Santa Clara Valley
Urban Runoff
Pollution Prevention Program

Watershed Monitoring and Assessment Program

Lower Silver-Thompson Creek Watershed Stressor Source Identification Project

Work Plan - Water Year 2019 - 2020

July 30, 2019

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1 INTRODUCTION

The purpose of this work plan is to describe the design and tasks to complete a Stressor/Source Identification (SSID) project required by Provision C.8.e.iii of the San Francisco Bay Region Municipal Regional Stormwater National Pollutant Discharge Elimination System (NPDES) Stormwater Permit (MRP) (Order No. R2-2015-0049). The Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP or Program) is working with the Bay Area Stormwater Management Agencies Association (BASMAA) Regional Monitoring Coalition (RMC) to collectively initiate eight new SSID projects during the five-year term of the MRP (i.e., 2016 – 2020).

SSID projects typically follow-up on monitoring conducted in compliance with MRP Provision C.8 (or monitoring conducted through other programs) with results that exceed trigger thresholds identified in the MRP. Trigger thresholds are not necessarily equivalent to Water Quality Objectives (WQOs) established in the San Francisco Bay Basin (Region 2) Water Quality Control Plan (Basin Plan, SFRWQCB 2017) by the San Francisco Bay Regional Water Quality Control Board (Water Board); however, sites where triggers are exceeded may indicate potential impacts to aquatic life or other Beneficial Uses.

The Program will conduct two SSID projects during MRP 2.0. The Coyote Toxicity SSID Project was initiated during WY 2018 and will continue through WY 2019. The project entails an investigation of the magnitude and extent of potential sediment related toxicity in an urban reach of the Coyote Creek mainstem. In addition, the project will evaluate potential causes and sources of toxicity (if found). A final report will be submitted to the Water Board by March 31, 2020.

In WY 2019, the Program will initiate the second and final SSID project for MRP 2.0. The Lower Silver-Thompson Creek SSID Project was triggered by creek status/condition data suggesting Lower Silver Creek and Thompson Creek have reduced biological integrity. In addition, existing water chemistry data collected during bioassessments indicate elevated nutrient concentrations at most of the monitoring locations. Nutrients are biostimulatory substances that may cause eutrophic conditions that can influence biological conditions.

The Lower Silver – Thompson Creek SSID work plan (this document) describes the steps that will be taken during WY 2019 and WY 2020 to investigate potential causes of low biological integrity in Lower Silver-Thompson Creek, San Jose, California.

1.1 SSID Regulatory Background

SSID projects are intended to be oriented toward taking action(s) to alleviate stressors and reduce sources of pollutants. MRP Provision C.8.e.iii requires that SSID projects are conducted in a stepwise process:

Step 1: Develop a work plan. The work plan must:

- Define the problem (e.g., magnitude and temporal and geographic extent) to the extent known;
- Describe the SSID project objectives, including the management context within which the results of the investigation will be used;
- Consider the problem within a watershed context and look at multiple types of related indicators, where possible (e.g., basic water quality data and biological assessment results);
- List candidate causes of the problem (e.g., biological stressors, pollutant sources, and physical stressors);

- Establish a schedule for investigating the cause(s) of the trigger stressor/source to begin upon completion of the work plan. Investigations may include evaluation of existing data and/or collection of new data.
- Conduct a site specific study (or non-site specific if the problem is wide-spread) in a stepwise process to identify and isolate the cause(s) of the trigger stressor/source. Study approaches are listed depending on the stressor being investigated.

Step 2: Conduct SSID investigations according to the schedule in the work plan and report on the status of the SSID investigation annually in the Urban Creeks Monitoring Report (UCMR) that is submitted to the Regional Water Board on March 31 of each year.

Step 3: Follow-up actions:

- If it is determined that discharges to the municipal separate storm sewer system (MS4) contribute to an exceedance of a water quality standard (WQS) or an exceedance of a trigger threshold such that the water body's beneficial uses are not supported, submit a report in the UCMR that describes Best Management Practices (BMPs) that are currently being implemented and additional BMPs that will be implemented to prevent or reduce the discharge of pollutants that are causing or contributing to the exceedance of WQS. The report must include an implementation schedule.
- If it is determined that MS4 discharges are not contributing to an exceedance of a WQS, the SSID project may end. The Executive Officer must concur in writing before an SSID project is determined to be completed.
- If the SSID investigation is inconclusive (e.g. the trigger threshold exceedance is episodic or reasonable methods do not reveal a stressor/source), the Permittee may request that the Executive Officer consider the SSID project complete.

1.2 SSID Work Plan Organization

This work plan fulfills **Step 1** of the SSID process presented in Section 1.1 and describes the steps that will be conducted to investigate potential sources and impacts to biological integrity in Lower Silver-Thompson Creek. The work plan is organized according to the work plan elements required by MRP Provision C.8.e.iii as described in Step 1.

Section 2.0 Problem Definition and Study Objectives

Section 4.0 Study Area, Existing Data, and Candidate Causes

Section 5.0 SSID Monitoring Approach and Schedule

Section 6.0 References

2 PROBLEM DEFINITION AND STUDY OBJECTIVES

2.1 Problem Definition

This SSID project was triggered by creek status/condition data suggesting Lower Silver-Thompson Creek watershed has reduced biological integrity. Specifically, the California Stream Condition Scores (CSCI), based on benthic macroinvertebrate data collected at six bioassessment sites on Lower Silver and Thompson Creek, were below the MRP threshold for CSCI scores. In addition, existing water chemistry data show that nutrient concentrations in the water column were elevated during the spring season when biological conditions were assessed. Furthermore, algal biomass measurements at selected sites indicate the potential for eutrophication. Excess nutrients may be problematic under certain conditions (e.g., sunlight exposure, high temperatures) that result in algal production. Increase in algal biomass can result in poor water quality or changes in food availability, resulting in reduced biological conditions.

An evaluation of bioassessment data collected in California stream and rivers suggests potential correlation between nutrients (i.e., total nitrogen and total phosphorus) and biological condition index scores (Mazor, *et al*. in prep). However, these associations are highly variable, indicating that confounding stressors may co-occur, especially in urban streams. Thus, the linkage between nutrients and biological conditions is not always clear.

An evaluation of five years of bioassessment data collected in San Francisco Bay watersheds (BASMAA 2019) identified physical habitat and landscape variables as the primary factors affecting variability of CSCI scores. In contrast, indices measuring health of benthic algae were more correlated to water quality variables.

Existing bioassessment data indicate that sampling locations in Lower Silver – Thompson Creek are likely impacted by multiple urban stressors. The majority of locations were modified channels with poor physical habitat conditions. In addition, five of the six sampling locations were in highly urban watersheds, with percent imperviousness in the surrounding landuse ranging from 31% to 53%.

2.2 Study Objectives

The objective of this SSID project is to focus on potential causes of reduced biological conditions in Lower Silver-Thompson Creek. Specifically, the study is designed to help answer the following questions:

1. What sources are contributing nutrients to the creek?
2. Are high nutrient concentrations contributing to the low biological quality in the creek?
3. Is euthropication occurring, and if so what conditions are potential contributing factors?
4. What other conditions might contribute to the low biological quality in the creek?

The data collected during this study will be combined with existing data (Section 3.2) to support a more robust characterization and evaluation of conditions and potential stressors and sources in the subwatershed.

3 STUDY AREA, EXISTING DATA, CANDIDATE CAUSES

3.1 Study Area

The Lower Silver – Thompson Creek subwatershed is the largest tributary (approximately 42 square miles) within the Coyote Creek watershed area below Anderson Dam. Thompson Creek originates in the Diablo Range foothills at an elevation of about 2,300 feet and flows northerly to its confluence with Lower Silver Creek at the eastern edge of the Santa Clara Valley.The transition from Thompson Creek to Lower Silver Creek orrurs just upstream of Lake Cunningham. There is no hydrological connection between the creek and the lake. Historically, with its gentle slopes and poorly drained soils, Lower Silver Creek flowed in an ill-defined channel; most of the flatter areas were swampy and prone to ponding and frequent floods. In the early 1950s, prior to urbanization, Lower Silver Creek was placed in an earthen channel and diverted to its present alignment (SCVURPPP 2003) to flow within an earthen levee around the western edge of Lake Cunningham. From there, it continues to flow in a northwesterly direction in a flood control channel to its confluence with Coyote Creek.

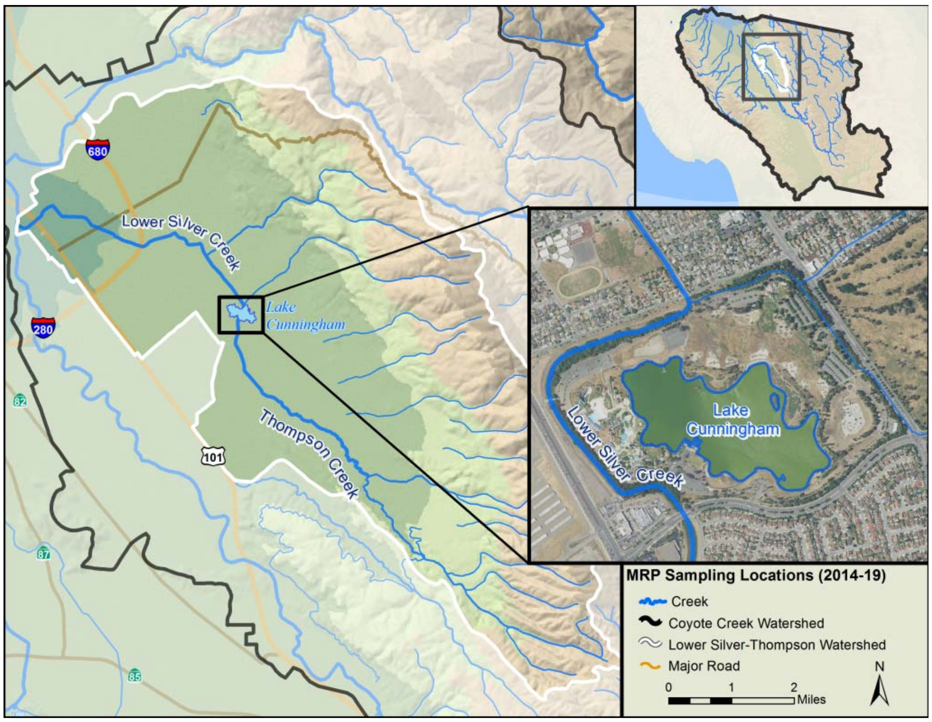

Figure 1. Lower Silver – Thompson Creek watershed, San Jose, California.

Existing land uses in the Lower Silver - Thompson Creek subwatershed are predominantly urban. The upland areas are devoted to uses ranging from rangelands to wildlife habitat, and are largely located outside of the City of San Jose's Urban Service Area boundary and in unincorporated areas of Santa Clara County. Two drop structures are present upstream and downstream of Quimby Road along Thompson Creek. Further upstream, the channel includes levees, rock slope protection, box culverts, and storm drain outfalls. Stream flow is typically intermittent throughout Thompson Creek and perennial in Lower Silver Creek (below Lake Cunningham).

The Lower Silver Creek Flood Protection Project, initiated by Valley Water[1] in early 2000, has resulted in major changes to the channel and physical habitat in the Lower Silver Creek. The primary goal of the

[1] Formerly known as Santa Clara Valley Water District.

project was to reduce potential flooding in the area by removing sediments from the channel to increase conveyance of flow during flood events. Sediment removal in the reach between Coyote Creek confluence and I-680 was completed in 2005. Sediment removal from the remaining section of creek, between I-680 and Lake Cunningham, was completed in 2017. The flood control project also included new levee walls, wider flood plain areas and vegetated banks. In addition, Valley Water has been working on a project to increase the capacity of Lake Cunningham to capture excess water during peak flow events by building a flood wall adjacent to Cunningham Avenue and White Road. Valley Water has also been working on bank stabilization projects in Thompson Creek to reduce erosion and sediment supply to the lower reaches.

3.2 Existing Data

Since 2014, the Program has conducted Creek Status Monitoring (CSM) and Pollutants of Concern (POC) Monitoring in Lower Silver-Thompson Creek to meet requirements under the MRP.

As part of the CSM, the Program conducted bioassessments at six locations in the watershed between 2014 and 2018 (Table 1 and Figure 2). The majority of the bioassessment sites were in low-gradient channels with adjacent urban/suburban land uses. All sites in Lower Silver Creek were within the channelized flood control channel, bordered by earthen levees. Due to recent channel construction associated with the Lower Silver Creek Flood Protection Project (see Section 3.1), riparian vegetation was relatively immature and provided minimal stream shading. Thompson Creek sites consisted of smaller channels with mature riparian forest providing shade and habitat complexity. Reach photos for each bioassessment site are provided in Attachment A.

The Program also collected nutrient samples at three locations in the Lower Silver-Thompson Creek watershed as part of the POC Monitoring (Table 1 and Figure 2). As shown on the map, two of the sample sites were co-located with a CSM site.

CSM and POC results are summarized below.

Table 1. Sampling locations in Lower Silver-Thompson Creek associated with Creek Status and Pollutant of Concern Monitoring.

Program	Creek Name	Station ID	Map ID	Site Location Description	Latitude	Longitude
Creek Status Monitoring	Thompson	205R03825	3825	Flowering Meadow Ln	37.28070	-121.75540
		205R00915	915	Aborn Rd	37.31470	-121.79620
	Lower Silver	205R02771	2771	S. Jackson Rd	37.35228	-121.83543
		205R01747	1747	Kammerer	37.35200	-121.84200
		205R00979	979	Lausett Ave	37.35400	-121.84660
		205R03795	3795	Plata Arroyo Park	37.35770	-121.85820
Pollutants of Concern Monitoring	Thompson	205COY205	205	Aborn Rd	37.31376	-121.79468
	Lower Silver	205COY185	185	S. Jackson Ave	37.35186	-121.83600
		205COY180	180	Wooster Av	37.35544	-121.87083

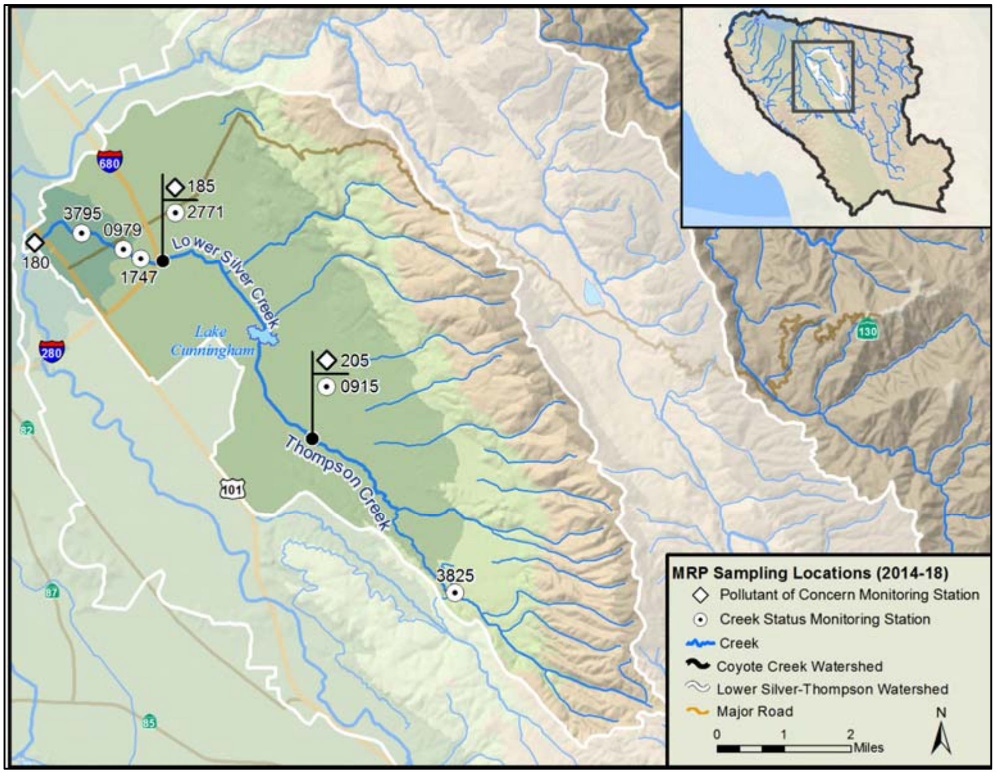

Figure 2. CSM and POCM monitoring stations in Lower Silver-Thompson Creek (2014 through 2018).

3.2.1 Biological and Physical Habitat Conditions

Benthic macroinvertebrate (BMI) and algae samples were collected during the spring season and evaluated as indicators for biological condition. BMI results were interpreted using the California Stream Condition Index (CSCI) (Mazor 2015). Algae results were interpreted using the hybrid Algae Stream Condition Index (ASCI), which integrates soft-bodied algae and diatom metrics (Theroux et al. in prep). The CSCI, ASCI and qualitative score for physical habitat condition (PHAB) at each site are presented in Table 2. Methods for calculating both indices for biological condition and Total PHAB are described in SCVURPPP 2019.

Table 2. Biological condition scores for bioassessment sites sampled in Lower Silver-Thompson Creek (2014 – 2018). Sites are ordered in upstream to downstream direction (from top to bottom of the table).

Station ID	Sampling Date	Elev. (m)	Flow Regime[1]	Benthic Macroinvertebrates		Algae	
				CSCI Score [2]	Condition Category	ASCI Hybrid Score	Condition Category
205R03825	5/1/2018	157	I	0.43	Very Likely Altered	0.64	Very Likely Altered
205R00915	4/24/2014	59	I	0.43	Very Likely Altered	0.68	Very Likely Altered
205R02771	6/3/2016	34	P	0.49	Very Likely Altered	0.49	Very Likely Altered
205R01747	5/18/2015	31	P	0.37	Very Likely Altered	0.56	Very Likely Altered
205R00979	4/24/2014	30	P	0.46	Very Likely Altered	0.78	Likely Altered
205R03795	5/30/2018	25	P	0.40	Very Likely Altered	0.61	Very Likely Altered

[1] Flow Regime: I = Intermittent; P = Perennial

[2] A CSCI score below 0.795 is appropriate for a Stressor Source Identification project as defined in MRP Provision C.8.e.

As shown in Table 2, the CSCI scores were relatively consistent across sites, ranging from 0.37 to 0.49. The ASCI hybrid score varied more, ranging from 0.49 to 0.78. All six bioassessment sites were in the Very Likely Altered or Likely Altered condition category for both CSCI and ASCI Hybrid Indices. Furthermore, all sites had a CSCI score below 0.795. MRP Provision C.8.d(8) states that sites with a CSCI score below 0.795 are considered appropriate for a SSID project.

Selected physical habitat variables measured at the six bioassessments sites in Lower Silver – Thompson Creek are summarized in Table 3. The Physical Habitat (PHAB) Assessment score consists of three attributes that are assessed for the entire bioassessment reach. These include channel alteration, epifaunal substrate, and sediment deposition. Each attribute is individually scored on a scale of 0 to 20, with a score of 20 representing good condition. The total PHAB score is the sum of three individual attribute scores with a score of 60 representing the highest possible score. The most highest elevation site had a total score of 41. The five remaining monitoring sites had PHAB scores ranging from 15 to 27.

Physical habitat endpoints (or metrics) were obtained using the SWAMP Bioassessment Reporting Module (SWAMP RM), which calculates metrics using reach-scale averages of transect-based measurements and observations. Three of the calculated metrics are shown in Table 3. The habitat metric scores indicate that most of the sites are deep with slow moving habitat (e.g, pools and glides), resulting in relatively high depsotion of sand and fine substrate.

Table 3. Physical habitat and landscape data for bioassessment sites sampled in Lower Silver-Thompson Creek (2014 – 2018). Sites are ordered in upstream to downstream direction (from top to bottom of the table

Station ID	Qualitative Physical Habitat Assessment				Quantitative Habitat Metric Score			Landscape
	Channel Alteration Score	Epifaunal Substrate Score	Sediment Deposition Score	Total Score[1]	Wetted Width to Depth Ratio	Slow Water Habitat (%)	Substrate Smaller than Sand (%)	Watershed Impervious area (%)
205R03825	18	10	13	41	34	60	50	6
205R00915	9	4	3	16	52	90	26	16
205R02771	5	9	10	24	29	86	39	21
205R01747	5	9	13	27	26	98	66	23
205R00979	4	2	16	22	29	88	7	24
205R03795	4	7	4	15	16	100	77	25

[1] Total PHAB score is the sum of three individual attribute scores.

Land use and transportation data layers were overlayed with the drainage areas to calculate landscape variables, such as percent impervious area in the area draining to the bioassessment location. With the exception of the highest elevation site (205R03825) which had a 6% impervious area, the bioassessment locations had relatively high percent impervious area, ranging from 16% to 25% (Table 3).

3.2.2 Nutrient Data

Water samples were collected during spring season at all CSM bioassessment locations and analyzed for nutrients. The total nitrogen and total phosphorus concentrations ranged from 1.8 to 8.2 mg/L and <.001 to 0.2 mg/L, respectively, across all sites (Table 4). Un-ionized ammonia concentrations are also presented in Table 34

Table 4. Nutrient concentrations measured at six bioassessment sites.

Project	Station ID	Sampling Date	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Un-ionized Ammonia (ug/L)
Creek Status Monitoring	205R03825	5/1/2018	1.8	0.05	0.6
	205R00915	4/24/2014	2.2	0.20	2.4
	205R02771	6/3/2016	4.5	0.08	4.1
	205R01747	5/18/2015	3.4	0.13	8.3
	205R00979	4/24/2014	3.9	0.09	3.2
	205R03795	5/30/2018	8.2	< 0.01	8.7

Water samples collected as part of POC monitoring during wet and spring seasons at three locations in Lower Silver-Thompson Creek were also analyzed for nutrients. Two of the POC stations were located at previously sampled CSM bioassessment stations. The total nitrogen and total phosphorus concentrations ranged from 3.3 to 5.8 mg/L and .051 to 0.88 mg/L, respectively, across all sites and samples (Table 5). Total nitrogen concentrations in samples collected in the spring season were slightly higher than concentrations in samples collected in the wet season. In contrast, total phosphorus concentrations in the “wet season” samples were higher than those in the “spring season” samples.

Table 5. Nutrient concentrations measured at POC sites.

Project	POCM Station ID	CSM Station ID	Sampling Date	Total Nitrogen (mg/L)	Total Phosphorus (mg/L)	Unionized Ammonia (ug/L)
Pollutant of Concern Monitoring	205COY205[1]	205R00915	1/09/2017	4.6	0.43	2.2
	205COY185	205R02771	1/09/2017	3.4	0.87	1.6
			6/01/2017	4.9	0.1	7.3
	205COY180	NA	1/09/2017	3.3	0.88	1.6
			6/01/2017	5.6	.051	6.7

[1] Sample was not collected during the dry season due to no flow.

An evaluation of existing nutrient concentration data collected in rivers and streams at different trophic states within the United States identified threshold concentrations for total nitrogen and total phosphorus in eutrophic conditions to be 1.5 mg/L and 0.75 mg/L, respectively (Dobbs and Smith 2016). All Lower Silver-Thompson Creek total nitrogen concentrations exceeded the threshold. Phosporus concentrations were below the threshold except two samples from separate POC locations collected during the wet season (See Table 5).

The data evaluation by Dobbs and Smith (2016) also found a strong statistical link between total nitrogen and total phosphorus and benthic algal biomass. Furthermore, they found strong evidence that anthropogenic sources of nitrogen and phosphorus have a large influence on eutrophication-related water quality in rivers and streams.

3.2.3 Eutrophication Indicator Data

The benthic algae samples collected during the spring CSM bioassessments were analyzed for biomass indicators, including ash free dry mass (AFDM) and chlorophyll a (Table 6). In addition, the relative amount of macroalgae cover at each site was estimated during pebble counts as part of the physical habitat condition assessment. These measurements are used as indicators of organic matter accumulation, which is one of the symptoms of eutrophication.

Temperature, dissolved oxygen, and pH readings were also taken from water quality grab samples collected during the bioassessments (Table 6). Reduced concentrations of dissolved oxygen (DO) are another indicator of eutrophication. While the grab sample results are presented in Table 6, it's important to mention that continuous water quality readings are more suitable to understand diurnal fluctuations in temperature and dissolved oxygen and therefore necessary for understanding eutrophication.

Table 6. Eutrophication indicator data measured at CSM bioassessment sites in Lower Silver-Thompson Creek between 2014 and 2018.

Station ID	Sampling Date	Water Temperature C	Dissolved Oxygen (mg/L)	pH	Ash Free Dry Mass (g/m^2)	Chlorophyll a (mg/m^2)	Macroalgae Cover (%)
205R03825	5/1/2018	14	8.5	8.12	135	96	33
205R00915	4/24/2014	15	7.2	8.07	224	47	10
205R02771	6/3/2016	21	9.0	8.08	736	123	34
205R01747	5/18/2015	17	9.9	8.15	350	3	28
205R00979	4/24/2014	18	13.3	8.09	1034	137	32
205R03795	5/30/2018	20	7.7	7.45	305	89	50

The data in Table 6 do not show a consistent pattern between the various eutrophication indicators. For example, there was no association between chlorophyll a or AFDM with percent macroalgae cover. The data also do not indicate a consistent pattern along the creek (upstream to downstream) (Figure 3).

Dobbs and Smith (2016) identified mean and maximum threshold levels for benthic chlorophyll a concentrations for rivers and streams in eutrophic conditions as 70 mg/m^2 and 200 mg/m^2, respectively. Chlorophyl a concentrations in samples from four of the six CSM bioassessment sites in Lower Silver-Thompson Creek exceeded the mean threshold concentration but all concentrations were below the maximum threshold for chlorophyll a. It is important to note, however, that biomass concentrations were measured during spring season and not during the dry season, when sunlight, temperature and flow conditions may be more conducive to the development of eutrophic conditions.

3.2.4 Association between Eutrophication Indicator Data and Biological Conditions

The biological indicator scores for BMI (CSCI) and algae (ASCI) are plotted for the six bioassessment sites sampled in Lower Silver-Thompson Creek in Figure 3. The sites are organized from left to right along the x-axis by decreasing elevation (i.e. from upstream on the left of the x-axis to downstream on the right). The nutrient concentrations and indicators of organic matter accumulation are also presented to allow visual comparison with the biological condition scores.

The CSCI and ASCI hybrid scores for six bioassessment sites are plotted with nutrient concentrations and biomass indicators in Figures 4 and 5. Due to the small number of samples, statistical tests for significance were not conducted. The ASCI hybrid scores show negative association with increasing concentrations of total nitrogen and ammonia, but a positive relationship with total phosphorus. The CSCI scores show very little response to changes in nutrient concentrations. Both the CSCI and ASCI hybrid indices show positive increase with both AFDM and Chl-a as biomass indicators. These data analyses should be interpreted with caution due to the small sample size and the number of factors (e.g., water quality, hydromorphology, etc) that may have confounding influence on biological conditions.

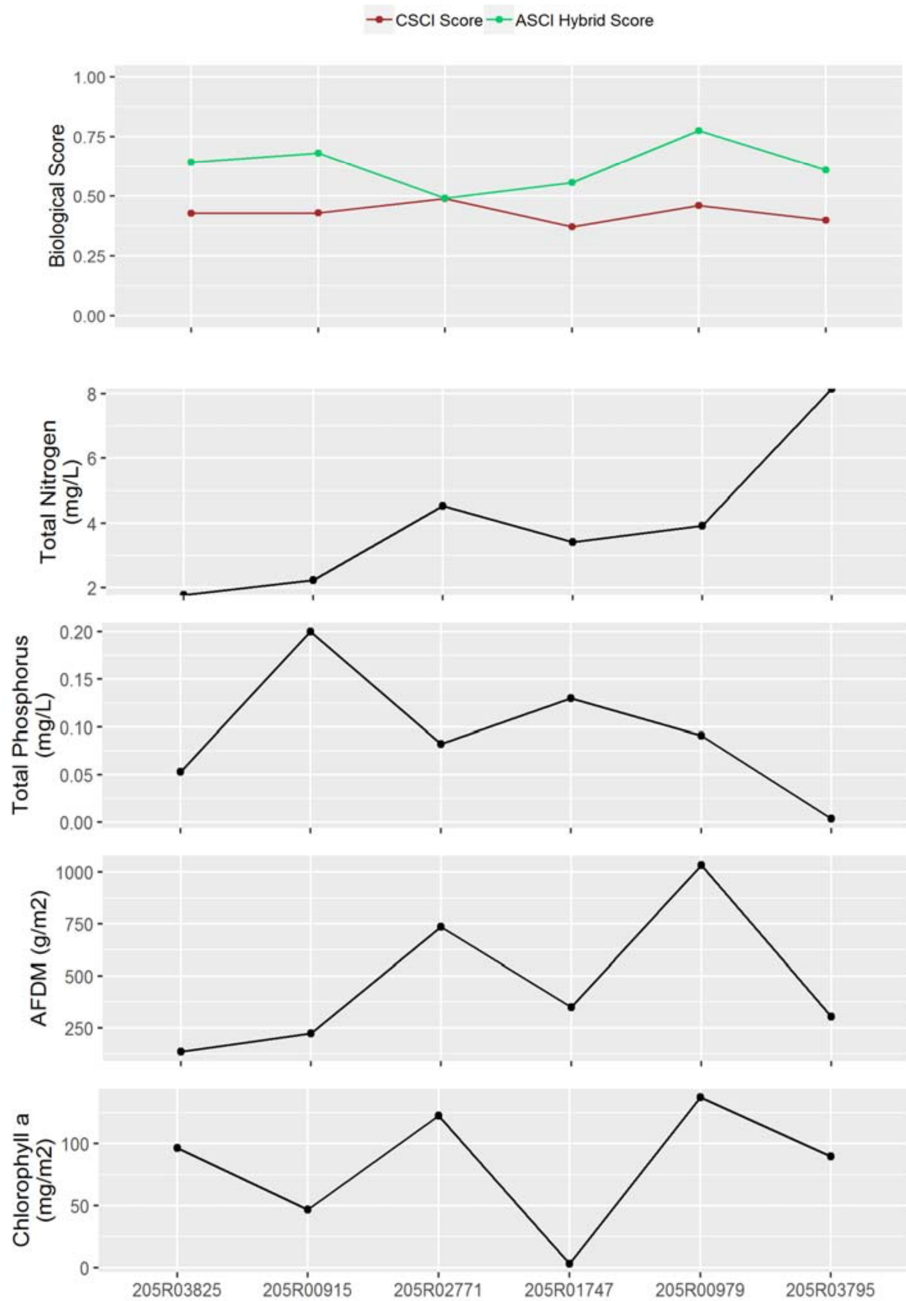

Figure 3. Biological indicator scores, nutrients and biomass indicators for six bioassessment sites in Lower Silver-Thompson Creek (2014-2018). Sites are orders upstream to downstream (right to left).

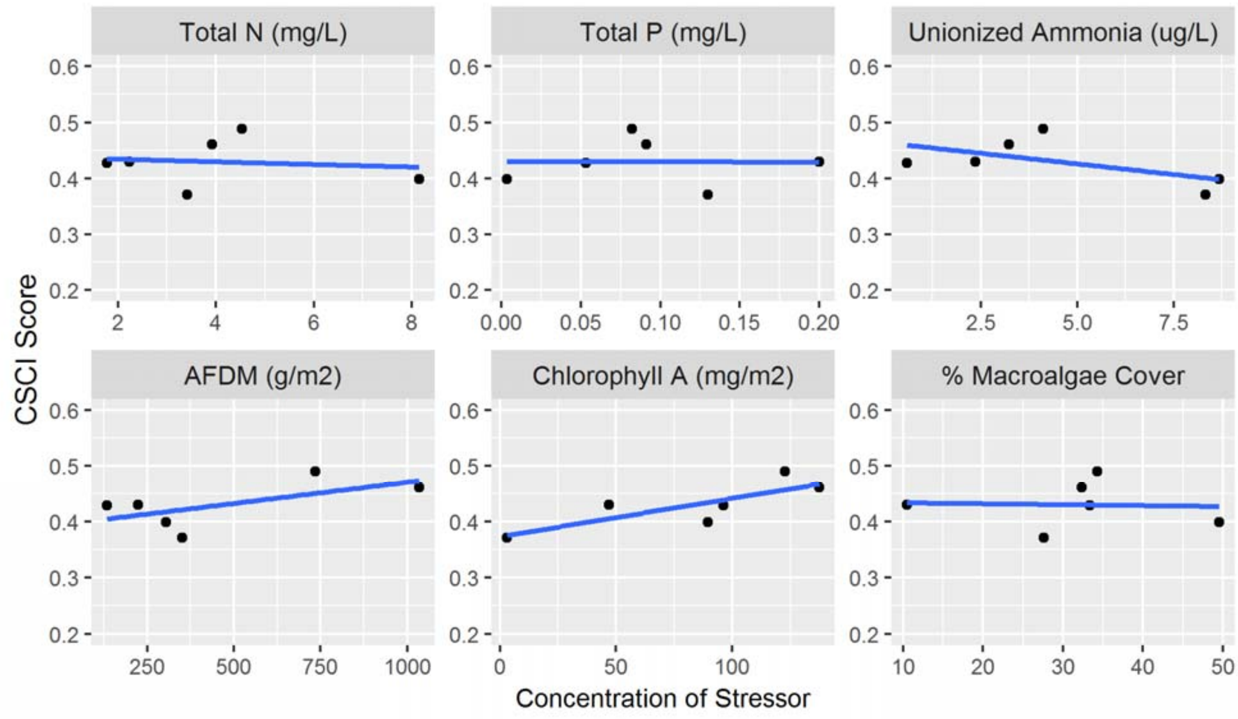

Figure 4. Scatter plots comparing CSCI score with nutrient concentrations (top three plots) and biomass indicators (bottom three plots). Trend lines are indicated, however due to small sample size, statistical test for significance was not conducted.

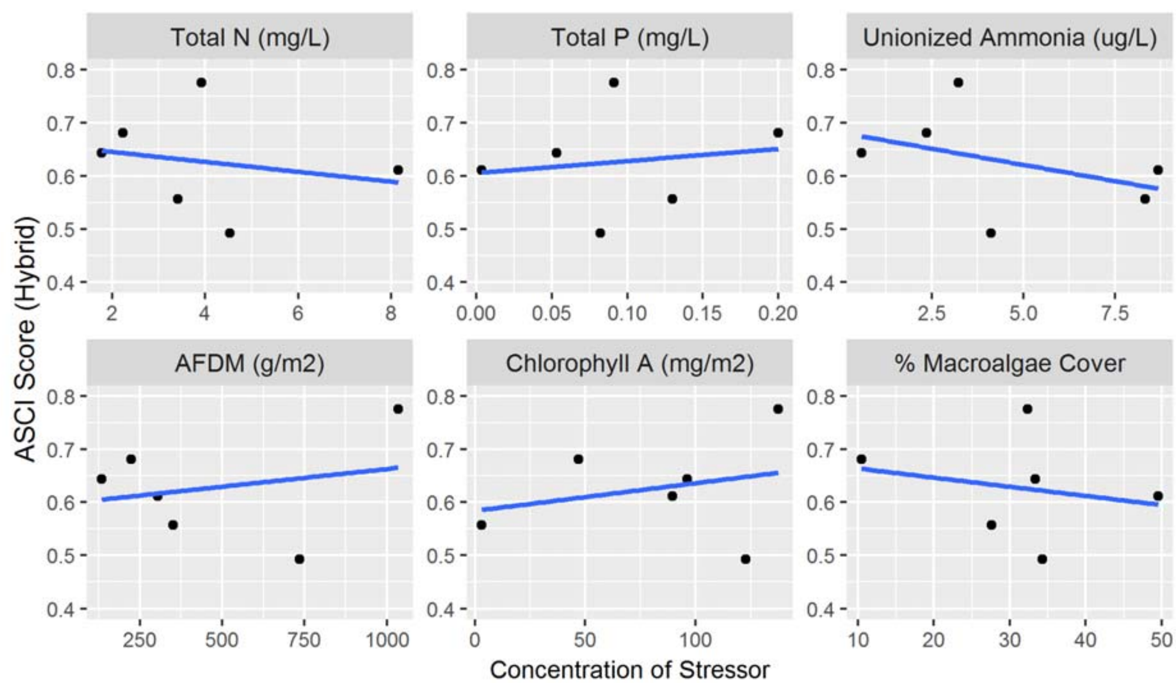

Figure 5. Scatter plots comparing ASCI hybrid score with nutrient concentrations (top three plots) and biomass indicators (bottom three plots). Trend lines are indicated, however due to small sample size, statistical test for significance was not conducted.

3.2.5 Association between Eutrophication Indicators and Physical Habitat

The physical habitat metric scores for wetted width to depth ratio were plotted against macroalgae cover measurements at the six CSM bioassessment sites (Figure 6). The figure indicates that percent algae cover increases with decreasing site depth (relative to width). Other physical habitat metrics and qualitative PHAB scores showed weak correlations with the eutrophication indicators.

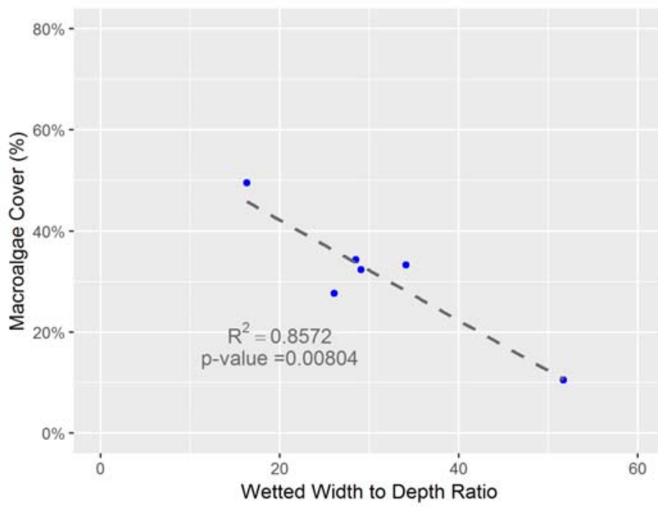

Figure 6. Scatter plots comparing macroalgae cover and wetted width to depth ratio at six bioassessment sites in Lower Silver – Thompson Creek.

3.2.6 Regional Data Comparison

The bioassessment data for the Lower Silver - Thompson Creek dataset were compared to data collected by the Program in other Santa Clara Basin watersheds between WY 2012 and WY 2018. The median CSCI score (0.43) and ASCI hybrid score (0.63) for the six bioassessment sites in Lower Silver-Thompson Creek were generally lower than the median scores for other Santa Clara Basin watersheds (Figures 7 and 8) and the median concentrations for total nitrogen (3.7 mg/L) and total phosphorus (0.087 mg/L) at six sites in Lower Silver-Thompson Creek watershed were higher than median concentrations in other Santa Clara Basin watersheds (Figures 9 and 10).

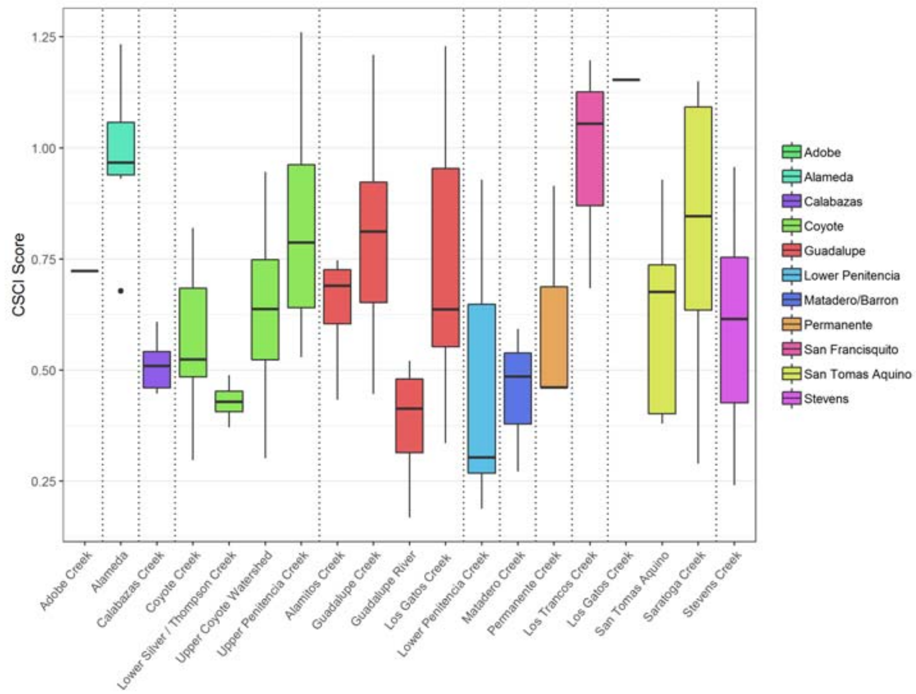

Figure 7. Box plot of CSCI scores for bioassessment sites, grouped by watershed/subwatershed, sampled between 2012 and 2018.

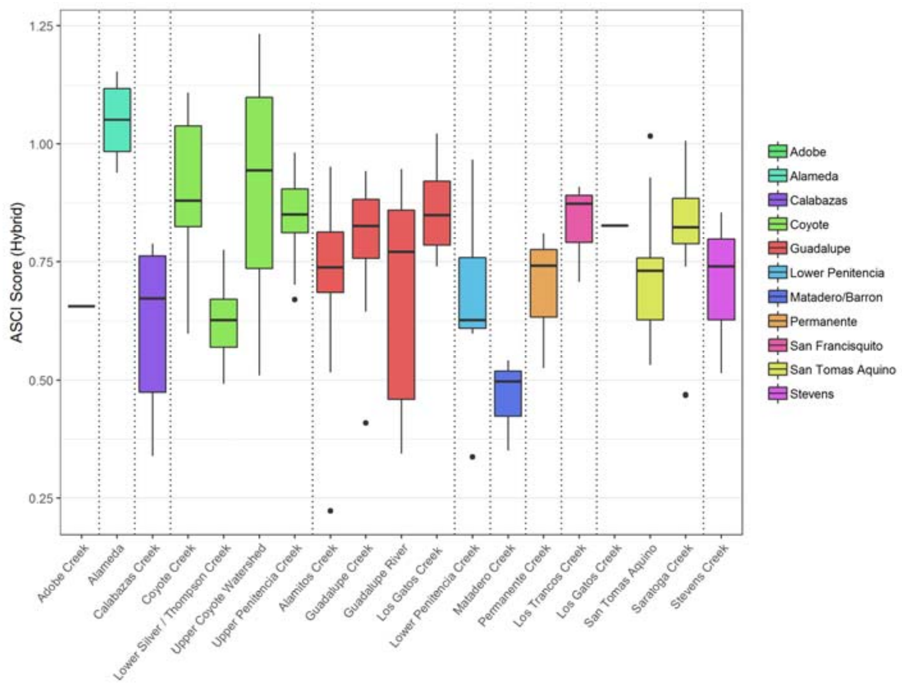

Figure 8. Box plot of ASCI hybrid scores for bioassessment sites, grouped by watershed/subwatershed, sampled between 2012 and 2018.

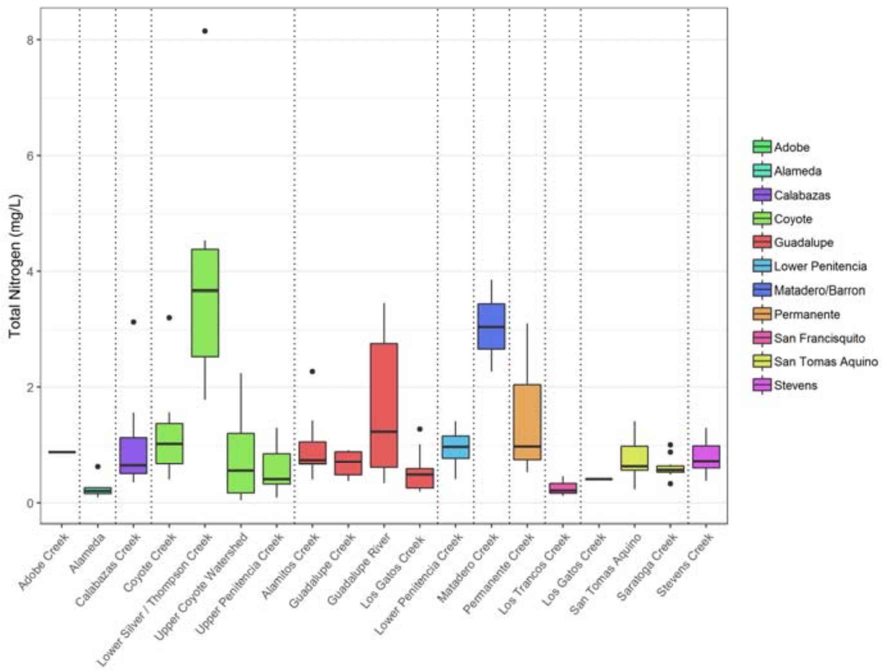

Figure 9. Box plot of total nitrogen concentrations for bioassessment sites, grouped by watershed/subwatershed, sampled between 2012 and 2018.

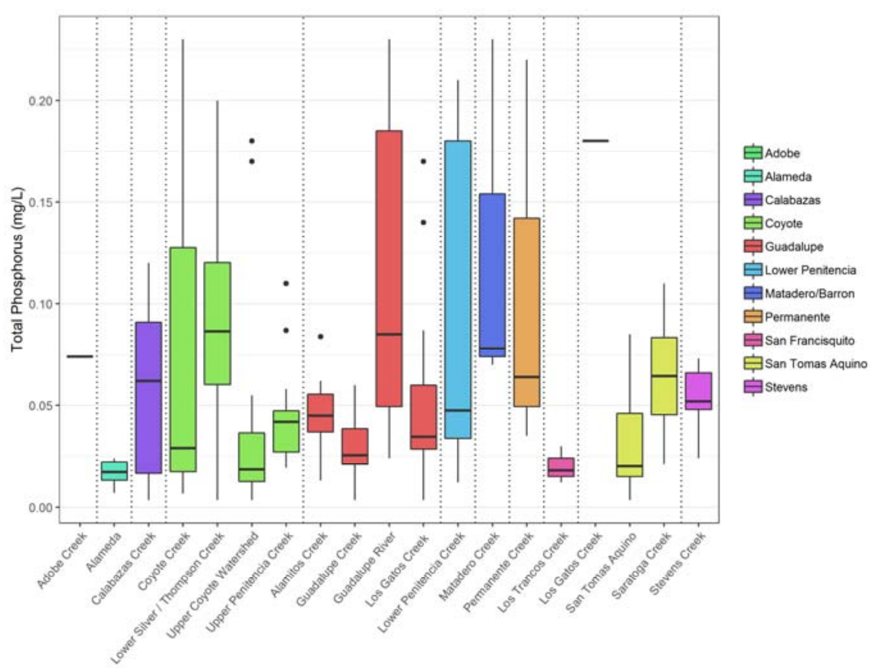

Figure 10. Box plot of total phosphorus concentrations for bioassessment sites, grouped by watershed/subwatershed, sampled between 2012 and 2018.

3.2.7 Data Evaluation for SSID Project

Based on the existing data, the following conclusions were drawn to inform monitoring design of the SSID Project:

Biological Conditions

1. Biological conditions below the MRP threshold (CSCI Score 0.795) indicate a substantially degraded biological community at all six bioassessment sites sampled between 2014 - 2018 in the Lower Silver - Thompson Creek watershed.
2. The median CSCI and ASCI hybrid scores at sites in Lower Silver-Thompson Creek were generally lower than median scores for other Santa Clara Basin watersheds.
3. Consistently low CSCI scores may reflect generally poor habitat conditions within a highly modified creek in an urban watershed. ASCI hybrid scores showed more variability across sites, indicating that other stressors (e.g., water quality, nutrients) may be impacting benthic algae community at some locations.

Stressor Data

1. In general, total nitrogen and un-ionized ammonia concentrations increased across sites in an upstream to downstream direction.
2. Limited wet season samples suggest that concentrations of total phosphorus are higher in the wet season than in the spring season. Spring season total phosphorus concentrations were highest at the Thompson Creek location upstream from Lake Cunningham ; concentrations generally decreased between sample locations along Lower Silver Creek.
3. Nutrient concentrations at most sites in Lower Silver-Thompson Creek are at levels that are associated with eutrophic rivers and streams (Dobbs and Smith, 2016).
4. Biomass indicators (AFDM, chlorophyll a, macroalgae cover) were highly variable among the bioassessment sites, indicating that site conditions (e.g., exposure to sunlight, flow conditions) may be important factors influencing algae production.
5. Biomass indicators were measured during spring season. Sampling was not conducted during the late summer season, when sunlight, temperature and flow conditions may be more conducive to the development of eutrophic conditions.
6. Physical habitat data indicate that a majority of the sites were deep, slow moving, and with a high percentage of sand and fine substrate at the time that data were collected.
7. Continuous water quality data were not available to evaluate as an indicator for eutrophication conditions.

Association of Stressors and Biological Conditions and Physical Habitat

8. Existing data indicate that different stressors may be impacting biological conditions at the different CSM bioassessment sites.
9. Biological indices results (CSCI, ASCI) in the Lower Silver - Thompson Creek watershed do not appear to be correlated to site elevation or flow regime.
10. Shallow physical habitat conditions (lower width to depth ratios) were significantly correlated with percent macroalgae cover.

3.3 Candidate Causes

Based on the available information, the candidate causes, or stressors, for poor biological conditions to be evaluated in the Lower Silver - Thompson Creek SSID Project include:

- Elevated nutrient (N, P) concentrations
- Increase in biomass (algae production)
- Water quality (changes to dissolved oxygen, pH)
- Altered physical habitat and stream flow

The focus of the SSID Project will be on evaluating sources of and impacts from nutrients. However, additional stressors associated with altered physical habitat and water quality will also be assessed. As shown in Figure 11, many of these stressors are interrelated. For example, physical habitat (channel) alteration can lead to increased delivery and/or residence time of nitrogen and phosphorus to the receiving water. And increased algal growth as a result of increased nutrient concentrations in the water can lead to reduced dissolved oxygen concentrations.

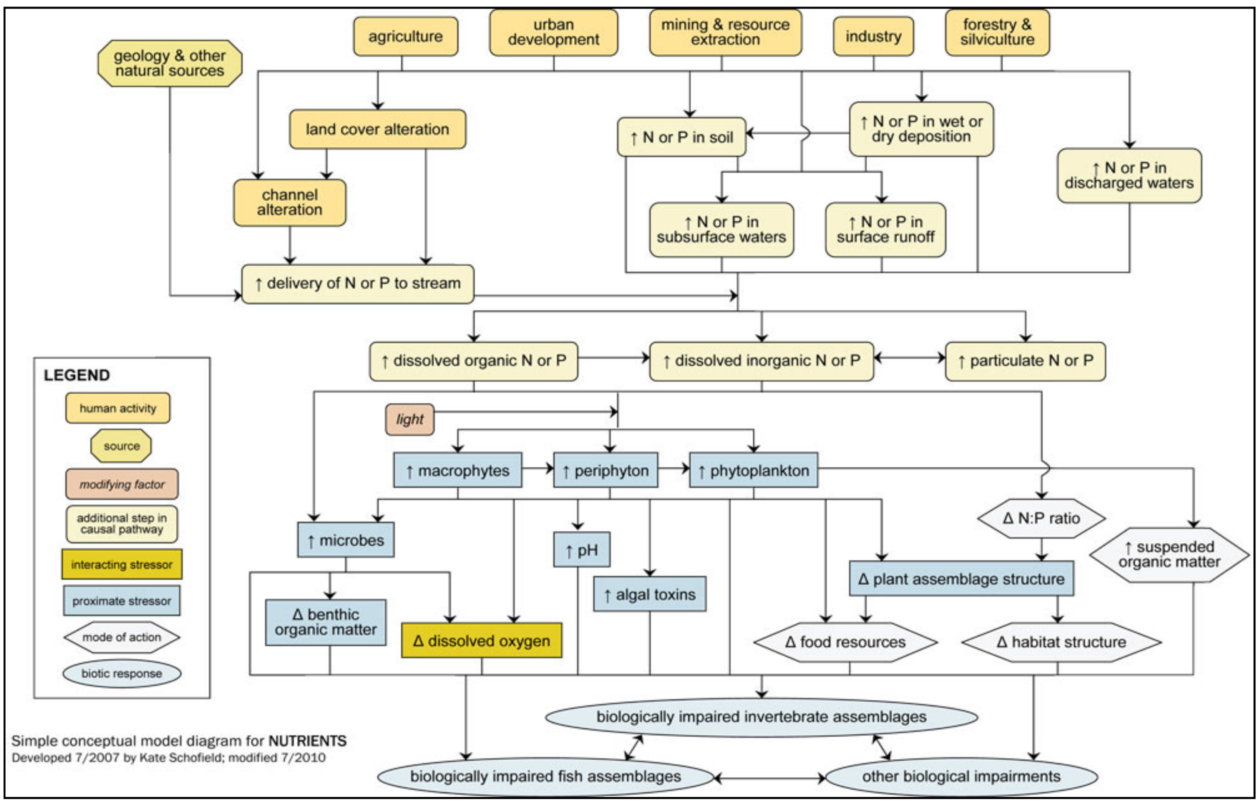

Figure 11. Conceptual model showing different causal pathways for nutrients to impact biological communities.

4 SSID MONITORING APPROACH AND SCHEDULE

The monitoring program described in this section has been designed to collect data in support of the study objectives outlined in Section 2.2 of this work plan. The program will consist of the following field data collection components:

- Nutrient Source Study
- Continuous Water Quality and Temperature Monitoring
- Biological Conditions Evaluation
- Eutrophication Assessment

The proposed schedule for each of these components is presented in Table 7 and the proposed approach is discussed in the sections below. The data will be evaluated to determine potential sources of nutrients in the watershed which can then inform potential management actions to reduce nutrient levels in the Lower Silver – Thompson Creek watershed. The monitoring data will also be evaluated to determine what, if any, correlation may existing between biological conditions and the stressor data (e.g., biomass, low dissolved oxygen).

4.1 Sample Frequency

Field sampling will occur over three seasonal time periods across two water years: dry season (WY 2019), and both spring and dry season (WY 2020) (Table 7). Water chemistry (nutrient) sampling and continuous water quality monitoring will occur during all three seasonal periods. Two nutrient sampling events will occur during both dry seasons, but only one event is planned during the spring season. The first nutrient dry season event will occur at 9 sampling locations; the subsequent sampling events will occur at 6 locations (Table 7). The continuous water quality and temperature monitoring will occur at 3 locations for all sampling periods. The biological assessments will occur at six locations during the spring of WY 2020. Eutrophication assessment will occur at the same six locations during the dry season of 2020.

Table 7. SSID Work Plan Field Data Collection Components and Schedule.

Sampling Timeframe	Water Chemistry (Nutrients)	Continuous Water Quality Monitoring	Continuous Temperature	Biological Conditions Evaluation	Eutrophication Assessment
Dry Season (WY 2019)	9 (2X)	3	3	-	-
Spring Season (WY 2020)	6	3	3	6	-
Dry Season (WY 2020)	6 (2X)	3	3	-	6
Total Samples	30	9	9	6	6

WY = water year .

4.2 Sampling Locations

The nutrient monitoring sites will be established within stream reaches that represent different channel types (flood control, natural) and hydrologic conditions (outfalls, tributary confluences). Proposed study reaches are presented in Table 8. Existing monitoring stations previously sampled by the Program as part of CSM or POC monitoring activities are shown in Figure 12. Potential new monitoring stations are indicated for study reaches above and below Lake Cunningham that do not have existing data (sites T-1 and T-2). All sampling stations will be confirmed following a field reconnaissance to verify that flow conditions are suitable for collecting water samples and/or conducting biological assessments. Additional sites may be added where suspected sources (e.g., outfall discharges) are observed. There may be no sampling locations in the lower section of Thomspon Creek (Quimby Road to Yerba Buena), due to intermittent flow conditions.

Table 8. Proposed study reaches and monitoring locations for Lower Silver – Thompson SSID Project.

Creek	Study Reach	Potential Sample Location ID	Channel Type	Major Tributaries	Number of Outfalls > 36 inch diameter	Potential Nutrient Sources
Lower Silver Creek	Coyote Cr to I-680	3795, 979	Mix of Concrete channel and earth levee; flood control project completed 2005	Miguelita Creek	6	Residential; industrial land uses; illegal encampments
	I-680 to Cunningham Ave	2771, 467	Earth levee; flood control project completed 2017	Babb Cr	4	Residential
	Cunningham Ave to Tully Rd	T-1	Channel adjacent to Lake Cunningham; earth levee; flood prone area with mature riparian forest	Flint Creek; Ruby Creek	2	Lake Cunninham (overflow; groundwater)
	Tully Rd to Quimby Rd	T-2	Wetland type channel; sediment depositional area	Norwood Cr	3	Depositional Area/wetland
Thompson Creek	Quimby Rd to Yerba Buena Rd	915	Intermittent; incised with eroding banks;	Quimby Cr; Evergreen Cr	3	Residential/ Commercial
	Yerba Buena Rd to Silver Creek Rd	4418	Mostly flowing; meandering channel, narrow riparian buffer	Yerba Buena Cr, Cribari Cr	2	Residential; Golf Course
	Upstream Silver Creek Rd	4537	Rangeland	Dry Creek	0	Agriculture and range land

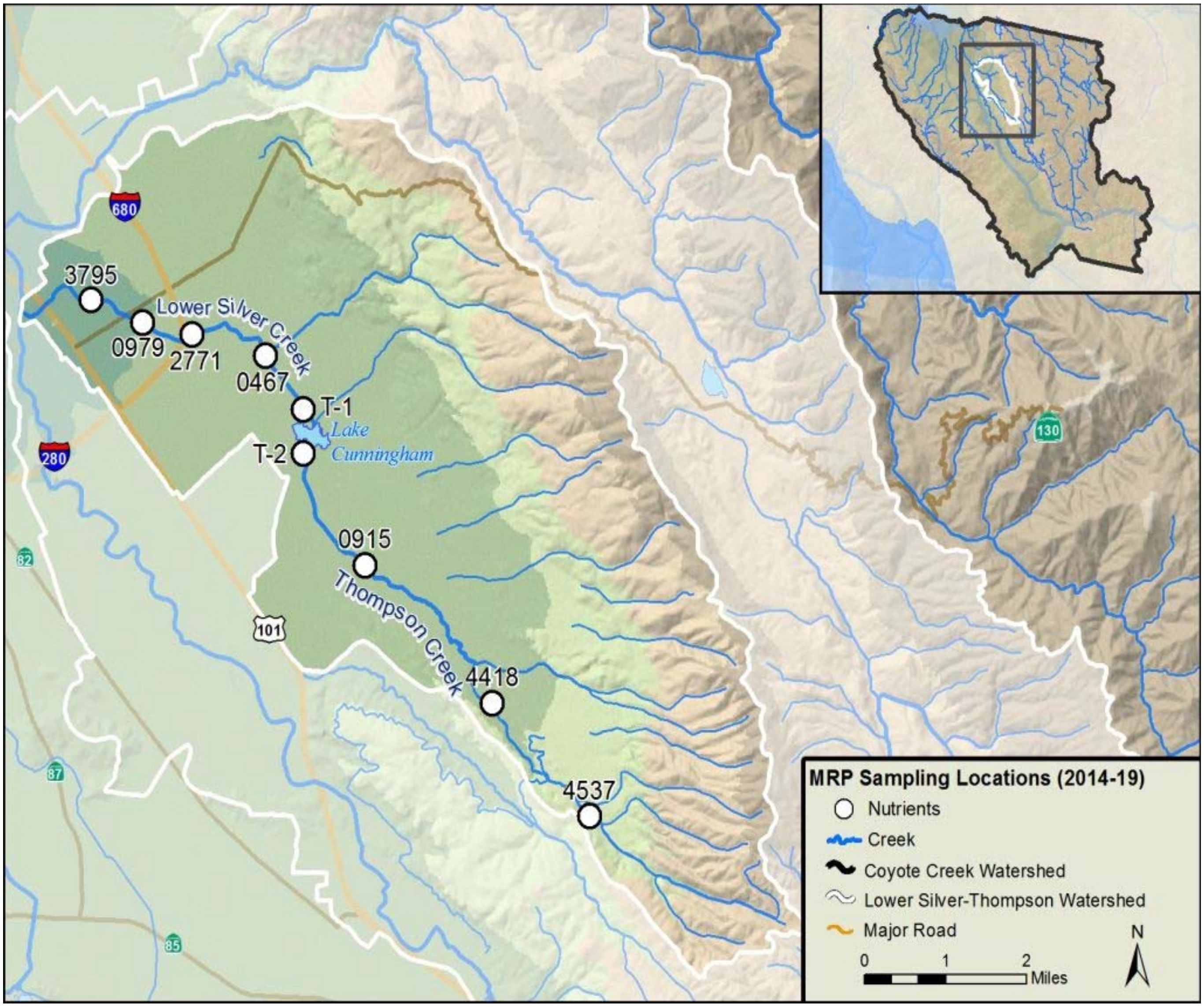

Figure 12. Proposed locations for water sampling and benthos/habitat assessment in Lower Silver-Thompson Creek.

4.3 Field Methods

4.3.1 Water Chemistry (nutrients)

Water samples will be collected at sites for nutrients and conventional analytes using the Standard Grab Sample Collection Method (BASMAA 2016a). Sample containers are rinsed using ambient water and completely filled and recapped below water surface whenever possible. An intermediate container is used to collect water for all sample containers with preservative already added in advance by the laboratory. A syringe filtration method is used to collect samples for analyses of Dissolved Ortho-Phosphate and Dissolved Organic Carbon. All sample containers will be labeled and stored on ice for transportation to laboratory.

4.3.2 Continuous Water Quality and Temperature Monitoring

Water quality monitoring equipment recording dissolved oxygen, temperature, conductivity, and pH at 15-minute intervals (YSI 6600 data sondes) will be deployed for 7-10 day period during each sampling event. Procedures used for calibrating, deploying, programming and downloading data are described in BASMAA (2016a).

Digital temperature loggers (Onset HOBO Water Temp Pro V2) will be programmed to record data at 60-minute intervals. The loggers will have pressure transducers to record water depths at same intervals as temperature data. Procedures used for calibrating, deploying, programming and downloading data are described in BASMAA (2016a).

4.3.3 Biological Conditions Evaluation

Each bioassessment sampling site will consist of an approximately 150-meter stream reach that will be divided into 11 equidistant transects placed perpendicular to the direction of flow. Benthic macroinvertebrate (BMI) and algae samples will be collected at 11 evenly spaced transects using the Reachwide Benthos (RWB) method described in the SWAMP SOP (Ode et al. 2016). The full suite of physical habitat data will be collected within the sample reach.

Biological samples will be sent to laboratories for analysis. The laboratory analytical methods for BMIs will follow Woodward et al. (2012), using the Southwest Association of Freshwater Invertebrate Taxonomists (SAFIT) Level 1 Standard Taxonomic Level of Effort, with the additional effort of identifying chironomids (midges) to subfamily/tribe instead of family (Chironomidae). Soft algae and diatom samples will be analyzed following SWAMP protocols (Stancheva et al. 2015).

4.3.4 Eutrophication Assessment

The eutrophication assessment will include two components. The first component will be to conduct field reconnaissance at each of the study reaches to determine if eutrophic conditions are present (e.g., evidence of algal blooms, fish kills). A hand-held sonde will be used to take grab samples to measure water quality conditions. Sites of algal blooms and/or fish kills will be recorded on a map.

The second component will include a modified bioassessment method that includes only the collection of benthic algae and a physical habitat assessment (Ode et al. 2016). The benthic algae samples will be sent to laboratories for analysis of taxonomic composition and ash free dry mass and chlorophyll a.

4.4 Testing and Analytical Methods

Water chemistry samples will be analyzed using the methods and reporting limits shown in Table 9.

Table 9. Analytical constituents, methods and reporting limits used for water and biogical samples collected for the Lower Silver-Thompson Creek SSID Project.

Analyte	Method	CalTest MRL	Units
Water			
Phosphorus, Total	SM 4500-PE	0.01	mg/L
Orthophosphate as Phosphorus (dissolved)	SM 4500-PE	0.01	mg/L
Nitrogen, Total Kjeldahl	SM 4500-NH_3 C	0.1	mg/L
Nitrate as Nitrogen	EPA 300.0	0.05	mg/L
Nitrite as Nitrogen	SM4500-NO_2 B	0.005	mg/L
Ammonia as Nitrogen	SM 4500-NH_3 C	0.02	mg/L
Benthic			
Benthic Macroinvertebrates	SWAMP Bioassessment SOP (2016)	Not specified	
Benthic Algae			
Chlorophyll a	SM 10200 H-2b	5	mg/L
Ash Free Dry Weight	CALTEST B-AFDW	2	mg/L

4.5 Data Analysis Methods

The BMI and algae data will be used to assess the biological condition (i.e., aquatic life Beneficial Uses) of the sampled reaches using condition index scores described in SCVURPPP (2019). Physical habitat data will be used to characterize physical habitat conditions using a multimetric index scoring tool (SCVURPPP 2019). Physical habitat and water chemistry data will also be evaluated as potential stressors to biological health using triggers and water quality objectives identified in the MRP and existing thresholds from literature (Dobbs et al. 2016, Mazor et al. (in preparation)).

The association of stressors with biological indicator scores will be evaluated using simple regression models. Linear regressions will be tested between variables within each of the stressor data types (e.g., physical habitat and water chemistry) and biological conditions indicators (i.e., CSCI and ASCI scores). Scatter plots showing trend lines will be presented for some of the variables to show positive or negative correlation.

Potential sources of nutrients to the Lower Silver – Thompson creek will be identified using available land use data and observations collected during field work. Relationships between potential sources and nutrient concentrations and biological conditions as well as other physical habitat will be evaluated qualitatively and quantitively, to the extent possible.

4.6 Quality Assurance

Quality Assurance/Quality Control (QA/QC) analyses include levels of precision and accuracy, and tolerable levels of error as presented in detail in the RMC QAPP (BASMAA et al., 2016a). Caltest Laboratories will perform all chemical analyses in accordance with the RMC QAPP and their respective quality assurance programs.

4.7 Reporting

The Program will prepare a Final Report with data results and interpretation as an attachment to the WY 2020 Urban Creeks Monitoring Report, which will be submitted to the Water Board on March 31, 2021.

5 REFERENCES

Bay Area Stormwater Management Agency Association (BASMAA) Regional Monitoring Coalition (RMC). 2016a. Creek Status and Pesticides & Toxicity Monitoring Quality Assurance Project Plan, Final Version 3. Prepared for BASMAA by EOA, Inc. on behalf of the Santa Clara Urban Runoff Pollution Prevention Program and the San Mateo Countywide Water Pollution Prevention Program, Applied Marine Sciences on behalf of the Alameda Countywide Clean Water Program, and Armand Ruby Consulting on behalf of the Contra Costa Clean Water Program. 83 pp plus appendices.

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