	8	27	57	20	41	5	31	50
Urban	Physical	75Pct	21	66	7	53	78	28	59	6	46	72
Urban	Physical	90Pct	27	75	5	66	84	35	74	7	61	87
Urban	Physical	95Pct	27	81	4	73	89	40	81	4	72	89
Urban	Physical	Mean	30	52	3	46	58	44	50	2	46	54
Non-urban	Physical	5Pct	2	25	1	22	28	3	25	2	21	29
Non-urban	Physical	10Pct	2	26	2	21	31	3	25	3	19	32
Non-urban	Physical	25Pct	2	37	4	28	45	6	40	5	30	49
Non-urban	Physical	50Pct	10	52	5	43	61	6	49	3	43	55

			2012 baseline survey (updated to v.6.1)					2022 reassessment survey (v.6.1)				
PAI	***CRAM Indicator***	***Statistic***	***n AAs***	***CRAM Score Estimate***	***Std. Error***	***LCB95 Pct***	***UCB95 Pct***	***n AAs***	***CRAM Score Estimate***	***Std. Error***	***LCB95 Pct***	***UCB95 Pct***
Non-urban	Physical	75Pct	10	60	5	51	69	16	61	5	52	71
Non-urban	Physical	90Pct	19	68	4	61	75	24	71	6	58	83
Non-urban	Physical	95Pct	19	71	3	65	78	24	74	6	63	85
Non-urban	Physical	Mean	23	55	2	50	60	31	56	3	51	61

Table C.5 CRAM Biotic Structure Attribute Score CDF percentile estimates for the 2012 and 2022 Surveys.

			2012 baseline survey (updated to v.6.1)					*2022 reassessment survey (v.6.1)*				
PAI	***CRAM Indicator***	***Statistic***	***n AAs***	***CRAM Score Estimate***	***Std. Error***	***LCB95 Pct***	***UCB95 Pct***	***n AAs***	***CRAM Score Estimate***	***Std. Error***	***LCB95 Pct***	***UCB95 Pct***
Watershed	Biotic	5Pct	2	33	1	31	34	7	31	1	29	32
Watershed	Biotic	10Pct	4	35	3	31	45	7	32	0	32	33
Watershed	Biotic	25Pct	13	49	6	36	58	20	46	5	34	53
Watershed	Biotic	50Pct	23	63	3	56	67	35	56	2	53	60
Watershed	Biotic	75Pct	34	68	3	65	79	56	68	4	59	76
Watershed	Biotic	90Pct	48	78	4	69	86	66	77	3	73	83
Watershed	Biotic	95Pct	48	80	4	72	86	70	79	2	76	83
Watershed	Biotic	Mean	53	61	2	57	65	75	57	2	54	61
Urban	Biotic	5Pct	2	31	2	27	34	2	28	0	27	29
Urban	Biotic	10Pct	3	33	3	27	39	2	29	1	28	31
Urban	Biotic	25Pct	7	46	7	32	60	11	33	4	25	42
Urban	Biotic	50Pct	15	64	4	56	72	21	56	4	48	64
Urban	Biotic	75Pct	22	73	3	67	78	31	66	3	60	71
Urban	Biotic	90Pct	25	77	3	71	83	39	71	4	64	79
Urban	Biotic	95Pct	28	79	3	74	84	41	77	4	70	84
Urban	Biotic	Mean	30	61	2	56	66	44	54	2	50	57
Non-urban	Biotic	5Pct	1	34	1	32	35	3	33	1	32	35
Non-urban	Biotic	10Pct	1	35	2	30	40	3	33	2	30	37
Non-urban	Biotic	25Pct	5	49	6	37	61	6	46	5	36	56
Non-urban	Biotic	50Pct	11	63	3	56	69	14	57	2	52	61

			2012 baseline survey (updated to v.6.1)					2022 reassessment survey (v.6.1)				
PAI	*CRAM Indicator*	*Statistic*	*n AAs*	*CRAM Score Estimate*	*Std. Error*	*LCB95 Pct*	*UCB95 Pct*	*n AAs*	*CRAM Score Estimate*	*Std. Error*	*LCB95 Pct*	*UCB95 Pct*
Non-urban	Biotic	75Pct	16	68	4	60	75	23	70	5	61	79
Non-urban	Biotic	90Pct	20	73	4	66	81	25	77	3	71	83
Non-urban	Biotic	95Pct	20	80	4	73	87	29	79	2	76	82
Non-urban	Biotic	Mean	23	61	2	56	66	31	58	2	54	63

Change Analysis Test Results

Change analysis test results, from the *spsurvey's analysis package in R.* The test takes into account the 53 paired revisit sites in effectively a paired t-test and was run on the continuous data employing the mean CDF results from the CRAM Index and Attribute Scores (Table C.6), and the categorical CRAM condition class results of the estimated proportions of stream miles in Good, Fair, and Poor condition (Table C.7). The tests were run for the watershed as a whole, and its Urban and Non-urban PAIs. The *change analysis* test compares the 2022 reassessment survey (survey2) to the 2012 baseline assessment (survey1). A negative DiffEst indicates a decline in condition, while a positive number indicates an increase in condition with consideration of the error estimates.

Table C.6. Change analysis results from the continuous, mean CDF data for 2012 and 2022 surveys. The first two columns identify the subpopulation or primary area of interest (PAI) and the response variable (CRAM Indicator). The next four columns list the Percent Difference results: estimated percent difference (DiffEst) and standard error (StdError) in the proportions of stream miles that changed between survey periods, and the lower and upper 95% confidence limits. The next two sets of Survey 1 and Survey 2 columns (5 columns each) provide mean CDF estimates for from each survey: the first column is the number of AAs (nResp; or number of responses); the next four columns contain the survey estimates, standard error, and lower and upper confidence bounds (LCB95 and UCB95) in the same percent scale. * indicates results that are mentioned in Section 4 of the main report.

PAI	*Indicator*	*Percent Difference*				*Survey 1 (2012)*					*Survey 2 (2022)*				
				95% C.I.											
		DiffEst	*StdError*	*Lower*	*Upper*	*nResp*	*Estimate*	*StdError*	*LCB95 Pct*	*UCB95 Pct*	*nResp*	*Estimate*	*StdError*	*LCB95 Pct*	*UCB95 Pct*
Watershed	Index	-0.1	1.1	-2.3	2.1	53	67.8	0.8	66.2	69.4	75	67.6	0.8	66.1	69.2
Nonurban	Index	0.6	0.8	-0.9	2.2	23	70.1	0.9	68.4	71.9	31	70.8	0.9	69.0	72.6
Urban	Index	-2.9*	1.0	-4.9	-1.0	30	59.6	1.9	55.8	63.4	44	56.7	1.4	53.9	59.4
Watershed	Buffer	2.2	3.0	-3.6	8.0	53	80.4	2.4	75.7	85.2	75	82.6	1.7	79.2	86.0
Nonurban	Buffer	2.9*	1.0	1.0	4.9	23	86.5	3.0	80.7	92.4	31	89.5	2.1	85.3	93.7
Urban	Buffer	-0.8	1.3	-3.5	1.8	30	59.3	2.7	53.9	64.7	44	58.5	2.1	54.4	62.6
Watershed	Hydrology	1.0	2.0	-2.9	5.0	53	75.0	1.5	72.2	77.9	75	76.1	1.4	73.4	78.8
Nonurban	Hydrology	1.8	1.5	-1.1	4.6	23	77.5	1.8	74.0	81.1	31	79.3	1.7	75.9	82.7
Urban	Hydrology	-1.6	1.7	-5.0	1.7	30	66.4	1.9	62.7	70.0	44	64.8	1.6	61.6	67.9
Watershed	Physical	0.1	2.8	-5.5	5.7	53	54.3	2.0	50.3	58.2	75	54.4	2.0	50.4	58.4
Nonurban	Physical	0.8	2.0	-3.2	4.7	23	54.9	2.4	50.1	59.7	31	55.6	2.5	50.7	60.6
Urban	Physical	-2.1	1.7	-5.3	1.2	30	52.1	3.0	46.2	57.9	44	50.0	2.3	45.6	54.4
Watershed	Biotic	-3.6	2.8	-9.1	1.8	53	61.0	2.0	57.1	64.9	75	57.4	1.9	53.6	61.1
Nonurban	Biotic	-2.6	2.1	-6.7	1.6	23	61.0	2.5	56.1	65.9	31	58.4	2.4	53.7	63.1
Urban	Biotic	-7.4*	1.4	-10.2	-4.6	30	61.0	2.3	56.5	65.6	44	53.6	1.9	50.0	57.2

Table C.7. Change analysis test results from the categorical CRAM condition class data for 2012 and 2022 surveys. The first three columns identify the region or primary area of interest (PAI) being compared, the response variable (CRAM Indicator), and category of the response variable (Good, Fair, Poor condition classes). The next four columns list the Percent Difference results: estimated percent difference (DiffEst) and standard error (StdError) in the proportions of stream miles that changed between survey periods, and the lower and upper 95% confidence limits (LCB95 Pct and UCB95 Pct). The next two sets of Survey 1 and Survey 2 columns (5 columns each) provide the estimated proportions of stream miles by condition class (or Category) from each survey: the first column is the number of AAs (nResp; or number of responses); the next four columns contain the survey proportion estimates, standard error, and lower and upper confidence bounds in the same percent scale. These results essentially reflect the continuous test results (presented above in Table C.6), but with more resolution at the CRAM condition class level. Ecological condition classes are based on the full range of possible CRAM Scores (25-100) divided into three equal-intervals of poor (25-50), fair (51-75), and good (76-100) conditions. * indicates results that are mentioned in Section 4 of the main report.

PAI	*Indicator*	*Category*	*Percent Difference*				*Survey 1 (2012)*					*Survey 2 (2022)*				
					95% C.I.											
			DiffEst	*StdError*	*Lower*	*Upper*	*nResp*	*Estimate*	*StdError*	*LCB95 Pct*	*UCB95 Pct*	*nResp*	*Estimate*	*StdError*	*LCB95 Pct*	*UCB95 Pct*
Watershed	Index	1.Good	-3	6	-15	8	8	14	5	5	23	5	11	4	3	18
Watershed	Index	2.Fair	2	6	-10	14	37	80	5	71	89	55	82	4	74	90
Watershed	Index	3.Poor	2	2	-2	5	8	6	2	3	9	15	8	1	5	10
Nonurban	Index	1.Good	0	5	-10	10	3	13	6	2	24	4	13	5	4	22
Nonurban	Index	2.Fair	0	5	-10	10	20	87	6	76	98	27	87	5	78	96
Nonurban	Index	3.Poor	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Urban	Index	1.Good	-14*	5	-25	-4	5	17	6	5	28	1	2	2	0	6
Urban	Index	2.Fair	7	7	-8	22	17	57	8	42	72	28	64	6	53	75
Urban	Index	3.Poor	7*	5	-3	18	8	27	7	13	40	15	34	5	24	44
Watershed	Buffer	1.Good	2	6	-11	15	25	71	5	61	81	34	73	4	66	81
Watershed	Buffer	2.Fair	3	5	-7	12	18	16	3	9	23	29	19	3	12	25
Watershed	Buffer	3.Poor	-5	5	-14	5	10	13	4	4	21	12	8	2	3	13
Nonurban	Buffer	1.Good	3	2	0	7	20	87	6	74	100	28	90	5	81	100
Nonurban	Buffer	2.Fair	2	3	-4	8	1	4	4	0	12	2	6	4	0	14
Nonurban	Buffer	3.Poor	-5	4	-13	2	2	9	5	0	19	1	3	3	0	8
Urban	Buffer	1.Good	-3	5	-13	7	5	17	6	6	27	6	14	4	6	21
Urban	Buffer	2.Fair	5	6	-7	16	17	57	8	41	73	27	61	6	49	73

PAI	Indicator	Category	Percent Difference				Survey 1 (2012)					Survey 2 (2022)				
					95% C.I.											
			DiffEst	StdError	Lower	Upper	nResp	Estimate	StdError	LCB95 Pct	UCB95 Pct	nResp	Estimate	StdError	LCB95 Pct	UCB95 Pct
Urban	Buffer	3.Poor	-2	4	-10	7	8	27	7	12	41	11	25	5	14	36
Watershed	Hydrology	1.Good	11	10	-7	30	14	29	7	15	43	24	40	6	28	52
Watershed	Hydrology	2.Fair	-11	10	-30	7	33	67	7	52	81	42	55	6	43	67
Watershed	Hydrology	3.Poor	0	2	-3	3	6	4	1	2	7	9	5	1	3	6
Nonurban	Hydrology	1.Good	15*	7	2	28	7	30	9	12	49	14	45	8	30	60
Nonurban	Hydrology	2.Fair	-15*	7	-28	-2	16	70	9	51	88	17	55	8	40	70
Nonurban	Hydrology	3.Poor	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Urban	Hydrology	1.Good	-1	6	-13	11	7	23	5	14	33	10	23	5	14	32
Urban	Hydrology	2.Fair	0	7	-13	13	17	57	7	43	71	25	57	6	45	69
Urban	Hydrology	3.Poor	0	5	-9	10	6	20	6	8	32	9	20	5	12	29
Watershed	Physical	1.Good	2	2	-2	7	3	2	1	0	4	5	5	2	0	9
Watershed	Physical	2.Fair	-10	10	-29	9	23	51	7	37	65	26	41	6	29	54
Watershed	Physical	3.Poor	8	9	-11	26	27	46	7	33	60	44	54	6	42	67
Nonurban	Physical	1.Good	3	3	-2	8	0	0	0	0	0	1	3	3	0	8
Nonurban	Physical	2.Fair	-11	9	-29	7	13	57	9	39	74	14	45	8	29	61
Nonurban	Physical	3.Poor	8	9	-9	25	10	43	9	26	61	16	52	8	36	67
Urban	Physical	1.Good	-1	3	-6	4	3	10	4	1	19	4	9	4	2	17
Urban	Physical	2.Fair	-6	6	-17	5	10	33	8	18	48	12	27	5	17	38
Urban	Physical	3.Poor	7	6	-4	18	17	57	7	42	71	28	64	6	53	75
Watershed	Biotic	1.Good	3	7	-10	16	8	14	5	4	23	9	17	5	7	26
Watershed	Biotic	2.Fair	-6	10	-25	14	31	60	8	45	75	40	54	6	42	67
Watershed	Biotic	3.Poor	3	9	-14	20	14	26	7	13	39	26	29	6	18	40
Nonurban	Biotic	1.Good	6	7	-8	21	3	13	6	1	25	6	19	6	8	31
Nonurban	Biotic	2.Fair	-6	10	-26	14	14	61	10	42	80	17	55	8	39	71

PAI	Indicator	Category	Percent Difference				Survey 1 (2012)					Survey 2 (2022)				
					95% C.I.											
			DiffEst	StdError	Lower	Upper	nResp	Estimate	StdError	LCB95 Pct	UCB95 Pct	nResp	Estimate	StdError	LCB95 Pct	UCB95 Pct
Nonurban	Biotic	3.Poor	0	7	-14	14	6	26	8	10	43	8	26	7	12	40
Urban	Biotic	1.Good	-10*	4	-17	-3	5	17	5	7	26	3	7	3	0	13
Urban	Biotic	2.Fair	-4	6	-17	8	17	57	8	42	72	23	52	6	41	64
Urban	Biotic	3.Poor	14*	5	4	25	8	27	7	14	39	18	41	5	30	51

Appendix D: How to Use EcoAtlas for Data Access and the Landscape Profile Tool

Project D5 utilizes EcoAtlas (www.EcoAtlas.org) and CRAM's statewide data entry and management service to manage CRAM data (www.cramwetlands.org) and publish ambient survey watershed assessment CDFs This means that users can access the CRAM data online and create their own landscape profile summaries (via the Landscape Profile Tool described below) employing Valley Water's survey results.

EcoAtlas is a free, statewide data access, visualization, and summary tool that supports a watershed approach to stream and wetland restoration and mitigation project planning, monitoring, and assessment. It is designed around the WRAMP framework of using geospatial data, field rapid assessments of condition, and more involved field samples to support resource management and regulation. EcoAtlas is the main public access point for CARI, which is the interactive aquatic resources base map on the site.

EcoAtlas includes many kinds of geospatially referenced ecological data including:

- wetland restoration and compensatory mitigation project information, which is uploaded via a Project Tracker data entry tool, and can be interactively explored as a data layer and interactive database,
- CRAM stream and wetland condition results (data are uploaded via the CRAM website),
- data visualization layers for a number of habitat datasets (including CARI, historical ecology, CALVEG, SSURGO hydric soils),
- data visualization and access for the California Stream Condition Index (CSCI; a benthic bioassessment method), and other water quality monitoring data from the California Environmental Data Exchange Network database (CEDEN), and

EcoAtlas has several interactive data access and evaluation tools that support wetland project tracking and ecological condition assessments that employ CRAM. These tools are part of the statewide WRAMP framework for standardized monitoring and assessment and can be used at various landscape scales.

Landscape Profile Tool

EcoAtlas' Landscape Profile Tool summarizes the amount, distribution, and condition of aquatic resources, and other ecological information at various spatial scales for assessment, planning, and reporting. Based on a user-specified area of interest, or predefined areas such as the USGS Hydrologic Units (HUCs) and Valley Water's five watersheds within Santa Clara County. The tool generates graphical summaries of the following data sources:

- abundance and diversity of existing aquatic resources based on BAARI and CARI;
- abundance and diversity of historical aquatic resources, and terrestrial plant communities;
- abundance of protected aquatic resources based on CARI and CPAD and CCED;
- survey and project summary statistics for eelgrass aquatic resources;
- ecological restoration or compensatory mitigation based on Wetland Habitat Projects;

- aquatic resource condition assessments based on CRAM; includes a comparison of selected CRAM scores to Project D5's baseline survey local watershed CDF curves for streams or other eco-regional *CDF* curves (when available).
- Stream condition based on the California Stream Condition Index CSCI.
- human population (2010 Census) and language spoken at home (2008-2012 American Community Survey);
- species of special status (federally and California listed species) based on the California Natural Diversity Database (CNDDB); and
- developed land cover by the 2011 National Land Cover Database (NLCD).

It is intended that, over time, local and regional entities will develop watershed specific project performance curves (a.k.a., habitat development curves) and ambient condition assessments using CRAM (a.k.a., ambient probability surveys and CDF estimates).

1. HDCs: Wetland Habitat Development Curves are used to evaluate project performance to the expected rate of habitat development for the same age and habitat type based on CRAM. HDCs have been developed for three BAARI wetland types (riverine, estuarine, and depressional) using existing CRAM assessments from wetlands across California. Each curve represents the average rate of development bounded by its 95% Confidence Interval (CI), average condition and 95% CI for a set of reference sites. Projects that are well designed for their location and setting, and well managed tend to be on or above the curve. In general, as projects age, their habitats should mature and their CRAM scores should increase at a similar rate as the HDC. Comparing project Index and/or Attribute scores to the expected level on HDCs can help identify general ecological functions that are performing well, or that may warrant corrective actions.
2. CDFs: Cumulative distribution functions (CDFs) are developed from probabilistic ambient surveys using CRAM. CDFs estimate the relative abundance of stream miles (or wetland areas) within a surveyed geographic extent that is likely to have conditions below (or above) any particular score. CDFs can be developed for any geographic extent, from large wetland project areas to watersheds, eco-regions, or statewide. CRAM project scores or other targeted assessments can be compared to CDF curves of wetlands of the same type in the same geographic area. These comparisons provide a watershed (or eco-regional) context to evaluate if a targeted assessment falls within the upper or lower 50th percentile of similar wetlands in the area, or if it falls within the top (or bottom) 25th percentile of similar wetlands in the surveyed area. This information helps inform management actions.

The CDFs for the five watersheds in Santa Clara County are available through the Landscape Profile Tool on EcoAtlas (Figure D.1). A manager can view existing CRAM assessment scores plotted on a watershed CDF by:

- Going to www.EcoAtlas.org and zooming into Santa Clara County on the map (in the lower South Bay area within the Bay/Delta Ecoregion)
- Go to "Layers" dropdown and select "CRAM" to see the distribution of CRAM scores on the map. You can also turn on the "Habitat Projects" layer to see restoration or mitigation project areas on the map if they have been uploaded to Project Tracker.

- Click on the “Show Tools” button in the top right side and select “Landscape Profiles”[14].
    - The “Landscape Profiles” tool summarizes CARI, CRAM, and other environmental data for a specific region or user defined area. There are three profiles available:
        1. *Landscape* (which is a summary of geospatial data),
        2. *Condition* (which summarizes ecological conditions based on available CRAM and California Stream Condition Index (CSCI) data and includes interactive access to local and regional CDFs), and
        3. *Connectivity* (which characterizes several aquatic resource connectivity metrics such as nearest neighbors and wetland size categories based on CARI).
    - A user can define a profile region by drawing a polygon, selecting a predefined area, uploading a KML, or shape file and then run any of the profiles. For example, to compare a set of user selected riverine CRAM scores within Coyote Creek to the D5 Project’s Coyote Creek riverine CDF curve, zoom into the target area on the map that includes the CRAM AAs of interest (Figure D.1). Select the “Condition” profile option, the “Draw a Polygon” option, and then use the edit tool to draw your area by clicking around the perimeter of the area of interest.

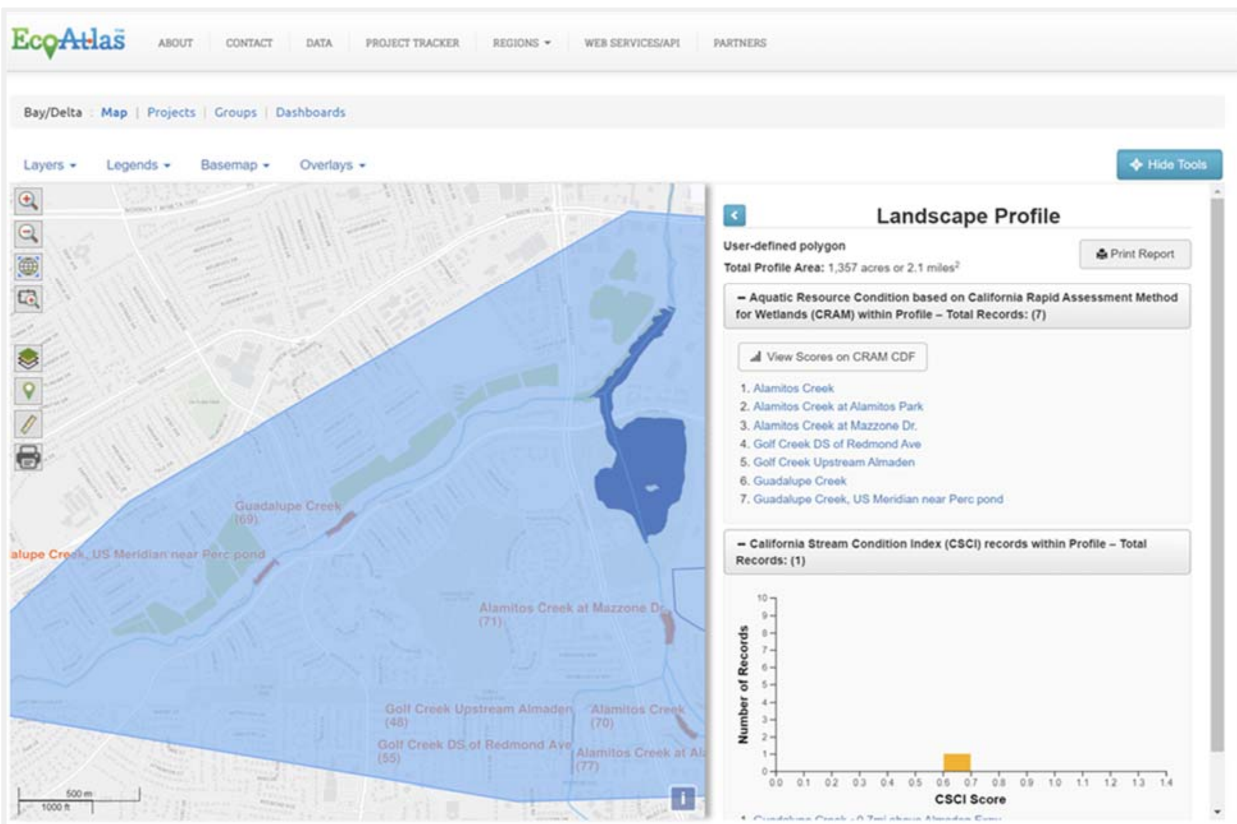

Figure D.1. Screenshot of CRAM AAs and a user defined area within the Guadalupe River watershed.

[14] Side note: The “Wetland Condition (CRAM)” tool allows a user to select, view, and download CRAM data.

- Double-click inside the polygon to generate a pop-up box that lists the CRAM AAs located within the polygon and plots any CSCI scores within the area on a chart indicating the number of scores by condition class (Figure D.2). You can explore specific AA information by clicking on the Site Name in the list.
    - Click on the "View Scores on CRAM CDF" button and final pup-up allows you to select wetland type and available CDFs (from drop-down lists). The CRAM scores from the user-defined area are then plotted on the selected watershed or regional CDF (they appear as grey diamonds, Figure D.2).

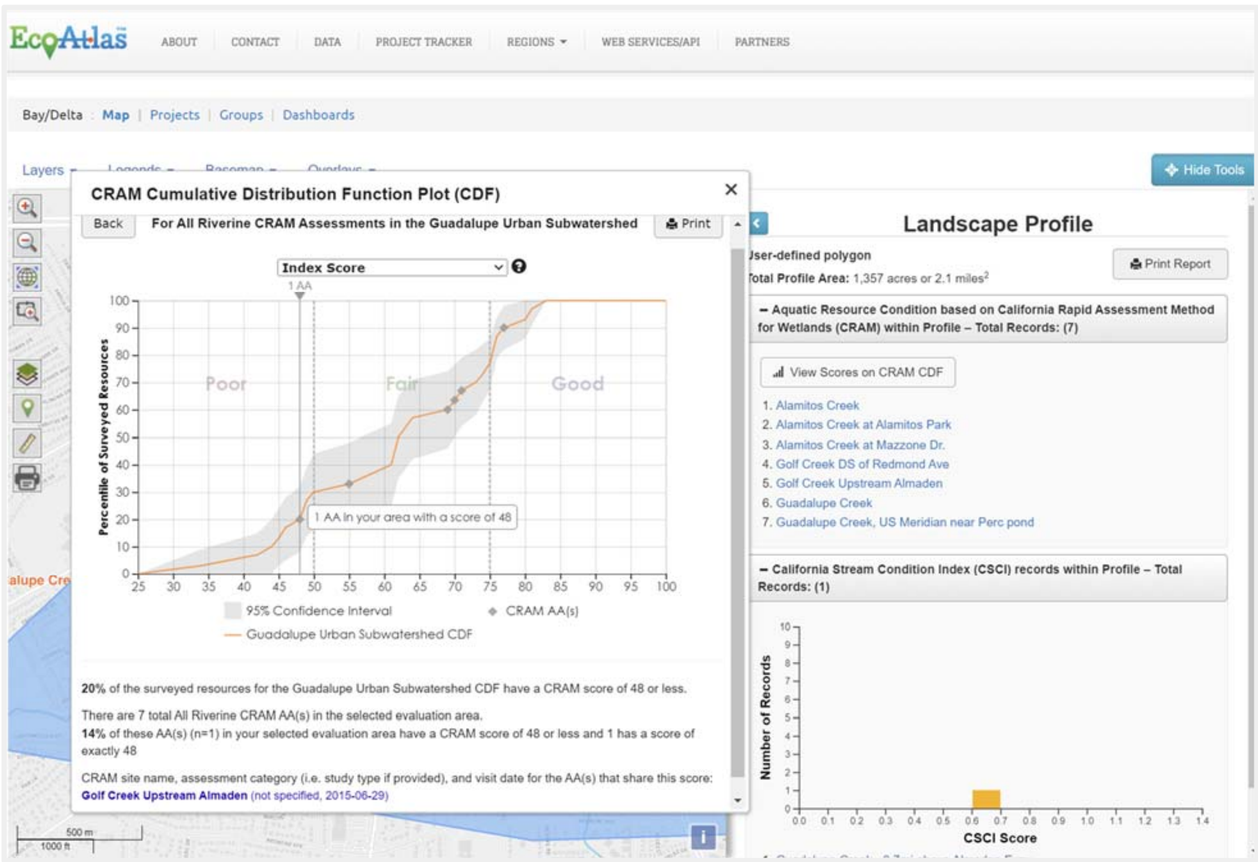

Figure D.2. Screenshot of the Guadalupe River Urban PAI CDF (2012) accessed through EcoAtlas with overlaid CRAM scores (gray diamonds) from AAs located within the user defined area shown in Figure D.1.

Appendix E: Survey Primary Areas of Interest

The two Primary Areas of Interest (PAIs) used within the Guadalupe River watershed surveys are consistent with the Headwaters, Foothills, and Lowland Valley regions in Project D5's Five Watershed Synthesis Report (Lowe *et al.*, 2020) for the Guadalupe River watershed (Table E.1). The Urban PAI is the same as the Lowland Valley region, while the Non-urban PAI is composed of both the Foothills and Headwaters subregions. These regions are also generally consistent with the One Water Plan, where the Urban PAI (in this report) comprises One Water's Lower Valley Floor area, and the Non-urban PAI (in this report) comprises One Water's Upper Valley Floor and Hills area.

Table E.1. Project D5 PAIs relative to the Five Watershed D5 Synthesis Report and to the One Water Plan.

D5 Guadalupe Reassessment	*D5 Synthesis Report*	*One Water*	*Habitats*
Non-urban	Headwaters	Hills	Open space, forest, chaparral, scrub, grassland, rangeland (>1,000 feet elevation)
	Foothills	Upper Valley Floor	Rural, grassland, woodland, wildlife friendly agriculture (<1,000 feet elevation)
Urban	Lowland Valley	Lower Valley Floor	Urban or intensive agriculture, limited riparian and parkland (<1,000 feet elevation)
na	na	Baylands	South San Francisco Bay tidal wetlands, intertidal creeks and sloughs

Appendix F: Geomorphic Zones

Channel geomorphic characteristics such as channel shape, complexity, and sediment and water transport processes vary across a watershed. This variability is a result of the channel response to natural drivers such as underlying geologic units, slope, and geomorphic/hillslope process, as well as to anthropogenic drivers such as adjacent land use, channel management, and channel modification or engineering, among many other factors. These geomorphic characteristics control the ecology of the channel, including the ability to support a healthy riparian area and community of wildlife. In turn, this suite of geomorphic characteristics can create reaches, areas, or "zones" that are distinct in terms of their morphology, functioning and condition, and which can be very different from immediately adjacent reaches or areas. As a result, geomorphic zones can be valuable tools for evaluating potential for ecological enhancement and identifying effective and feasible actions for doing so.

For the Guadalupe River watershed, a suite of characteristics that define changes in channel morphology were used to delineate geomorphic zones that could be used for channel management and enhancement decision-making. These characteristics, which stem from many of the existing data sources described in the methods section of this report, include tidal or fluvial hydrology, flow regime, stream order, slope, channel type (natural, engineered, underground), morphology, adjacent land use, riparian characteristics, ecological condition based upon CRAM scores, and various hydrologic characteristics like tributary confluences, reservoirs, and grade control structures. On-the-ground experience in the watershed, which was gained through the 2022 CRAM surveys, proved to be invaluable in interpreting this data and checking that the data matched observations in the field.

This process identified 11 geomorphic zones in the watershed below the 1,000 ft elevation boundary (Figure F.1). (Streams above this boundary were considered headwaters and not included in this analysis because they are subject to different management practices.)

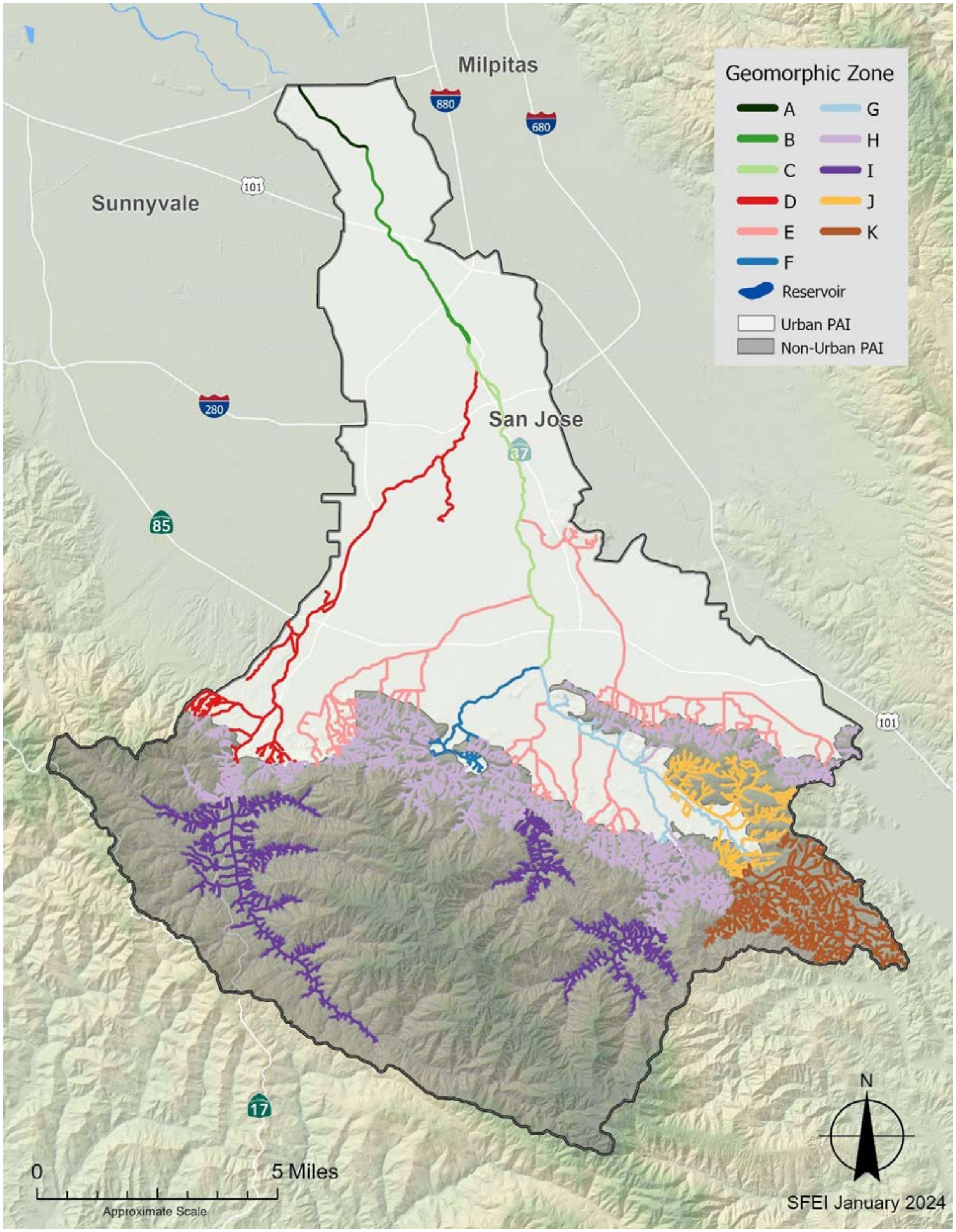

Figure F.1. Map illustrating the channel network within the 11 Geomorphic Zones (color coded and lettered) defined within the Guadalupe River Watershed below the 1,000 ft boundary. In addition, the Urban region PAI boundary and the Non-urban region PAI boundary are shown.

Descriptions of each individual Zone (below) illustrate the differences in geomorphic characteristics, as well as current or potential future management.

Zone A extends 3.4 km (2.1 mi) from the Southbay Freeway 237 (the Project D5 watershed boundary) upstream to the head of tide location at Montague Expressway. This zone is characterized by an extremely low slope, less than 0.1%, and is the only tidal zone, with two daily water surface elevation minima and maxima. There are levees on both sides of the channel to protect adjacent urban areas from flooding, and the channel alignment has been straightened compared to its historical planform. The ecological condition is fairly consistent throughout the zone, with one CRAM assessment with a score of 67 (Fair condition).

Zone B extends for 8 km (5 mi) of the Guadalupe River mainstem, from the head of tide at Montague Expressway upstream to Coleman Avenue. This zone has a modified channel (partially leveed, straightened) but still maintains a relatively wide channel corridor and a dense riparian area. The channel from Montague Expressway upstream to Highway 101 exists within levees, however upstream from Montague, the channel is simply incised into the valley floor. Five 2022 CRAM assessments were in this zone, with Index Scores ranging from 63 to 78, indicating that the mainstem is on the upper end of the Fair condition class and the low end of the Good condition class. These scores reflect the width and complexity of the floodplain surface and associated vegetation, yet the degraded water source and limited buffer.

Zone C is a Guadalupe River mainstem zone that extends 13 km (8 mi) from Coleman Avenue upstream to the confluence with Guadalupe and Alamitos Creek. The channel in this zone is relatively narrow and incised, with a narrow but largely continuous woody riparian corridor. The channel is not leveed but has been straightened in segments, and is bounded by adjacent roads and vertical concrete walls through downtown San Jose. Five 2022 CRAM assessments were in this zone, with most Index Scores ranging from 54 to 60, which is the lower half of Fair condition.

Zone D is Los Gatos Creek from the confluence with Guadalupe River, upstream 17.5 km (11 mi) to the urban/non-urban boundary. Although variable, generally the Los Gatos Creek channel in this zone is confined, incised, has no floodplain, and supports a very narrow woody riparian corridor. The middle portion of the zone includes grade control structures, percolation ponds, and Vasona Dam and Reservoir. The upper portion of the zone consists of a number of smaller-order channels that extend up into the foothill edges of suburban development. Nearly the entire channel length supports a riparian area of mixed native and non-native tree species and understory species, with the riparian area width generally increasing in the upstream direction. There are five 2022 CRAM assessments in this zone, with Index Scores varying from 55-69, indicating a Fair condition class.

Zone E includes Ross, Canoas, Golf, Greystone, and Randol Creeks, which share many morphological, flow regime, and management characteristics. The majority of channels in this zone are straightened, trapezoidal channels with compacted, earthen banks, surrounded by nearby development. Many of the upper reaches of these tributaries consist of storm drains. Overall, these streams have intermittent flow regimes, are managed for stormflow conveyance, and riparian vegetation is sparse, with occasional overhanging trees from adjacent yards. The 18 CRAM scores in this zone range from 31-65, with an average score of 46, indicating that most of the zone is in Poor condition.

Zone F is the urban area of Guadalupe Creek from the confluence with Guadalupe River near Almaden Lake upstream to the urban/non-urban boundary. It is characterized by a natural, meandering channel with a relatively wide riparian corridor. The riparian area has a mix of native and non-native tree species, along with recreational trails, parks, and groundwater percolation ponds. The lowest portion of this zone was restored in 2002 as a part of the Guadalupe Creek Restoration Project. A single 2022 CRAM assessment score exists in this zone, and scored 74 (Fair condition).

Zone G includes Alamitos Creek from its confluence with Guadalupe Creek upstream to the urban boundary, and Calero Creek upstream to Calero Reservoir. This zone captures the mainstem channels that receive flows released from Almaden and Calero Reservoirs. The Alamitos and Calero Creek mainstems are natural, meandering channels, with a moderately wide channel corridor. The land use in Zone G is urbanized, primarily residential, with some commercial infrastructure, and rural residential upstream of the urban boundary. There are four 2022 CRAM scores in this zone, with Index Scores ranging from 59-75 (Fair condition).

Zone H encompasses multiple small channels in the foothills between the urban boundary and 1,000 ft elevation boundary. Many of these streams are first and second order channels, with small drainage areas, steep slopes (average of 24%), and step-pool or pool-riffle morphology. Flow regimes are primarily ephemeral. The land use in this zone is mostly open space, either forest or grassland. Riparian areas consist of native tree species and a mix of native and non-native understory grasses, herbs/forbs, and vine species. Thirteen 2022 CRAM assessments are in this zone with Index Scores typically in the mid-60s and low 70s, but ranging between 51 and 73 (Fair condition).

Zone I includes foothill streams draining into Lexington, Guadalupe, and Almaden Reservoirs. These are low order streams higher in the watershed, and range from small ephemeral channels to perennial streams fed by higher elevation drainages. Land use in this zone is primarily forested and chaparral open space. There are five 2022 CRAM assessments in this zone, with Index Scores ranging from 65-76, indicating that these channels are in the upper half of the Fair condition class. Condition scores are a result of the channel's position in the watershed (in the foothills, largely surrounded by open space, with unmodified hydrology), but relatively simple physical and biotic structure due to the naturally small size and steepness of the channels.

Zone J includes the tributaries of Calero Creek below Calero Dam. This zone is distinguished by its rural, agriculture and open space land use and grassland-dominated setting. The tributaries consist of small first and second order streams that include both ephemeral and perennial flow regimes. Riparian areas are narrow, likely due to a combination of agricultural practices and the arid conditions unfavorable for extensive tree growth. There are two 2022 CRAM assessments here with Index Scores of 57 and 75 (Fair condition).

Zone K contains all the channels from Calero Dam upstream to the 1,000 ft elevation boundary. These are mostly steep, low order headwater streams, with an average slope of 17%. Land use is sparsely forested open space, with some roads and a golf course. Like Zone I, this zone drains into a reservoir, but is distinguished based upon the aridity of the zone, and different riparian vegetation. There are six 2022 CRAM assessments here, with Index Scores from 62-75 (Fair condition).

Appendix G: Wildfire History

Over the past decade, California has experienced multiple large wildfires, including an unprecedented 4.4 million acres (1.8 million ha) that burned in 2020. Recent wildfires, such as the 2020 Santa Clara Unit (SCU) Lightning Complex fire in the Coyote Creek Watershed (CAL FIRE, 2020) and the San Mateo-Santa Cruz Unit (CZU) Lightning Complex fire on the western slope of the Santa Cruz Mountains illustrate the potential catastrophic effects that fire can have on watersheds and overall channel condition. For example, the SCU Lightning Complex fire burned 396,624 acres (160,500 ha) (with about 28,000 of those acres [11,000 ha] within the Coyote Creek watershed). Despite the large area of the fire, the portion within the Coyote Creek watershed had low burn severity, burning vegetation, but did not cause substantial negative impacts upon the hillslope stability (Mallen *et al.*, 2020 unpublished data).

The increased intensity and frequency of drought across California driven by climate change necessitates managing stream resources for increased frequency of wildfire, making wildfire management an essential component of holistic resource management. A number of factors affect the fire hazard within Santa Clara County watersheds, including:

- the Mediterranean climate, which provides moisture for fuels to grow in the winter, giving way to hot and dry conditions in the summer;
- increasing wildland-urban interface in the upper portions of each watershed; and
- current and future climate change.

Fire can be regenerative for a landscape, by clearing low-growing shrubs and debris, regenerating grasses, herbs and shrubs, killing pests such as bark beetles and triggering seed germination for native species such as manzanita and chamise. But, fire can also be destructive. Large areas of high intensity burn can have negative ecological effects by destroying habitat either long-term or permanently, or by encouraging reestablishment by invasive vegetative species. Geomorphically, negative effects of fire include increased runoff from a watershed during the following wet season, excess sediment delivered to creeks and other receiving water bodies, and formation of landslides or debris flows in burned areas. Increased nutrient loads from burned areas can impact water quality. Socially, wildfires destroy houses, structures and infrastructure, and even cause loss of life. Controlling fire through suppression, cutting fire roads, clearing firebreaks, mowing, and replanting post-fire with unsuitable vegetation alters the landscape. Due to its Mediterranean climate, fires in the Bay Area often occur during the dry summer and fall months, and are often driven by the dry Diablo winds, which are east winds that quickly remove moisture from vegetation in the watersheds.

Fire risk in the region has been increasing largely due to climate change that is altering the timing and amount of annual precipitation, increasing summer/fall temperatures, and altering wind patterns that affect evapotranspiration, each intensifying the periods of drought. Other risk factors include increased residential activities along the wildland-urban interface that has increased wildfire risks to those communities. And, changes in the amount and diversity of vegetation communities in the watersheds, partly as a result of fire suppression and other land management practices, has increased the amount of available fuel to burn.

Prior to human habitation of the Bay Area, lightning was the primary ignition source of fire. Using data from the past 75 years, Keeley (2005) has shown that lightning-caused fire in the South Bay and the East Bay (specifically the hills in Contra Costa, Alameda and Santa Clara Counties) occurs at a much lower incidence than the Sierra Nevada or other areas of the state. Between 1945 and 2002, Santa Clara County had an average of 5.3 lightning-caused fires per 247,000 acres (100,000 ha) each decade, as compared to

200-300 fires per 247,000 acres (100,000 ha) each decade for locations in the Sierra Nevada (Keeley, 2005).

With the arrival of Native Americans in the early Holocene, the primary cause of fires shifted to anthropogenically ignited fire. Native Americans used fire as an effective landscape-scale management technique. Fires during this time period were used by the tribes to control the distribution of chaparral, maintain grassland cover and forage for wildlife, control pathogens, improve access to acorns, aid in hunting rabbits and other small game (Stanford *et al.*, 2013). This purposeful management of the land and burning at relatively high frequencies likely modified the plant succession, and shaped the vegetation communities that were encountered by the early European settlers (Stanford *et al.*, 2011).

The use of fire as a part of landscape management decreased with the arrival of European missionaries and settlers in the 19th century. Reduced area of burns, in addition to the increase in grazing (sheep and cattle), began a shift in the vegetation community from shrubland and woodland with small areas of grasslands to larger areas of grasslands (Keeley, 2005).

By the end of the 19th and first half of the 20th centuries, as population and development pushed into the foothills and headwaters of the watersheds, the wildfire regime shifted to largely accidental human-caused fires. Practices such as smoking and arson, as well as cars and machinery caused many of the fires. In the second half of the 20th century, the practice of fire suppression along with establishment of large protected lands and park lands (and the cessation of grazing) allowed the vegetation communities to shift towards larger areas of shrublands that reduced the amount of grasslands (Keeley, 2005). Fire suppression practices have resulted in a reduction in total area that has burned and an increase of available fuels in the foothills and upper watersheds, increasing the risk for high intensity fires.

An analysis by Keeley (2005) using California Department of Forestry and Fire Protection (CAL FIRE) records from 1931-2002 characterized the annual fire frequency for Santa Clara County. For the period 1930 to 1950, the annual number of fires per 247,000 acres (100,000 ha) were typically between 15 and 40. However, the number of fires increased after 1950 to 30 to 80 fires per 247,000 acres (100,000 ha). The total area burned annually decreased from 1930 to 1950 and then (with the exception of a few individual years), the total area burned annually has been fairly constant at less than 2,471 ac/247,000 ha (1,000 ha/100,000 ha) since 1950. Keeley's analysis shows the effect of fire suppression practices since the 1950s; despite the increase in the number of fires, the total area burned has remained relatively low.

Large fires still occur despite, or perhaps as a result of past, fire suppression practices. CAL FIRE, along with the US Forest Service, Bureau of Land Management, and National Parks Service jointly developed the Fire and Resource Assessment Program (FRAP; https://frap.fire.ca.gov/frap-projects/fire-perimeters/) that compiles the perimeters of individual fires annually, and makes the data publicly available in GIS. While some areas of the state have older records (back to 1898), the record for Santa Clara County covers the period from 1950 to 2022. Fires must be 10 acres (4 ha) or larger to be recorded in this database, however CAL FIRE records only include brush fires that are 30 acres (12 ha) or larger, and grassland fires that are 300 acres (121 ha) or larger. As a result, this is an incomplete record of regional wildfires in terms of cataloging every fire that has occurred. Nonetheless, FRAP data represents the best publicly available digital dataset for analysis. FRAP documented eight fires in the Guadalupe River watershed between 1950 and 2022 (Figure G.1 and Table G.1).

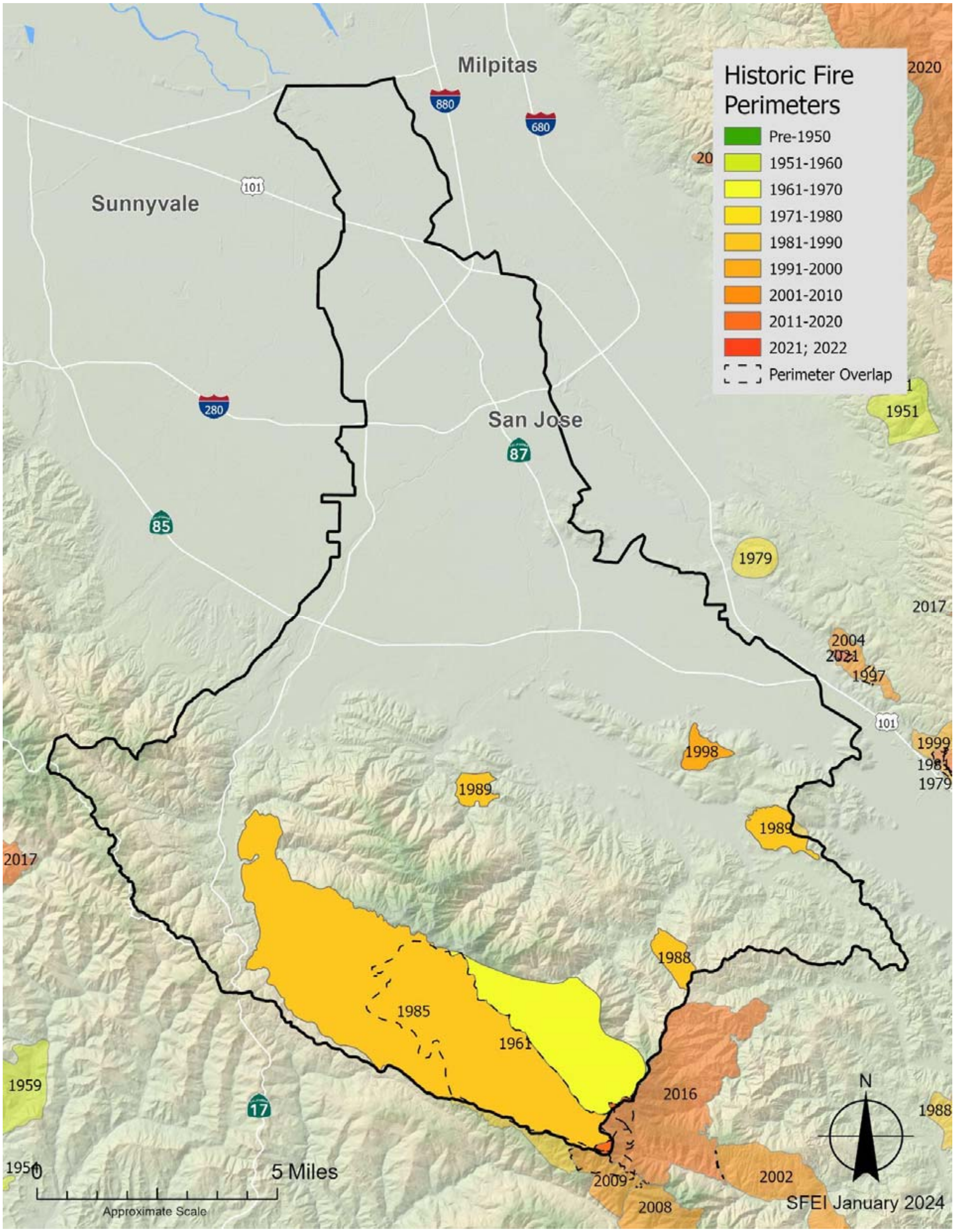

Figure G.1. Map showing the most recent footprint of wildfires (>10 acres/4 ha) that have occurred in and around the Guadalupe River watershed between 1950 and 2022 as documented by the Fire and Resource Assessment Program (FRAP, 2023). This map corresponds to fires listed in Table G.1.

Table G.1. List of fires that occurred within the Guadalupe River watershed between 1950 and 2022 mapped by the Fire and Resource Assessment Program (FRAP, 2023) (https://frap.fire.ca.gov/frap-projects/fire-perimeters/) and acres/hectares within the watershed that were burned.

Year	*Fire Name*	*Acres Burned*	*Hectares Burned*
1961	Austrian Gulch	8,844	3,579
1985	Lexington	12,039	4,872
1988	Alamaden	389	157
1989	PGE #2	304	123
1989	PGE #2	532	215
1998	Curie	320	129
2009	Loma	6	2.4
2016	Loma	81	33

Most of the fires in the watershed have been relatively small (500 acres/200 ha or less) and have occurred in unique areas without overlapping areas that have previously burned. However, the 1961 Austrian Gulch and the 1985 Lexington fires had a large area of overlap in the upper watershed. In addition, these two fires were both relatively large, burning more than 8,000 acres (3,240 ha) each. As compared to the neighboring Coyote Creek watershed, the Guadalupe River watershed has not had as many fires, nor as large of fires. Unfortunately, the FRAP dataset does not provide additional information about fire severity and therefore, we do not know how these fires may have affected the ecological conditions in the burned areas.

References

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