SANTA CLARA BASIN WATERSHED MANAGEMENT INITIATIVE

STATE OF THE SANTA CLARA BASIN
PHASE I ENVIRONMENTAL INDICATORS DEVELOPMENT
INTERIM TECHNICAL REPORT

SANTA CLARA BASIN

WMI

WATERSHED MANAGEMENT INITIATIVE

Prepared by

Indicators Workgroup

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EXECUTIVE SUMMARY

The 2003 Watershed Action Plan developed by the Santa Clara Basin Watershed Management Initiative (WMI) identified a goal of developing and using environmental indicators to characterize progress toward the protection of watershed health. The WMI completed a Watershed Action Plan (Action Plan) in 2003 that discusses environmental protection programs, outlines strategic objectives for the Basin and next steps for achieving a vision of watershed health for the Basin. One of the next steps is to "prepare annual reports, updating key indicators of watershed health and describing recent progress in preserving and enhancing Basin watersheds, new findings and study results, and WMI achievements and successes." To achieve this next step, the WMI formed two Workgroups. Workgroup H was tasked to develop a programmatic report card and Workgroup I (Indicators Workgroup) was tasked to develop and report on watershed health indicators. The Indicators Workgroup indicator development will also serve the Water Resources Protection Collaborative (Collaborative) and the Santa Clara Valley Water District (District) efforts.

This report summarizes the efforts of the Indicators Workgroup from late 2004 to June 2005 and provides a checkpoint for the Phase I indicators development scope of work. The report presents the framework used to develop environmental indicators for the Basin as well as recommendations for Candidate Indicators, which will be further developed for use in reporting on stream ecosystem condition.

Phase I initiates indicator development and will result in a suite of Pilot Indicators, a status and trends report card, and a scope for Phase II. Phase I will rely largely on best professional judgment and emphasize indicators that can be developed using existing information to the extent possible. Phase I is limited in geographic scope to in-stream and riparian habitats within the Santa Clara Basin, and focuses on the dimensions of stream health that are strongly affected by land-use decisions. Future phases will further refine and expand the suite of indicators identified in Phase I, extend the geographic scope to include the South San Francisco Bay, including the Baylands.

Specifically, the objectives for Phase I are to:

1. Develop a pilot suite of 3 to 5 environmental indicators for use by the WMI, the District and the Municipalities of the Collaborative to assess ecosystem condition with a focus on in-stream and riparian habitat in the Santa Clara Basin by June 30, 2005.

2. Develop a preliminary reporting format for presenting the results of assessments using indicators by March 30, 2005.

3. Use a subset of the Objective No. 1 pilot environmental indicators to characterize and report on the progress toward the strategic objectives and an assessment of "next steps" identified in the WMI Watershed Action Plan by June 30, 2005. (Schedule was extended to June 2006 due to lack of adequate time for a scientifically credible analysis.)

4. Develop a scope of work for Phase II by June 30, 2005, to include a broader geographic area (Bay, Baylands) and additional environmental indicators. (Schedule extended to June 2006.)

Environmental indicators are measurable environmental features that provide insight into changes in the condition of an ecosystem, the pressures put on the environment caused by human activities or environmental perturbations and the societal response to the pressures. Because it is not practical, and in some cases not possible, to measure everything of interest, indicators serve as surrogate measures of ecosystem functions that cannot be measured directly. Indicators can be used to communicate information regarding the condition of an ecosystem at a particular point in time, changes in condition and trends in condition over time. Indicator values can inform decision-makers about the need for interventions to bring about desirable changes and what interventions might be the most effective and inform managers about the success of past interventions.

The major steps in the development of indicators so far have included development of a general conceptual model to better understand relationships between stressors, stream ecosystem condition, and management responses (Pressure-State-Response [PSR] model); development of assessment questions based on the WMI's vision, the WMI's Action Plan and work products from the Collaborative and District Stewardship Planning process; prioritization of assessment questions for Phase I; and identification and screening of Preliminary Indicators using three criteria (decision support, data availability, and cost effectiveness) to determine Candidate indicators. The analysis is preliminary and will be revisited as Phase I indicator development continues.

Assessment questions focused on the status and trends in (1) the condition, distribution, and extent of riparian and wetland habitat; (2) condition of aquatic habitats; (3) biological communities; and (4) hydrogeomorphic processes. A total of 22 indicators were advanced to Candidate Indicator status as presented in the following table.

Next steps for the Phase I indicators development include:

1. Establish a vision for watershed health as a basis for indicator selection.

2. Identify Pilot Indicators by further evaluating Candidate Indicators and refining the PSR model (may include adding new indicators).

3. Develop implementation plan.

4. Implement Pilot Indicators using existing data, including the development and use of a preliminary scoring system.

5. Prepare Pilot Report Card.

The Indicators Workgroup will develop a pilot report card and a technical report summarizing Phase I by June 2006.

TABLE 1

RECOMMENDED CANDIDATE INDICATORS

(The type of indicator according to the PSR model is presented in parentheses.)

ASSESSMENT QUESTIONS	INDICATOR CATEGORIES	CANDIDATE INDICATORS	RATIONALE	POTENTIAL METRICS
Riparian and Riverine Wetland Habitat Condition: What are the status and trends in the condition, distribution, and extent of riparian and riverine wetland habitats?				
How extensive are wetland and riparian habitats?	Riparian and wetland habitat condition	Extent of riparian and wetland habitat *(Condition Indicator)*	Strong decision support and can be derived from existing aerial imagery. Photointerpretation is needed to summarize the data.	• Acres of riparian and wetland habitat • Width of habitat • Ratio of habitat width to ideal riparian width as per policy or ordinance
To what extent is the riparian corridor fragmented due to land use changes and to what degree are habitat patches connected?	Riparian and wetland habitat condition	Extent of riparian habitat fragmentation *(Stress Indicator)*	Strongly supports assessment questions and can be derived from existing aerial imagery. Photointerpretation is needed to summarize the data.	• Linear feet of contiguous riparian corridor • Number and size of riparian habitat patches • Habitat patch indices: path contagion and interspersion, patch cohesion, inter-patch distance, distribution, etc.)
To what extent is the riparian corridor fragmented due to land use changes and to what degree are habitat patches connected?	Riparian and wetland habitat condition	Extent of development in riparian corridor *(Stress Indicator)*	Strongly supports assessment questions and can be derived from existing aerial imagery. Photointerpretation is needed to summarize the data.	• Distance of urban development from top of bank • Percentage riparian corridor developed • Acres of habitat loss due to land conversion
Where are opportunities to protect, restore, and enhance riparian and wetland habitats?	Riparian and wetland habitat condition	Extent of invasive riparian and wetland species *(Stress Indicator)*	Strong decision support but limited data availability; a cost-effective rapid assessment approach could be developed.	Acres and taxa of invasive species colonization

ASSESSMENT QUESTIONS	INDICATOR CATEGORIES	CANDIDATE INDICATORS	RATIONALE	POTENTIAL METRICS
Riparian and Riverine Wetland Habitat Condition: How much riparian and wetland habitat is protected, restored, and enhanced?				
How much riparian and wetland habitat is protected, restored, and enhanced?	Riparian and wetland habitat protected, restored, or enhanced	Extent of riparian and wetland habitat protected *(Response Indicator)*	Strongly supports assessment questions and can be derived from existing information.	Percent of riparian corridor under public ownership and permanently protected
		Extent of riparian and wetland habitat restored *(Response Indicator)*	Strongly supports assessment questions and can be derived from existing information.	Acres of riparian and wetland habitat restored
		Extent of riparian and wetland habitat enhanced *(Response Indicator)*	Strongly supports assessment questions and can be derived from existing information.	Acres of riparian and wetland habitat enhanced
Aquatic Habitat Condition: What are the status and trends in the condition of aquatic habitats?				
What are the status and trends in the quality of in-stream waters?	Stream water quality	Physiochemical water Quality *(Condition Indicator)*	Strong decision support and data availability. Could be very cost effective or not cost effective over the long-term, depending on the method.	• Number and location of impaired water bodies or Exceedences of established water quality criteria • Concentration of mercury in fish tissue • Water quality index
Are sensitive macroinvertebrate species present?	Stream water quality	Macroinvertebrate assemblages *(Condition Indicator)*	Strong decision support, some data availability, and potential for greater cost-effectiveness over water quality monitoring.	• % Intolerants & Intolerants • % Dominant taxa • Taxanomic richness • % Functional feeding groups • Composition measures
How extensive is trash?	Stream water quality	Extent of trash *(Stress Indicator)*	Current “hot spot” methodology is not representative of status and does not allow tracking trends in improvement; consider adjusting methodology.	Number and location of trash hotspots

ASSESSMENT QUESTIONS	INDICATOR CATEGORIES	CANDIDATE INDICATORS	RATIONALE	POTENTIAL METRICS
Are flows adequate for habitat? What changes in in-stream habitat are attributed to changes in water availability and water management practices?	In-stream flows	In-stream flows *(Condition Indicator)*	Strong decision support and cost effective. Available data from existing gages may not be representative.	• Linear miles and frequency of dry back • Average cfs during indicator period at representative monitoring sites • Measure of deviation from measurable objective annual flow targets (magnitude, timing, duration) at representative monitoring sites
What are the status and trends of in-stream habitat complexity and diversity to support fisheries and other animals?	Anadromous fish habitat suitability	Anadromous fish spawning habitat *(Condition Indicator)*	Strong decision support, cost effective; data available for isolated segments on certain streams.	• Abundance (or number of river miles) of spawning gravel (or number of river miles with coarse sediments suitable for spawning) • Proportion of inundated spawning gravel • Average percentage fines
What are the number, location, and severity of fish passage barriers?	Anadromous fish habitat suitability	Anadromous fish passage barriers *(Stress Indicator)*	Strong decision support, cost effective; limited data availability.	• Water depth in low flow during adult upstream migration • No. of barriers (ratio of staging pool to vertical barrier height • Percentage of stream length of pools, rifles, runs • Number of river miles within potential spawning habitat unimpeded by dams
Is there adequate spawning and fish rearing habitat to support recruitment of anadromous fish and SRA to moderate temperature?	Anadromous fish habitat suitability	Anadromous fish rearing habitat complexity and diversity *(Condition)*	Strong decision support and long-term data available. Cost effective depending on methodology.	

ASSESSMENT QUESTIONS	INDICATOR CATEGORIES	CANDIDATE INDICATORS	RATIONALE	POTENTIAL METRICS
Is there adequate spawning and fish rearing habitat to support recruitment of anadromous fish and SRA to moderate temperature?	Anadromous fish habitat suitability	Shaded riverine aquatic cover *(Condition Indicator)*	Strong decision support and long-term data available. Cost effective depending on methodology.	Percentage shaded stream surface, others
Biological Communities: What are the status and trends in the biological communities?				
Are reproductive populations of anadromous fish supported in streams that are considered capable of supporting them?	Native Fish Recruitment	Anadromous fish species recruitment: juvenile recruitment *(Condition Indicator)*	Strong decision support, marginal cost-effectiveness, and data limited to Guadalupe River and is not systematically monitored. Candidate indicator status limited to Guadalupe watershed.	Number of outmigrating juveniles
Are reproductive populations of anadromous fish supported in streams that are considered capable of supporting them?	Native Fish Assemblages	*Anadromous fish species assemblages: overwintering habitat* *(Condition Indicator)*	Strong decision support, marginal cost-effectiveness, but limited data (Guadalupe River and Stevens Creek).	% suitable overwintering habitat
Hydrogeomorphology: Are streams and streambanks in dynamic equilibrium?				
To what extent are streambeds and banks stable?	Hydrogeomorphic processes	Channel condition: stream bed and bank characteristics *(Condition Indicator)*	Strong decision support, somewhat cost-effective, limited data availability	% stream length eroded

ASSESSMENT QUESTIONS	INDICATOR CATEGORIES	CANDIDATE INDICATORS	RATIONALE	POTENTIAL METRICS
To what extent is stream modification occurring and what type?	Hydrogeomorphic processes	Channel condition: extent, quality and type of channel modification *(Stress Indicator*)	Strong decision support, cost effective and data available.	
To what degree are the floodplains connected to their creeks?	Hydrogeomorphic processes	Floodplain connectivity *(Condition Indicator)*	Strong decision support, cost effective if derived from aerial imagery; photointerpretation needed to summarize data.	• Number of and percent modified stream length by type • Percent of channel modification sites where erosion is occurring at head or toe of the modification • Number of and percent stream length underground or in complete culvert/tunnel
To what extent is hydromodification occurring?	Hydrogeomorphic processes	Stream hydrograph *(Condition Indicator)*	Strong decision support; may not be cost-effective and data are not readily available to date.	• Entrenchment ratio (width:depth) • Bankfull depth:Top of bank height

1.0 INTRODUCTION

1.1 Purpose and Background of Phase I Indicator Development

The Santa Clara Basin (Basin) Watershed Management Initiative (WMI), formed in 1996, is a collaborative, stakeholder-driven effort among representatives from regional and local public agencies; civic, environmental, resource conservation and agricultural groups; professional and trade organizations; business and industrial sectors; and the general public. The WMI's mission is to protect and enhance the Basin's watershed, creating a sustainable future for the community and the environment. The Basin is defined as the portion of San Francisco Bay south of Dumbarton Bridget and the 840-square-mile area of land that drains to it.

The WMI completed a Watershed Action Plan (Action Plan) in 2003 that discusses environmental protection programs, outlines strategic objectives for the Basin and next steps for achieving a vision of watershed health for the Basin. One of the next steps is to "prepare annual reports updating key indicators of watershed health and describing recent progress in preserving and enhancing Basin watersheds, new findings and study results, and WMI achievements and successes." To achieve this next step, the WMI formed two Workgroups. Workgroup H was tasked to develop a programmatic report card and Workgroup I (Indicators Workgroup) was tasked to develop and report on watershed health indicators.

Indicator development will occur in a series of evolving phases. Phase I initiates indicator development and will result in a suite of Pilot Indicators, a status and trends report card, and a scope for Phase II. Phase I will rely largely on best professional judgment and emphasize indicators that can be developed using existing information to the extent possible. Phase I is limited in geographic scope to in-stream and riparian habitats within the Santa Clara Basin, and focuses on the dimensions of stream health that are strongly affected by land-use decisions. Future phases will further refine and expand the suite of indicators identified in Phase I, extend the geographic scope to include the South San Francisco Bay, including the Baylands, and use indicators to report on watershed condition.

In addition to developing indicators for the WMI, Phase I will meet the interests of the Water Resources Protection Collaborative (Collaborative) to gauge performance of stream protection measures (referred to as Tier II indicators in the Collaborative's Adaptive Management Framework). The indicators will also serve the interests of the Santa Clara Valley Water District (District), which developing environmental indicators to provide periodic assessments on the status and trends of stream ecosystem condition to inform and evaluate the effects of management decisions. The environmental indicators developed by the Workgroup will therefore serve a diverse group of stakeholders.

1.2 Phase I Goals and Objectives

1.2.1 Phase I Goal

The goal of Phase I is to provide a suite of candidate environmental indicators that can be used to periodically assess the status and trends of stream and riparian ecosystems. The indicators can also be used to (1) evaluate management actions within a watershed context in the Santa Clara Basin; (2) improve environmental planning; and (3) adaptively manage emerging issues.

1.2.2 Phase I Objectives

The objectives for Phase I are to:

1. Develop a pilot suite of 3 to 5 environmental indicators for use by the WMI, the District and the Municipalities of the Collaborative to assess ecosystem condition with a focus on in-stream and riparian habitat in the Santa Clara Basin by June 30, 2005.

2. Develop a preliminary reporting format for presenting the results of assessments using indicators by March 30, 2005.

3. Use a subset of the Objective No. 1 pilot environmental indicators to characterize and report on the progress toward the strategic objectives and an assessment of "next steps" identified in the WMI Watershed Action Plan by June 30, 2005. (The schedule was extended to June 2006 due to lack of adequate time for a scientifically credible analysis).

4. Develop a scope of work for Phase II by June 30, 2005 to include a broader geographic area (Bay, Baylands) and additional environmental indicators. (The schedule was extended to June 2006).

Objectives 3 and 4 are not discussed in this interim report.

1.3 Purpose and Structure of Report

This Phase I Environmental Indicators Report is an interim report that summarizes the work accomplished in the first five months of Phase I. Its purpose is four-fold: (1) to present the framework used to develop environmental indicators for the Santa Clara Basin; (2) to present recommendations for Candidate Indicators to the WMI, District and Collaborative; (3) to provide a basis for evaluating the current direction and identify any appropriate corrective measures in the approach; and (4) to provide an overview of the development and use of indicators to inform readers who are unfamiliar with environmental indicators. While the content is technical in nature, the report is intended to serve a wide audience, including managers who have responsibilities for programs and policies that affect land use, environmental regulators, biologists, and planners involved in the development and use of indicators, and scientific peer reviewers who will evaluate the approach for its technical merit.

The report is organized as follows:

> ***Section 1*** introduces readers to the purpose of the project and the report and presents the goal for the Indicators Workgroup and the objectives for Phase I.
>
> ***Section 2*** presents a brief description of the natural resources contained in the geographic scope for which indicators are being developed.
>
> ***Section 3*** describes the approach used to establish the groundwork for indicator development, and specifically, the methods used in Phase I to identify Candidate Indicators.
>
> ***Section 4*** presents the recommendations for candidate indicators for consideration by the WMI, the Water Resources Protection Collaborative, and the Santa Clara Valley Water District.

Section 5 describes the concept for the Santa Clara Basin Status and Trends Report.

A glossary is provided in Appendix I.

1.4 Relationship to Other Efforts

1.4.1 Santa Clara Valley Water Resources Protection Collaborative

The Collaborative is a cooperative decision making process comprised of members representing all of the cities, the County, the Santa Clara Valley Water District, San Francisco Regional Water Quality Control Board, citizens, businesses and community groups in Santa Clara County (Water Resources Protection Collaborative 2004). The Collaborative members have pledged to further the goals of watershed and water resources protection by implementing existing policies and the timely adoption of land development policies, guidelines and standards. To promote local control by local governments and the County in implementing resource protection goals through their land use planning and permit regulations, collaborative members have developed and are refining a suite of tools including Guidelines and Standards for Land Use Near Streams (Guidelines and Standards) and an Adaptive Management Framework that includes two tiers of reporting by local permitting agencies to track the implementation of the Guidelines and Standards.

1.4.2 Santa Clara Valley Water District Stewardship Plans

The District is responsible for providing stream stewardship, water supply, and flood protection for the County of Santa Clara. Watershed-specific stewardship plans are being developed to facilitate a consistent and systematic approach for watershed stewardship and the comprehensive management of water resources on a watershed-by-watershed basis, to foster partnerships with others, and to inform policy framework for joint use by cities, the county, and the District in support of the following:

- Provide a reliable, healthy, and clean water supply.
- Ensure the safety and protection of human life and property through flood protection.
- Protect and restore water quality for both drinking water and aquatic life.
- Comprehensively consider the value of healthy watersheds through ecosystem restoration and enhancement.
- Where possible, address other value added opportunities for the community through recreation, trails, and open space.

Concurrent with Phase I, Stewardship Plans were in development for all of the watershed management units within Santa Clara County that drain to San Francisco Bay. Tasks of the Stewardship planning effort related to the Workgroup include developing vision statements of watershed health for the different watershed management units and indicators that could be used to measure progress toward achieving the following District Board's Ends Policies: Flood Protection, Water Supply, Ecosystem Health, and Open Space, Trails, and Recreation. The Workgroup tracked the progress of the Watershed Stewardship Plan indicators to ensure that our emerging indicators were developed to be as consistent as possible with Stewardship Plan indicators.

1.4.3 Santa Clara Valley Water District Watershed Monitoring and Assessment Program (WMAP)

The District is developing stream health indicators to provide periodic assessments on the status and trends of stream health in Santa Clara County. These periodic assessments will be used to inform watershed management actions, to evaluate the effectiveness of District policies and programs in providing stream stewardship, to improve environmental planning for flood protection and water supply projects and to adaptively manage emerging opportunities and problems. Stream health indicators are being developed in coordination with the Workgroup. It was recognized that consolidating indicator development activities would prevent duplication of effort, overextension of limited participant time, and ensure consistency of the outcomes for the different but related efforts. The geographic area of interest includes stream ecosystems located within the District's jurisdiction and will address those watershed features that impact stream ecosystem health, regardless of proximity (e.g., extent impervious surface). The District's geographic area of interest extends beyond the Basin into the Pajaro River watershed that drains into the Monterey Bay, and therefore extends beyond the area of interest for the WMI. Indicators developed to meet the District's interests within the WMAP will focus on environmental indicators of stream ecosystem health and will not include indicators of flood protection or water supply (i.e., how well these services are provided to the community).

1.4.4 Santa Clara Valley Urban Runoff Pollution Prevention Program (SCVURPPP)

SCVURPPP is an association of thirteen cities and towns in the Santa Clara Valley, together with Santa Clara County and the Santa Clara Valley Water District. SCVURPPP participants share a common permit to discharge storm water to South San Francisco Bay, California. To reduce pollution in urban runoff to the maximum extent practicable, SCVURPPP incorporates regulatory and outreach measures, as well as a monitoring and assessment program aimed at improving the water quality and ecosystem functions of streams in the Santa Clara Valley and the South San Francisco Bay. SCVURPPP embraces a watershed approach to provide a coordinating framework for environmental management that focuses efforts to address the highest priority problems within hydrologically defined areas (SCVURPPP 2004). High priority issues are defined and addressed through the implementation of activities that include environmental monitoring and assessment using ecological indicators. Although there was no direct coordination with SCVURPPP's Monitoring and Assessment Program during this initial Phase I effort, the Workgroup will identify opportunities for such coordination to assist in further developing indicators in future phases.

2.0 DESCRIPTION OF THE SANTA CLARA BASIN

The Basin is located in the northern part of California's Central Coast Range. It is defined as the portion of San Francisco Bay south of the Dunbarton Bridge and the 840-square-mile area of land that drains into it. It is situated between the Santa Cruz Mountains to the west and the Diablo Range to the east. These steep mountain ranges contribute moderate to high sediment yields to the Basin and cause rapid runoff. The Basin has a Mediterranean climate, characterized by dry summers and cool wet winters. Flow in surface streams reflects the seasonality of precipitation, and all but the larger order streams are dry throughout the summer.

For the purposes of the WMI, the Basin is comprised of 13 major watersheds and the Baylands. The 13 watersheds are associated with the main streams in the Basin and the lands that drain to them and are listed in Table 1. The Baylands consist of the tidal wetlands bordering the Bay that lie between mean low water and the highest observed tide[1].

About one-third of the land surface in the Basin is urbanized, while the remainder is open space. Residences and commercial and industrial premises occupy 23.4 percent and 11.2 percent of the land, respectively. Most of the open space is categorized as Urban Recreation or Vacant, undeveloped (33.8 and 19.6 percent of total land uses in Basin, respectively). The remaining open space is agricultural, forested, parks, rangeland, wetlands, and open water.

TABLE 1

WATERSHEDS WITHIN THE SANTA CLARA BASIN (SOURCE: SCBWMI 2001)

WATERSHEDS WITHIN THE SANTA CLARA BASIN[2]	
Watershed	**Area (square miles)**
Coyote Creek	321
Guadalupe River	170
Arroyo la Laguna	74
San Tomas Aquino/Saratoga Creeks	45
San Francisquito Creek	43
Baylands	33
Stevens Creek	29
Lower Penitencia Creek	29
Calabazas Creek	21
Permanente Creek	17
Matadero/Barron Creeks	17
Adobe Creek	11
Sunnyvale West Channel	8
Sunnyvale East Channel	7

[1] The Wetlands Advisory Group has proposed a more refined definition of the Baylands for use by the WMI in future analysis and reporting (see Glossary in Attachment B and discussion in Section 7.2.1, SCBWMI 2001).

[2] Eleven of the watersheds lie wholly within Santa Clara County. The Arroyo la Laguna and San Francisquito Creek watersheds lie primarily within Alameda and San Mateo counties, respectively. Watershed boundaries and areas were delineated by EOA, Inc.

Main stem streams and lower tributary reaches vary considerably among watersheds, but all are altered significantly by human impacts. The most significant and characteristic alterations include encroachment; increased impervious surface, drainage density, sediment and pollutant loading; channelization; loss of floodplain; and colonization by invasive species. These alterations have impacted riparian and wetland habitat; altered the biological assemblages of plant, fish and wildlife supported by these habitats; impaired surface and groundwater water quality; decreased the complexity and diversity of in-stream habitats; and altered stream flow characteristics and channel dynamics.

The riparian plant communities in the Basin include central coast arroyo willow riparian forest, central coast cottonwood-sycamore riparian forest, white alder riparian forest, sycamore alluvial woodland, central coast live oak riparian forest, and central coast riparian scrub. The continuous bands of dense vegetation that characterized historic riparian forests are now constrained, especially in the lower tributary reaches, by adjacent land use and flood protection levees. The narrow strips are often broken into short segments and have been landscaped with nonnative trees, such as eucalyptus and acacia and the understory colonized by invasive, nonnative plant species.

One of the highest levels of wildlife species diversity and abundance in California is associated with riparian habitats. The importance of riparian habitats to wildlife is related primarily to the presence of water and the vegetation characteristics, including community composition, diversity and cover and structural components. The stratified vegetation structure created by layers of tress, shrubs, and herbaceous and aquatic vegetation provides a variety of ecological niches, especially for birds. The productivity and diversity of plant species create a broad food base. The dense vegetation more typical of unaltered riparian habitats provides cover from predators, protected nesting areas, and serves as dispersal and migratory corridors.

Streamside pools and low-flow shallows provide breeding habitat for Pacific tree frogs and California newts. Other species, such as the California slender salamander, seek the moist shelter beneath fallen logs and woodland debris for breeding and refuge. Common reptile species that use aquatic habitat within riparian corridors for foraging or escape cover include western skinks and western aquatic and terrestrial garter snakes, and the common garter snake. California red-legged frogs, western pond turtle, and western toad may also be observed in the riparian corridors. Other representative wildlife species that use in riparian habitats include raccoons, skunks, opossums, long-tailed weasels, gray foxes, bobcats, and several bat species, including Yuma myotis and Brazilian freetail bat. Bird species that occur in this habitat include the following neotropical migrants, Wilson's warblers, warbling vireos, and olive-sided flycatchers, and the following resident birds, winter wrens, Hermit thrushes, and song sparrows, American dippers, herons, belted kingfishers, and a variety of waterfowl. Swifts, swallows, and flycatchers can be found hawking their insect prey over water. Red-shouldered hawks use riparian trees for nesting.

Most native fish species are intolerant of disturbance caused by human activities and have declined as a result. Loss of shaded riverine aquatic habitat, reduction in riffle and pool complexes, structural barriers to fish migration, and predation by nonnative warmwater fishes are among the more significant impacts to native fisheries in the Basin. Currently, the known fish fauna of flowing streams in the Basin consists of approximately 11 native species and 19 nonnative species. California roach and Sacramento sucker are likely the most abundant of the native species. Remnant steelhead runs exist in Coyote Creek, Stevens Creek, San Francisquito Creek, and Guadalupe River. Runs of Chinook Salmon have been observed recently in both the Guadalupe River and Coyote Creek.

3.0 APPROACH FOR PHASE I INDICATOR DEVELOPMENT

3.1 Develop Organizing Framework: General Pressure-State-Response (PSR) Model

A general Pressure-State-Response (PSR) Model (Figure 1) was developed for the Basin's stream ecosystems. This type of model is widely accepted and robust for evaluating the effects of human activities on ecosystems and for use in adaptive management (OECD 2001). Generally, the premise of the PSR model is that human activities and natural events exert pressure or stress, which may induce changes in the condition (state) of the environment. Management actions (responses) are taken as a result of the observed changes, and the outcomes of the responses can be measured. The PSR model was developed to provide guidance for future phases in identifying pressure, state, and response indicators. Pressure and state indicators provide information that can be used in adaptive management to respond to changes in condition through policies and programs intended to prevent, reduce or mitigate environmental risks and impacts and monitor improvements. The model developed in Phase I will be expanded in future phases.

A review of the literature on PSR models and knowledge of team members of the ecology and land use issues associated with stream ecosystems in Santa Clara County were used to develop the PSR model. Considerations in developing the model for regional stream ecosystems included such factors as (1) essential stream and riparian system attributes and interactions to be included in the model; (2) natural and anthropogenic stressors that may affect the stream and riparian ecosystems; (3) pathways by which stressors may affect stream and riparian ecosystems; (4) ecological attributes that may be exposed and therefore are at risk to stressors; and (5) descriptions of the relationships between stressors, ecological attributes and responses.

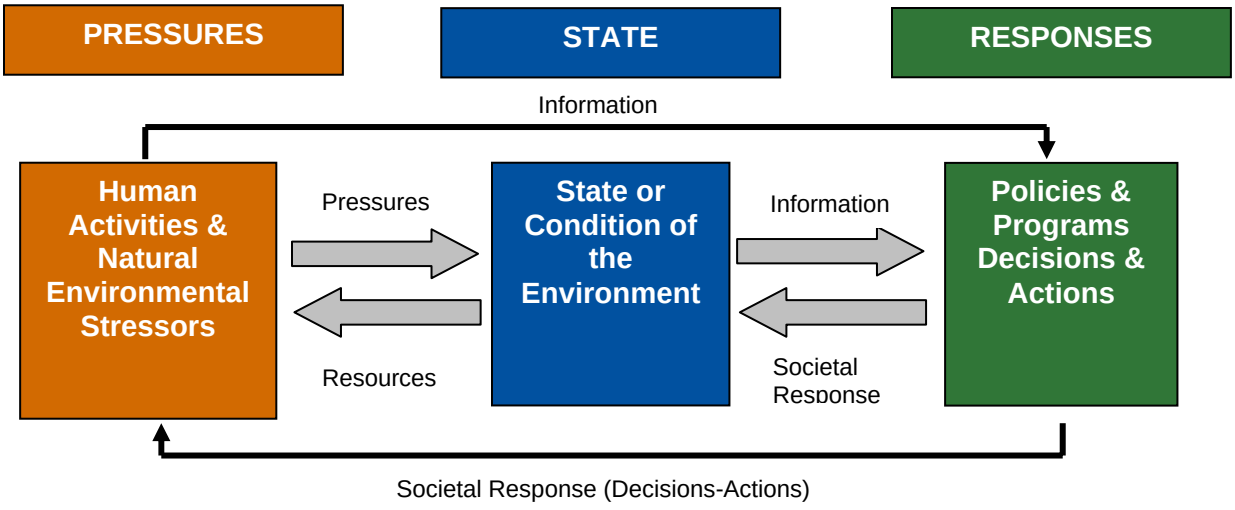

Figure 1. Example of a Pressure-State-Response Model Framework (Modified from OECD 1993)

3.2 Identify Assessment Questions

Relying on a review of existing work, a list of environmental concerns framed as assessment questions were developed. Priority was given to those assessment questions that are most important to the WMI, District, and municipalities of the Collaborative. The Workgroup considered the WMI's Action Plan strategic objectives and vision, and in particular, the assessment questions previously prepared by the Watershed Assessment and Monitoring Subgroup (WAMS) in the development of the Indicators Workgroup assessment questions.

3.2.1 Linkage With the Collaborative

For this first phase, the Workgroup intended to select environmental indicators to complement the Collaborative's Tier 1 Indicators (see Section 1.4.1 above for additional information on the Collaborative) concurrently being developed in the form of best management practices. The Tier 1 indicators were not developed for timely use by the Indicators Workgroup. Therefore, we relied on the following existing information to develop Tier II indicators for use in the Collaborative's Adaptive Management Framework: the relevant water resource protection goals and the proposed Guidelines and Standards. The Resource Protection Goals considered in Phase I were "Habitat Protection and Enhancement" and "Surface & Groundwater Quality & Quantity." The major categories of the Guidelines and Standards considered were:

- Riparian Corridor Protection.
- Bank Stability/Streambed Conditions.
- Encroachment between the Top of Bank.
- Erosion Prevention and Repair.
- Channelization.
- Trash Control and Removal.
- Protection of Water Quality.

3.2.2 Linkage With the District's Stewardship Plans

The Indicators Workgroup also tracked the progress of Watershed Stewardship Plans. The Watershed Stewardship Plans will include indicators that relate to the District's Ends Policies, which includes Ecosystem Health. The following four attributes are included in the draft Stewardship Plans that relate to Ecosystem Health:

- Riparian Habitat
- Biological Assemblages
- Surface Water Quality
- Aquatic Habitat

These attributes were considered in the formulation of assessment questions and an attempt was made to be as consistent as possible with the indicators of the Watershed Stewardship Plan as they evolved through the review process.

In addition to the Ecosystem Health Attributes, the vision statements that were emerging for the watershed management units also served as a reference for identifying indicators. Although the visions statements for the watershed management units were not finalized at the time of this report and are tailored to the individual watershed management units, the following excerpts of the draft vision statements served as a useful reference to determine a general degree of consistency between the two efforts.

- A continuous, vegetated riparian corridor that helps prevent bank erosion while promoting water quality and habitat.

- A stream with natural earth channels that continues to support important populations of cold-water fish and other special status species.

- A stream without barriers to fish passage.

- A stream that will have a geomorphically stable channel that is in dynamic equilibrium where site constraints permit.

3.3 Identify Environmental Indicators

3.3.1 Overview of Environmental Indicators

Environmental indicators are measurable environmental features that provide insight into changes in the condition of an ecosystem ("state" indicators), the pressures put on the environment caused by human activities or environmental perturbations ("pressure" indicators) and the societal response to the pressures ("response" indicators). Stream ecosystems are dynamic and complex, representing a unique set of functional, structural, and compositional characteristics that are shaped by a combination of processes unique to a region. Because it is not practical, and in some cases is not possible, to measure everything of interest, indicators serve as surrogate measures of ecosystem functions that cannot be measured directly. Indicators that are judiciously selected can be used to communicate information regarding the condition of an ecosystem at a particular point in time, changes in condition and trends in condition over time. Indicator values can inform decision-makers about the need for interventions to bring about desirable changes and what interventions might be the most effective and inform managers about the success of past interventions (Figure 2).

To be useful, a clear association must exist between assessment questions, indicators, and the functions and processes occurring in a specific local ecosystem where it is being applied. Because of the unique regional characteristics of stream ecosystem, indicators cannot be "taken from the shelf." Although there are a number of efforts underway to develop and use indicators in the San Francisco Bay region (e.g., Thompson and Gunther 2004), there is no established suite of indicators currently available for assessing the health of Santa Clara Basin stream ecosystems.

Considerable work has been done on the development of indicators. The work presented here draws to a large degree on prior efforts that have been adapted for our purposes. Existing frameworks serving as a model for this effort include the EPA's Environmental Monitoring and Assessment Program, The Bay Institute's Ecological Scorecard, and the CALFED Bay-Delta Program, among others. The approach developed here will necessarily be iterative and flexible, beginning with a suite of promising indicators that can be developed with greater confidence as knowledge increases and adapted as resource conditions change.

Due to time constraints, no attempt was made to differentiate between the natural geologic, physical, chemical, or biological properties specific to each watershed, nor to the scalability of the indicators. For example, indicators relating to anadromous fisheries would not apply to streams that do not currently support or are unlikely to support anadromous fish. This report does not address that level of specificity. It also does not present an assessment framework that would specify, for example, what constitutes different categories of condition. It is

recognized, however, that what may be nominal condition in one reach within a creek may be different for another reach in the same creek, as well as among creeks within watersheds. These and other issues will be addressed in future phases.

The Candidate Indicators presented in this report are the first step in the development of scientifically credible indicators. It is not the intention to provide a scientifically defensible suite of indicators that can be used to completely describe the health of stream ecosystems or of all pressures on these systems. In addition, the indicators developed in this and future phases are expected to show plausible cause and effect relationships between land use activities and condition, rather than a direct one to one relationship.

3.3.2. Indicator Development Phases

The Workgroup will screen potential indicators through four development phases, representing increasing levels of confidence:

> ***Preliminary indicators*** are a list of potential environmental indicators that have either not been formally evaluated using indicator selection criteria or do not meet the initial screening criteria due to lack of information but show promise.
>
> ***Candidate indicators*** have not been fully evaluated using all of the indicator selection criteria but meet some criteria and show promise in being able to demonstrate status and trends in stream health.
>
> ***Pilot indicators*** meet at least some key criteria and require further evaluation to determine their usefulness within an assessment framework.
>
> ***Core indicators*** meet the indicator selection criteria and have been shown to be useful and robust in an environmental assessment framework.

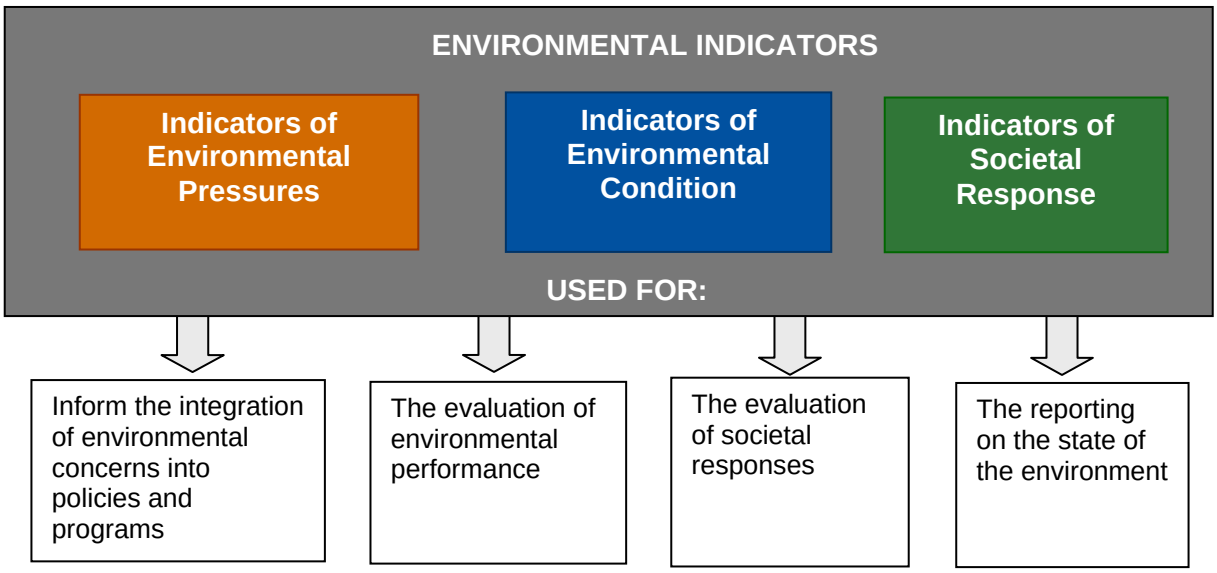

Figure 2. Use of Environmental Indicators Within a Pressure-State-Response Framework (Modified from OECD 1993)

A list of Preliminary Indicators was developed in Phase I and an initial screening exercise identified Candidate Indicators. The approach is described below and the results of the indicator screening process are presented in Section 5.

3.3.3 Identify Preliminary Indicators

Preliminary indicators were identified based on the assessment questions, knowledge of the stream ecosystems and land use context summarized in the conceptual model, and a review of existing information. The singular pressure of land use decisions that affect streams was the focus of Phase I. State indicators were identified that support the assessment questions (e.g., state indicator of habitat, biological assemblages, and water quality). The review of existing information included the WMI Watershed Action Plan, draft Guidelines and Standards prepared by the Collaborative, and other past and present assessments of local watersheds, including those of the Santa Clara Valley Urban runoff Pollution Prevention Program (e.g., Assessment of Stream Ecosystem Functions for the Coyote Creek Watershed and the Multi-Year Receiving Waters Monitoring Activities), the Stream Stewardship Plans (District), and others.

3.3.4 Identify Candidate Indicators

Existing indicator selection criteria were reviewed to identify Tier I screening criteria. Tier I screening criteria are used in the early stage of indicator development (Preliminary and Candidate Indicators) and are considered to be basic criteria, which must be met in order for an indicator to advance to the next level of development. The following criteria were identified as appropriate for Phase I.

- Data Availability: Data are currently available and likely to be available in the future.
- Decision Support: Provides information that informs decision-making; links to conceptual model and relates to the interests of the WMI, the Collaborative, and the District.
- Cost Effective: Apparent reasonable cost for data collection required to support the indicator in evaluating condition and/or to develop the indicator.

These Tier I indicator screening criteria were applied to the Preliminary Indicators to identify Candidate Indicators. The screening did not consider other important criteria, such as data quality, sensitivity (ability to detect meaningful differences in condition), or representativeness that would establish them as being unambiguously meaningful. The indicators will be evaluated for these and other Tier II criteria as part of the continuation of Phase I and in Phase II.

Indicator Screening Approach: Candidate Indicators were selected that generally met the Tier I criteria. Workgroup members scored each Preliminary Indicator according to how well it met each of the three criteria. A score of 3 was given if the screener thought the indicator fit the criteria, a score of 2 was given if the indicator met the criteria somewhat, and a score of 1 was given if the indicator did not meet the criteria or was considered to be a poor fit. Limited information was available in this first phase to accurately evaluate Data Availability and Cost Effectiveness, and the scoring relied largely on best professional judgment.

The indicators were assigned to one of three categories based on their overall strength in meeting the criteria: Candidate Indicator, Preliminary Indicator, or eliminated from further consideration. Candidate Indicators ranked high in relating to the assessment questions

(Decision Support Indicator) and ranked either high or intermediate in terms of availability of data and cost-effectiveness. Those indicators that did not advance to Candidate Indicator status ranked high in Decision Support, but ranked low in either data availability or cost effectiveness. These indicators will be retained as Preliminary Indicators for further evaluation. Indicators that scored poorly in two or more categories were eliminated from further consideration at this time.

A preliminary quantitative ranking of the indicators was used to identify the highest ranking candidate indicators for each indicator category (e.g., Riparian and Wetland Habitat Condition). The average scores were calculated for each criterion (Data Availability, Decision Support, Cost Effective) and then an overall average for each indicator was tallied. Indicators within each indicator category were identified that had the highest value for each indicator criterion and had a minimum average score of 3.

4.0 CANDIDATE INDICATOR RECOMMENDATIONS

This section outlines the results of the Phase I indicator development effort. It presents the generalized conceptual model, assessment questions, outlines recommendations for Candidate Indicators, Preliminary Indicators, possible metrics, provides a summary of the strength of the criteria, and provides descriptions for each indicator. The results presented here represent the progress of the initial five-months of a long-term effort.

4.1 Pressure-State-Response Model

A generalized PSR model of stream ecosystems in the Santa Clara Basin is presented in Figure 3. The major stressor categories identified that impact stream ecosystem health in the Basin include development, flood protection, recreation, water supply, and invasive species. These stressor impact riparian, wetland, and in-stream habitat quality, hydrologic and geomorphic processes, and biological resources. Impairments to stream ecosystem functions result in a decrease in ecosystem services or benefits and inform management actions that can be taken to improve ecosystem health.

4.2 Assessment Questions

Preliminary assessment questions were developed that reflect natural resource management concerns relating to environmental attributes of stream ecosystem health. A number of the assessment questions are generic and have not yet been scaled to or placed in the context of a particular stream, watershed, or taxa. For example, the assessment question, “Are flows adequate for habitat?” will be further detailed to specify the habitat components for which adequate flows would be assessed. Likewise, increases in “the extent of habitat fragmentation” may benefit some species while impacting others. Some assessment questions, such as those relating to biological communities, may be added.

Assessment questions are hierarchical. The broadest assessment question addressed by this project is, *What are the status and trends in the condition of stream ecosystems?* Or more simplistically, *What is the health of our streams and how is it changing?* The following attributes were identified as the major categories of environmental issues that relate to stream ecosystem health and were used to guide the development of assessment questions:

- Riparian and Riverine Wetland Habitat Condition
- Aquatic Habitat Condition
- Biological Communities
- Hydrogeomorphology

A fourth attribute of stream health, Human Use and Governance, was identified by the Workgroup and will be considered in Phase II.

Table 2 shows how the Workgroup’s categories of stream health attributes relate to the relevant major categories of the Collaborative’s Guidelines and Standards and the District’s Stewardship Plan Ecosystem Health attributes.

TABLE 2

RELATIONSHIP BETWEEN THE ATTRIBUTES OF STREAM ECOSYSTEM HEALTH IDENTIFIED BY THE WMI, COLLABORATIVE, AND THE DISTRICT

WMI	COLLABORATIVE	DISTRICT STEWARDSHIP
Riparian and Riverine Wetland Habitat Condition	Riparian Corridor Protection	Riparian Habitat
Aquatic Habitat Condition	Protection of Water Quality	Surface Water Quality and Aquatic Habitat
Biological Communities	None identified	Biological Assemblages
Hydrogeomorphology	Bank Stability/Streambed Conditions Erosion Prevention and Repair Channelization	Hydrogeomorphic attributes are considered under "Aquatic Habitat"

The overarching assessment questions are presented first, followed, in most cases, by a list of more specific questions. *The list below is a work in progress and will be revised and updated to include additional assessment questions.*

Riparian and Riverine Wetland Habitat Condition

1. What are the status and trends in the condition, distribution, and extent of riparian and riverine wetland habitats?

    1a. How extensive are wetland and riparian habitats?

    1b. To what extent is the riparian corridor fragmented due to land use changes and to what degree are habitat patches connected?

    1c. Where are opportunities to protect, restore, and enhance riparian and wetland habitats?

    1d. What invasive species are present in riparian and wetland habitats, where are they located and how extensive is colonization?

2. How much riparian and wetland habitat is protected, restored, and enhanced?

Aquatic Habitat Condition

1. What are the status and trends in the condition of aquatic habitats?

    1a. What are the status and trends in the condition of in-stream waters?

    1b. Are sensitive macroinvertebrate species present?

    1c. Is the sediment load (volume and movement) causing degradation of in-stream habitat?

1d. How extensive is trash?

1e. What are the status and trends in the quality of in-stream sediments?

1f. Are flows adequate for habitat?

1g. What changes in in-stream habitat are attributed to changes in water availability and water management practices?

1h. What are the status and trends of in-stream habitat complexity and diversity to support fisheries and other animals?

1i. What are the number, location, and severity of fish passage barriers?

1j. Is there adequate spawning and fish rearing habitat to support recruitment of anadromous fish and SRA to moderate water temperature?

Biological Communities

1. What are the status and trends in the biological communities?

1a. Are reproductive populations of anadromous fish supported in streams that are considered capable of supporting them?

1b. What are the status and trends in native fish assemblages?

1c. Are warmwater native communities supported where Warm uses exist and where experts indicate they may be additionally supported?

1d. What are the status and trends in warmwater nonnative fish assemblages?

Hydrogeomorphology

1. Are streams and streambanks in dynamic equilibrium?

1a. To what extent are streambeds and banks stable?

1b. To what extent is stream modification occurring and what type?

1c. To what degree are the floodplains connected to their creeks?

1d. To what degree do creeks have room to meander consistent with their grade?

1e. To what extent is hydromodification occurring?

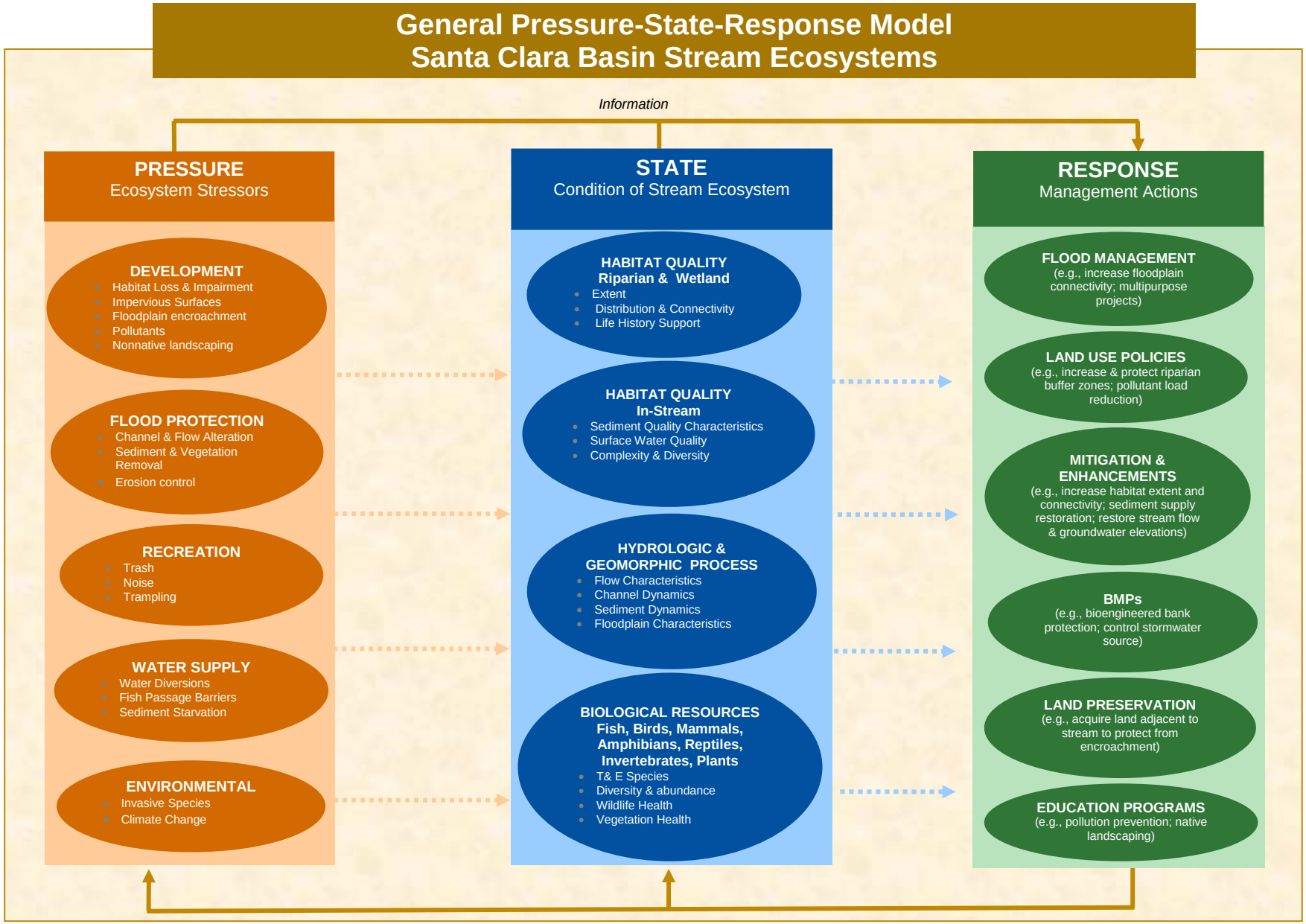

Figure 3. General Pressure-State-Response Model of Stream Ecosystems in Santa Clara County, California

4.3 Results of Indicator Screening

4.3.1 Candidate Indicators

A total of 22 indicators were advanced to Candidate Indicator status. Because limited information was available in this first phase to accurately evaluate data availability and cost effectiveness, the list of Candidate Indicators is more inclusive than it would have been had the screening been more rigorous.

Table 3 presents the recommendations for Candidate Indicators. The indicators advanced to Candidate status all ranked high in relating to an assessment questions (Decision Support Indicator) and ranked either high or intermediate in terms of availability of data and cost-effectiveness. The results of a quantitative scoring described in Section 3.4 identified the candidate indicators that had the highest scores within each indicator category (see Appendix 2). This was a preliminary exercise and will be revisited in the second part of Phase I.

The fish habitat indicators all scored higher than the indicators Native Fish Species Assemblages and Recruitment. Habitat characterization is often used as a surrogate for direct measures of population monitoring and species distributions due to the expense of the latter approaches, but the limitations of this approach need to be articulated. While habitat monitoring can indicate the absence of a species when its habitat is nonexistent, measures of habitat extent and quality do not result in a representative estimate of the extent of species with small or declining populations. Furthermore, they do not reliably predict population parameters, such as size, structure, or recruitment. The life stage requirements of key species are often poorly understood and monitoring of limiting habitat requirements necessary to provide a representative assessment can also be expensive. The strength of the habitat indicators retained as Candidate Indicators may need to be improved through validation monitoring of habitat-species relationships, if this information does not already exist.

The indicators Anadromous Fish Species: Juvenile Recruitment and Overwintering Habitat scored high for Decision Support but low for Data Availability and Cost Effectiveness. Despite the overall lower scores, they were advanced to Candidate Indicator Status, because additional evaluation of Data Availability may indicate that sufficient information exists to do limited reporting for the Guadalupe River and Stevens Creek.

For a number of the Candidate Indicators, such as those that could be derived from aerial images (e.g., Extent of Development in Riparian Corridor) or extracted from existing databases (Extent, Quality and Type of Channel), data sources may be available, but additional steps are needed to analyze the information and calculate the metric (e.g., percentage of riparian corridor under public ownership) or the data may be outdated, collected irregularly or of poor quality. For data that are not readily available, further evaluation of cost effectiveness for analyzing and summarizing the data is needed.

Candidate Indicators will be evaluated more rigorously in the continuation of Phase I for their ability to meet the Tier I. They may also be evaluated for some Tier II criteria. The screening process will result in a reduced number of indicators that will be advanced to Pilot indicator status.

TABLE 3

RECOMMENDED CANDIDATE INDICATORS

(The type of indicator according to the PSR model is presented in parentheses.)

ASSESSMENT QUESTIONS	INDICATOR CATEGORIES	CANDIDATE INDICATORS	RATIONALE	POTENTIAL METRICS
Riparian and Riverine Wetland Habitat Condition: What are the status and trends in the condition, distribution, and extent of riparian and riverine wetland habitats?				
How extensive are wetland and riparian habitats?	Riparian and wetland habitat condition	Extent of riparian and wetland habitat *(Condition Indicator)*	Strong decision support and can be derived from existing aerial imagery. Photointerpretation is needed to summarize the data.	• Acres of riparian and wetland habitat • Width of habitat • Ratio of habitat width to ideal riparian width as per policy or ordinance
To what extent is the riparian corridor fragmented due to land use changes and to what degree are habitat patches connected?	Riparian and wetland habitat condition	Extent of riparian habitat fragmentation *(Stress Indicator)*	Strongly supports assessment questions and can be derived from existing aerial imagery. Photointerpretation is needed to summarize the data.	• Linear feet of contiguous riparian corridor • Number and size of riparian habitat patches • Habitat patch indices: path contagion and interspersion, patch cohesion, inter-patch distance, distribution, etc.)
To what extent is the riparian corridor fragmented due to land use changes and to what degree are habitat patches connected?	Riparian and wetland habitat condition	Extent of development in riparian corridor *(Stress Indicator)*	Strongly supports assessment questions and can be derived from existing aerial imagery. Photointerpretation is needed to summarize the data.	• Distance of urban development from top of bank • Percentage riparian corridor developed • Acres of habitat loss due to land conversion
Where are opportunities to protect, restore, and enhance riparian and wetland habitats?	Riparian and wetland habitat condition	Extent of invasive riparian and wetland species *(Stress Indicator)*	Strong decision support but limited data availability; a cost-effective rapid assessment approach could be developed.	Acres and taxa of invasive species colonization

ASSESSMENT QUESTIONS	INDICATOR CATEGORIES	CANDIDATE INDICATORS	RATIONALE	POTENTIAL METRICS
Riparian and Riverine Wetland Habitat Condition: How much riparian and wetland habitat is protected, restored, and enhanced?				
How much riparian and wetland habitat is protected, restored, and enhanced?	Riparian and wetland habitat protected, restored, or enhanced	Extent of riparian and wetland habitat protected *(Response Indicator)*	Strongly supports assessment questions and can be derived from existing information.	Percent of riparian corridor under public ownership and permanently protected
		Extent of riparian and wetland habitat restored *(Response Indicator)*	Strongly supports assessment questions and can be derived from existing information.	Acres of riparian and wetland habitat restored
		Extent of riparian and wetland habitat enhanced *(Response Indicator)*	Strongly supports assessment questions and can be derived from existing information.	Acres of riparian and wetland habitat enhanced
Aquatic Habitat Condition: What are the status and trends in the condition of aquatic habitats?				
What are the status and trends in the quality of in-stream waters?	Stream water quality	Physiochemical water Quality *(Condition Indicator)*	Strong decision support and data availability. Could be very cost effective or not cost effective over the long-term, depending on the method.	• Number and location of impaired water bodies or Exceedences of established water quality criteria • Concentration of mercury in fish tissue • Water Quality Index
Are sensitive macroinvertebrate species present?	Stream water quality	Macro invertebrate assemblages *(Condition Indicator)*	Strong decision support, some data availability, and potential for greater cost-effectiveness over water quality monitoring.	• % Intolerants & Intolerants • % Dominant taxa • Taxanomic richness • % Functional feeding groups • Composition measures

ASSESSMENT QUESTIONS	INDICATOR CATEGORIES	CANDIDATE INDICATORS	RATIONALE	POTENTIAL METRICS
How extensive is trash?	Stream water quality	Extent of trash *(Stress Indicator)*	Current "hot spot" methodology is not representative of status and does not allow tracking trends in improvement; consider adjusting methodology.	Change in number and location of trash hotspots
Are flows adequate for habitat? What changes in in-stream habitat are attributed to changes in water availability and water management practices?	In-stream flows	In-stream flows *(Condition Indicator)*	Strong decision support and cost effective. Available data from existing gages may not be representative.	• Linear miles and frequency of dry back • Average cfs during indicator period at representative monitoring sites • Measure of deviation from measurable objective annual flow targets (magnitude, timing, duration) at representative monitoring sites
What are the status and trends of in-stream habitat complexity and diversity to support fisheries and other animals?	Anadromous fish habitat suitability	Anadromous fish spawning habitat *(Condition Indicator)*	Strong decision support, cost effective; data available for isolated segments on certain streams.	• Abundance (or number of river miles) of spawning gravel (or number of river miles with coarse sediments suitable for spawning) • Proportion of inundated spawning gravel • Average percentage fines
What are the number, location, and severity of fish passage barriers?	Anadromous fish habitat suitability	Anadromous fish passage barriers *(Stress Indicator)*	Strong decision support, cost effective; limited data availability.	• Water depth in low flow during adult upstream migration • No. of barriers (ratio of staging pool to vertical barrier height • Percentage of stream length of pools, rifles, runs • Number of river miles within potential spawning habitat unimpeded by dams

ASSESSMENT QUESTIONS	INDICATOR CATEGORIES	CANDIDATE INDICATORS	RATIONALE	POTENTIAL METRICS
Is there adequate spawning and fish rearing habitat to support recruitment of anadromous fish and SRA to moderate temperature?	Anadromous fish habitat suitability	Anadromous fish rearing habitat complexity and diversity *(Condition)*	Strong decision support and long-term data available. Cost effective depending on methodology.	
Is there adequate spawning and fish rearing habitat to support recruitment of anadromous fish and SRA to moderate temperature?	Anadromous fish habitat suitability	Shaded riverine aquatic cover *(Condition Indicator)*	Strong decision support and long-term data available. Cost effective depending on methodology.	Percentage shaded stream surface, others
Biological Communities: What are the status and trends in the biological communities?				
Are reproductive populations of anadromous fish supported in streams that are considered capable of supporting them?	Native Fish Recruitment	Anadromous fish species recruitment: juvenile recruitment *(Condition Indicator)*	Strong decision support, marginal cost-effectiveness, and data limited to Guadalupe River and is not systematically monitored. Candidate indicator status limited to Guadalupe watershed.	Number of outmigrating juveniles
Are reproductive populations of anadromous fish supported in streams that are considered capable of supporting them?	Native Fish Assemblages	Anadromous fish species assemblages: overwintering habitat *(Condition Indicator)*	Strong decision support, marginal cost-effectiveness, but limited data (Guadalupe River and Stevens Creek).	% suitable overwintering habitat

ASSESSMENT QUESTIONS	INDICATOR CATEGORIES	CANDIDATE INDICATORS	RATIONALE	POTENTIAL METRICS
Hydrogeomorphology: Are streams and streambanks in dynamic equilibrium?				
To what extent are streambeds and banks stable?	Hydrogeomorphic processes	Channel condition: stream bed and bank characteristics *(Condition Indicator)*	Strong decision support, somewhat cost-effective, limited data availability	% stream length eroded
To what extent is stream modification occurring and what type?	Hydrogeomorphic processes	Channel condition: extent, quality and type of channel modification *(Stress Indicator)*	Strong decision support, cost effective and data available.	
To what degree are the floodplains connected to their creeks?	Hydrogeomorphic processes	Floodplain connectivity *(Condition Indicator)*	Strong decision support, cost effective if derived from aerial imagery; photointerpretation needed to summarize data.	• Number of and percent modified stream length by type • Percent of channel modification sites where erosion is occurring at head or toe of the modification • Number of and percent stream length underground or in complete culvert/tunnel
To what extent is hydromodification occurring?	Hydrogeomorphic processes	Stream hydrograph *(Condition Indicator)*	Strong decision support; may not be cost-effective and data are not readily available to date.	• Entrenchment ratio (width:depth) • Bankfull depth:Top of bank height

4.3.2 Preliminary Indicators

Table 4 presents the preliminary indicators that were not advanced to candidate indicator status. The Preliminary Indicators ranked high in relating to the assessment questions, but ranked intermediate or poor in data availability or cost effectiveness. The Workgroup recommends that these indicators be further evaluated in the continuation of Phase I.

Warmwater Native and Warmwater Nonnative Fish Species Assemblages scored poorly for both Data Availability and Cost Effectiveness. The Workgroup agreed that they have the potential to be reliable and cost effective indicators and that the lack of information available for the screening process may have accounted for the low scores.

Riparian Community Composition and Abundance is considered to be an important indicator of riparian habitat condition. Traditional quantitative methods, such as those derived from

transects and age class evaluations, are time intensive and expensive and are currently limited to site-specific mitigation monitoring. We recommend that consideration be given in Phase II to developing a rapid assessment methodology that would provide information about the general health of the riparian community and that could be implemented at the same time as other field investigations are being done.

TABLE 4

PRELIMINARY INDICATORS TO BE FURTHER EVALUATED FOR CANDIDATE INDICATOR STATUS

(The type of indicator according to the PSR model is presented in parentheses.)

ASSESSMENT QUESTIONS	INDICATOR CATEGORIES	PRELIMINARY INDICATORS	RATIONALE	POTENTIAL METRICS
Riparian and Riverine Wetland Habitat Condition: What are the status and trends in the condition, distribution, and extent of riparian and riverine wetland habitats?				
What are the status and trends in the condition of riparian and riverine wetland habitats?	Riparian and wetland habitat condition	Riparian community composition and abundance (Condition)	Strong decision support but limited data availability; a cost-effective rapid assessment methodology could be developed	Percentage native and nonnative tree and shrub cover
Biological Communities: What are the status and trends in the biological communities?				
Are reproductive populations of anadromous fish supported in streams that are considered capable of supporting them?	Native Fish Recruitment	Anadromous fish species: juvenile recruitment (Condition)	Candidate indicator for Guadalupe where data being collected; otherwise data not available and not as cost effective as habitat indicators that may serve as surrogates.	Number of outmigrating juveniles
What are the status and trends in native fish assemblages?	Native Fish Assemblages	Anadromous fish species: overwintering habitat (Condition)	Candidate indicator for Guadalupe where data being collected; otherwise data not available and not as cost effective as habitat indicators that may serve as surrogates.	% suitable overwintering habitat

ASSESSMENT QUESTIONS	INDICATOR CATEGORIES	PRELIMINARY INDICATORS	RATIONALE	POTENTIAL METRICS
Are warmwater native communities supported where Warm uses exist and where experts indicate they may be additionally supported?	Native Fish Assemblages	Warmwater native fish species assemblages (Condition)	Strong decision support but limited by data availability and cost effectiveness	Number and taxa of native warmwater fish
What are the status and trends in warmwater nonnative fish assemblages?	Nonnative Fish Assemblages	Warmwater non-native fish species assemblages (Condition)	Strong decision support but limited by data availability and cost effectiveness	Number and taxa non-native warmwater fish

4.3.3 Rejected Indicator

Sediment quality, an indicator of Aquatic Habitat Condition, was eliminated from the list of Preliminary indicators. It scored well in the Decision Support Criteria, but was rejected as a candidate indicator and for further consideration in Phase II as a preliminary indicator on the basis of Cost Effectiveness and Data Availability criteria. The status and trends in aquatic habitat condition can be determined using more cost effective indicators that are currently available on at least a limited basis.

4.4 Overview of Next Steps

The recommendations presented in this report need to be reviewed and refined as the Workgroup continues Phase I, keeping in mind the following considerations:

- Clear vision statements or strategic objectives for watershed health need to be articulated to clarify the priority interests for the watersheds and to guide the development and appropriate use of indicators. Vision statements for the watersheds were being developed concurrently with this effort as part the District's Stewardship Plans and will be reviewed and considered in Phase II.

- Because Phase I will rely largely or entirely on information from existing monitoring programs, the protocols (e.g., frequency and locations), methods and data from these efforts need to be more thoroughly reviewed to evaluate more accurately availability, quality and suitability of existing data.

- Evaluation of metrics and monitoring methodology is needed to more accurately evaluate the cost criteria.

These considerations will be incorporated into the continuation of the Phase I scope of work along with the following major next steps:

1. Establish a vision for watershed health as a basis for indicator selection.

2. Identify Pilot Indicators by further evaluating Candidate Indicators and refining the PSR model (may include adding new indicators).

3. Develop implementation plan.

4. Implement Pilot Indicators using existing data, including the development and use of a preliminary scoring system.

5. Prepare Pilot Report Card.

5.0 STATE OF THE BASIN REPORT CONCEPT

5.1 Review of Existing Status and Trends Reports

As indicators are developed and ready for reporting on watershed condition, annual reports will be prepared to document the status of watershed health. The data and information will need to be transformed into formats that are useful for a variety of audiences, including environmental professionals, managers, policy-makers and the general public.

A number of organizations summarize data into indicators and present the results in annual reports that are accessible to a wide audience. The Workgroup reviewed a variety of status and trends reports to identify those that may serve as models for the WMI's report. For the purpose of evaluating appropriate models, the reports can be categorized into three different types. The EPA's Environmental Monitoring and Assessment Reports provide an example of the first category of reports. In these technical reports, results are presented using statistical tools, such as cumulative frequency diagrams and box-whisker plots, and statistical data are presented in tables. No attempt is made to score the results. These publications are intended for a technical scientific audience. In the second type of report, status and trends data are summarized in figures easily understood by the general public and include simple text accompanied by photos. Again, no attempt is made to score the results. Examples of this type of report are the San Francisco Estuary Institute's Pulse of the Estuary report and the Chesapeake Bay Program's State of the Chesapeake Bay report, which are non technical publications targeted to a public audience. In the third category, condition or health classes are assigned a score or letter grade resulting in a scorecard type of report. Examples of these reports are The Bay Institute's Environmental Scorecard and the Chesapeake Bay Foundation's Save the Bay report. The report cards published for the Upper Thames River Watersheds present condition grades and detailed information for each watershed within the Upper Thames River Basin.

5.2 State of the Santa Clara Basin Report Concept

A two-tiered reporting system is proposed for the State of the Santa Clara Basin Report Card. It will be used to present information on the health of stream ecosystems on a watershed basis, including major factors affecting stream health. The reports will inform potential management and policy actions that can be taken to improve stream health.

The first report will be a detailed interpretive report prepared for a technical audience that serves the dual purpose of documenting the sampling and analytical methods (e.g., a description of how reference condition was determined to establish scores), results (including statistical data) and conclusions, including information that can be used in project planning and watershed management. This technical report will include the necessary information for those who are not involved in the program to interpret the results and evaluate the technical credibility of the program.

The second document will be a distillation of the technical report in the form of a scorecard or report card for the general public and policy-makers. The technical information will be presented in a manner that is accessible to the non-technical person, such as simple bar graphs or letter grades representing the health of stream ecosystems. Scores will be developed for the major indicators or indicator categories for each watershed unit within the Santa Clara Basin. It

will be necessary to ensure that the reduction of information into a simple format retains the scientific integrity of the overall effort.

Balancing the evolving nature of indicator development to lend scientific credibility to the report and the great interest in publishing a report on watershed health, the first report that will be published at the end of Phase I will present scores for the Pilot Indicators. It is expected that the scorecard will not be fully populated at the end of Phase I but will evolve in time and will serve the dual purpose of identifying data gaps.

6.0 REFERENCES

Atkinson, A. C. Marn, and B. Fong. 2002. Terrestrial and Amphibious Monitoring Plan for the CALFED Bay-Delta Program. U.S. Geological Survey, Western Ecological Research Center. Prepared for CALFED Bay-Delta Program. Sacramento, California.

Buchan, L.A.J., and P.J. Randall. 2003. 2003. Assessment of Stream Ecosystem Functions for the Coyote Creek Watershed. Coyote Creek Watershed Integrated Pilot Assessment Final Report. Coyote Creek Watershed Integrated Pilot Assessment. 2003. EOA, Inc., Prepared for Santa Clara Valley Urban Runoff Pollution Prevention Program.

California Environmental Protection Agency. 2002. Environmental Protection Indicators for California. Understanding Environmental Condition through Indicators. California Resources Agency.

Chesapeake Bay Foundation. 2004. The State of the Bay Report.

U.S. Environmental Protection Agency. 2004. The State of the Chesapeake Bay: A Report to the Citizens of the Bay Region. The Chesapeake Bay Program. Annapolis, MD.

Cloak, D. 2003. Review of Methodologies and Preliminary recommendations for Assessing Stream Ecosystem Health. Dan Cloak Environmental Consulting, prepared for the Santa Clara Valley Water District.

Concur. 2004. Collaborative Key Outcomes Memorandum. Institutional Arrangements Work Team. January 11, 2005.

Jones & Stokes. 2005. Water Year 2004 mitigation monitoring report for the Guadalupe river Project, downtown San Jose, California. Draft. April (J&S 04670.04). Sacramento, Ca. Prepared for U.S. Army Corps of Engineers, Sacramento District, Sacramento, CA, in coordination with Santa Clara Valley Water District, San Jose, CA.

Organisation for Economic Co-Operation and Development (OECD). 1993. OECD Core Set of Indicators for Environmental Performance Reviews. Environmental Monographs No. 83. OCDE/GC(93)179.

Pawley, A. 2000. Program Performance Indicators for the CALFED Bay-Delta Ecosystem Restoration program. Report to CALFED from The Bay Institute.

San Francisco Estuary Institute (SFEI). 2004. The Pulse of the Estuary: Monitoring and Managing Water Quality in the San Francisco Bay. SFEI Contribution 78. San Francisco Estuary Institute, Oakland, CA.

Santa Clara Basin Watershed Management Initiative (SBMWI). 2001. Watershed Characteristics Report. Watershed Management Plan, Volume One (Unabridged). Prepared by the Santa Clara Basin Watershed Management Initiative, which is a stakeholder group organized to protect and enhance the Santa Clara Basin watershed. February 2001.

Santa Clara Basin Watershed Management Initiative (SCBMWI). 2003. Watershed Action Plan. Watershed Management Plan, Volume 3. Compiled by Dan Cloak Environmental Consulting. www.scbwmi.org.

Santa Clara Valley Urban Runoff Pollution Prevention Program. 2004. Revised Multi-Year Receiving Waters Monitoring Plan. Prepared by EOA, Inc., Managers of the Santa Clara Valley Urban Runoff Pollution Prevention Program.

Tetra Tech, Inc., and Design, Community & Environment. 2005. Guadalupe Watershed Stewardship Plan Draft. March. Prepared for Santa Clara Valley Water District. San Jose, CA.

The Bay Institute (TBI). 2003. The Bay Institute Ecological Scorecard. San Francisco Bay Index. TBI, Novato, CA.

Thompson, B. and A. Gunther. 2004. Development of Environmental Indicators of the Condition of San Francisco Estuary. A Report to the San Francisco Estuary Project. SFEI Contribution 113. San Francisco Estuary Institute, Oakland, CA.

Upper Thames River Conservation Authority. 2001. The Upper Thames River Watershed Report Cards. London, Ontario.

Water Resources Protection Collaborative. 2004. Guidelines and Standards for Land Use Near Streams: Manual of Best Practices for Protecting Streams and Riparian Areas.

APPENDIX 1: GLOSSARY

This glossary was developed to facilitate communication and achieve a common understanding of monitoring and assessment terminology by the Santa Clara Basin Watershed Management Initiative's Environmental Indicators Workgroup and readers of technical reports. Sources of definitions are provided at the end of the glossary.

Abundance

The numerical quantity of different organisms of an individual species or taxon.

Active Channel

The channel that contains the discharge where channel maintenance is most effective, where sediments are actively transported and deposited, and that is capable of containing most flows. Active channels are located within the area bounded by bankfull stages. (Leopold as cited in WRPC 2004)

Active Floodplain

Low lying areas built by watercourse sediment depositions between tops of bank that are adjacent to a watercourse and that have been constructed by the present river in the present climate. These areas are susceptible to frequent inundation during moderate and higher flows when the active channel's capacity is exceeded. Active floodplains are most prominent along low-gradient, meandering reaches and are often absent or undistinguishable along steep sloped stream channels. (Leopold from as cited in WRPC 2004)

Adaptive Management

The process of refining or redefining management actions as a process unfolds and results are obtained so that informed changes can be made if the desired results are not being achieved. Adaptive management is an interactive and iterative approach to decision making that incorporates feedback loops for evaluating actions and the use of new data and information as a basis to improve resource management practices and future planning. (Adapted from CalFed 2000 and U.S. Forest Service)

Anadromous Fish

Those species of fish born and reared in freshwater, move to the ocean to grow and mature, and return to freshwater to reproduce. (U.S. Forest Service)

Assessment

Evaluating, interpreting, and translating scientific results from environmental data collection activities and using this information to support decisions and actions designed to reduce human-induced stressors on watershed condition and processes regarding watershed condition. (Adapted from EPA Watershed Academy)

Assessment Framework

A logical structure containing the components of a system for the use and interpretation of data to assess the health or condition of an ecosystem or watershed.

Assessment Question

Environmental management concerns of policy-makers, watershed managers, and stakeholders stated as questions to be answered in an assessment.

Baylands

The shallow water habitats around the San Francisco Bay between the maximum and minimum elevations of the tides. Includes tidal and diked habitats. (BCDC 1982, Bay Institute 1987, Goals Project 1999)

Baylands Ecosystem

The abiotic environment and biotic communities of the baylands and adjacent habitats, including the ecological and physical structure and ecological functions. (Modified from Goals Project 1999)

Beneficial Use

The beneficial uses described in the Basin Plan of the San Francisco Regional Water Resources Control Board define the resources, services, and qualities of aquatic systems that are the ultimate goals of protecting and achieving high water quality. The Regional Board is charged with protecting all these uses from pollution and nuisance that may occur as a result of waste discharges in the region. Beneficial uses of surface waters, groundwaters, marshes, and mudflats serve as a basis for establishing water quality objectives and discharge prohibitions to attain this goal. They include: agricultural supply, cold and warm freshwater habitat, fishing, groundwater recharge, water supply, water contact and noncontact recreation, shellfish harvesting, and wildlife habitat. (Adapted from SFB RWQCB Basin Plan)

Biodiversity

The variety of life forms and processes within an area. Biodiversity considerations include the number and distribution of species, genetic variation, and the ways in which the variety of biological communities interact and function. (Modified from OTA 1987 and U.S. Forest Service)

Candidate Indicator

Candidate indicators have not been fully evaluated using all of the indicator selection criteria but meet some criteria and show promise in being able to demonstrate status and trends in stream health. See also Preliminary Indicator, Pilot Indicator, Core Indicator, and Indicator Development.

Community Composition

The assemblage of interrelated and interdependent plant (plant community composition) or animal species or taxa (animal community composition) co-occurring widely enough across a landscape to be recognized as a unit.

Community Structure

The architecture of the biotic community with respect to the density, horizontal stratification, and frequency distribution of species-populations, and the sizes and life forms of the organisms that comprise those communities. (Modified from SER Science & Policy Workgroup 2002)

Conceptual Model

A conceptual model in problem formulation is a visual representation and sometimes written description of the components of a system and how they are believed to interrelate and interact to function as a whole. Models may be conceptual or numerical and often serve to indicate the linkages and interrelationships between metrics, actions, and goals and relationships between system components and the stressors to which they may be exposed. See also Pressure-State-Response Model. (EPA and CalFed 2000)

Core Indicator

Core indicators meet the indicator selection criteria and have been shown to be useful and robust in an environmental assessment framework. See also Candidate Indicator, Pilot Indicator, and Indicator Development.

Ecological Condition

The degree of functionality or health of an ecosystem, measured by a broad array of indicators of condition that include biotic characteristics (e.g., native plant communities, fish or invertebrate populations, species and habitat biodiversity) and abiotic characteristics (e.g., streambank stability and erosion, assimilation and cycling of nutrients, maintenance of sufficient flow and water temperature. (EPA)

Ecosystem

The interacting system of a biological community and its nonliving environment.

Ecosystem Health

State or condition of an ecosystem in which its dynamic attributes are expressed within “normal” ranges of function relative to a reference condition. In a healthy ecosystem, the structure, composition, and function ensure the maintenance of biological diversity and ecological processes over time. (Adapted from U.S. Forest Service)

Endangered Species

Any species of animals or plants listed as “endangered” by the U.S. Fish and Wildlife Service and in danger of extinction throughout all or a significant portion of its range.

Environmental Indicator

A measurable environmental feature or features that describes the quantity and quality of natural resources (“state” indicators), the pressures put on the environment caused by human activities (“pressure” indicators) and the societal response to the pressures (“response” indicators). (Modified from EPA)

Extent

The contiguous geographic space, such as acres, occupied by a habitat, such as riparian, wetland, floodplain, and intact in-stream rivers and corridors.

Functions

In terms of ecosystem function, refers to the dynamic attributes of an ecosystem, as carbon fixation by photosynthesis, trophic interactions, decomposition, and mineral nutrient cycling. Impairments in one or more ecosystem function may jeopardize ecosystem sustainability.

Habitat

The dwelling place of an organism or community that provides the requisite conditions for its life processes. (SER 2002)

Index

An aggregation of indicators with similar impacts. Its main purpose is to communicate detailed information to an audience that requires condensed or simplified information.

Indicator

See “Environmental Indicator”

Indicator Development

The process through which an indicator is identified, tested, and implemented comprising a progressive series of stages, including candidate, pilot, and core indicators. Existing data are analyzed, indicator selection criteria are applied, and limited field tests may be conducted to advance potential indicators through the development stages. An indicator is considered a core indicator when it is selected for long-term, ecological monitoring as a result of its acceptable performance, demonstrated ability to satisfy the data quality objectives. (Modified from EPA)

Indicator Development Framework

A logical structure containing the components of a systematic and stepwise procedure to identify and select meaningful indicators that can be used to assess the health or condition of an ecosystem or watershed.

Index

Mathematical aggregation of indicators or metrics. (EPA EMAP)

Invasive Species

A non-indigenous plant or animal species which is able to proliferate and aggressively alter or displace indigenous biological communities. (Modified from CNPS)

Measurement

A quantifiable attribute that is tied to an indicator.

Metric

A unit of measure of a physical, chemical, or biological attribute that is empirically shown to change in value along a gradient of human influence (Modified from Karr and Chu 1999 as cited by TBI)

Monitoring

The organized collection of information (e.g., chemical, physical, biological) over time to aid the understanding of watershed health. The information may be used in watershed assessment, watershed planning, regulatory compliance and in overall watershed management decision making. Monitoring is also used to track the implementation accuracy and effectiveness of policies and projects. (Modified from CalFed 2000)

Native Species

Any plant or animal which is a member of a species which was present at a given site prior to European contact. (Modified from CNPS)

Nominal

Referring to the state of having desirable or acceptable ecological condition.

Neotropical Migrants

Neotropical birds migrate each spring to breeding grounds in the United States and Canada, and then fly south to spend the bulk of the year in Mexico, Central or South America or the Caribbean.

Pilot Indicator

Pilot indicators meet at least some key criteria and require further evaluation to determine their usefulness within an assessment framework. See also Preliminary Indicator, Candidate Indicator, Core Indicator, and Indicator Development.

Preliminary Indicator

Preliminary indicators are an unfiltered list of potential environmental indicators that have either not been formally evaluated using indicator selection criteria or do not meet the initial screening criteria due to lack of information but show promise. See also Candidate Indicator, Core Indicator, Pilot Indicator, and Indicator Development.

Pressure Indicator

Indicators of the effects, positive and negative, of natural events and human activities on the environment. Sometimes referred to as stress (or stressor) indicators. Pressure indicators should be responsive to management actions intended to improve an observed problem. They also serve as an incentive to solutions, since they demonstrate the effectiveness of policy actions. (See also State Indicator and Response Indicator.) (Modified as cited in CalFed)

Pressure-State-Response Model

Pressure-State-Response (PSR) Model is a type of conceptual model used in adaptive management where data-gathering informs environmental management decisions and evaluates the effect of human activities. Generally, the premise of the PSR model is that human activities and natural events exert pressure or stress on the environment, which may induce changes in the condition (state) of the environment that management actions (response) are taken as a result of the observed changes, and the outcomes of the responses can be measured. (See Pressure Indicator, State Indicator, and Response Indicator.) (OECD 2001 and CalFed 2000)

Reference Condition

The set of attributes of ecological resources that assist in identifying the location of a portion of the resource population along a condition continuum from the worst possible condition to the best possible condition given the prevailing topography, soil, geology, potential vegetation, and general land use of the region. This composite description gives a more realistic basis for a reference condition and is derived from a variety of sources, including reference sites (see definition below), ecological descriptions prior to impairment or of similar intact ecosystems, historical and recent photographs, and such. (Modified from EPA EMAP and SER)

Reference Site

One of a population of bench mark or control sampling locations that, taken collectively, represent an ecoregion or other large biogeographic area; the sites, as a whole, represent the best ecological conditions that can be reasonably attained, given the prevailing topography, soil, geology, potential vegetation, and general land use of the region or clearly subnominal condition. (Modified from EPA EMAP)

Resource

A valued ecological entity that is identified as a target of monitoring and is a group of general, broad ecosystem types or ecological entities sharing certain basic characteristics. Examples of such categories are estuaries, aquatic, wetlands, and riparian. These categories define the organizational structure of monitoring groups and are the resources subject to assessment and addressed in the Environmental Report Card. (Modified from EPA EMAP)

Response Indicator

Indicators of the efforts of society (i.e., policies, decision-makers) to solve observed environmental problems or concerns. (See also State Indicator and Pressure Indicator.)

Riparian

Riparian areas are transitional between terrestrial and aquatic ecosystems, providing linkages between water bodies and adjacent upland and include portions of terrestrial ecosystems that significantly influence exchanges of energy and matter with aquatic ecosystems. (Modified from National Research Council 2002)

Riparian Corridor

The vegetated banks of a perennial or intermittent water body that provides habitat, especially cover and shade, to fish and wildlife. Riparian corridors are important for landscape connectivity.

Special-Status Species

Species identified as rare, threatened, endangered, or otherwise of concern based on California Environmental Quality Act, which includes federal status, California Status, California Department of Fish and Game listing and California Native Plan Society listing.

State Indicator

Indicators of the condition of the environment, including its natural variability (e.g., the concentration of mercury at the confluence of Guadalupe River with the Baylands). (See Indicator.)

Status

The distribution of scores for state indicators with relation to the reference condition associated with specific social values or desired uses for a specific time period (Modified from EPA EMAP)

Stream

A body of water that flows at least periodically or intermittently through a bed or channel having banks. This may include watercourses having a surface or subsurface flow that supports or has supported riparian vegetation, fish, and or other aquatic life. (WRPC 2004b)

Streambed

The substrate plane bounded by the stream banks over which water moves. Also called stream bottom. It is the area kept mostly or completely bare of vegetation by the water of water of the stream. (King County Dept. of Public Works 1993 as cited in WRPC 2004)

Stream Bank

The portion of the channel cross section that restricts lateral movement of water. A distinct break in slope from the channel bottom (King County Dept. of Public Works 1993 as cited in WRPC 2004)

Stream Ecosystem

The interrelated abiotic environment and biotic communities of streams and adjacent habitats, including the ecological and physical structure and ecological functions.

Stressors

Any physical, chemical, or biological entity that can induce an adverse response (synonymous with agent). (RAF 1992 as cited in EPA EMAP)

Structure

In reference to an ecosystem, structure is the horizontal and vertical physical elements of the ecosystem.

Surface Water

Surface waters in the San Francisco Bay region consist of freshwater rivers, streams, and lakes (collectively described as inland surface waters), estuarine waters, and coastal waters. (SFB RWQCB Basin Plan)

Sustainability

The ability of a dynamic ecosystem to maintain its composition, function, and structure over time, and therefore, sustain diversity, productivity, resilience to stress, and yields of desired values (Modified from U.S. Forest Service).

Threatened Species

Any species of animals or plants listed as “threatened by the U.S. Fish and Wildlife Service and likely to become an endangered species within the foreseeable future throughout all or part of its range.

Top of Bank

A stream channel boundary where a majority of normal discharges and channel forming activities takes place. The top of bank boundary will contain the active stream channel, active floodplain and their associated banks. Top of bank of streams with levees will be delineated on the inner edge of the levee. (Modified from WRPC 2004b)

Trend

The directional change in the distribution of scores for state indicators over a minimum of three time periods. Trend evaluations require several estimates of conditions often over longer time periods. A change is a difference in a characteristic between just two sampling events. (EPA EMAP)

Watershed

Total land area draining into a river, river system or other body of water above a particular point. Commonly referred to as drainage basins. (e.g., Santa Clara Basin)

Watershed Monitoring

Monitoring primarily designed to sample and assess the characteristics and/or condition of a watershed or watersheds, or to sample and assess specific entities on a watershed basis (i.e., as a geographic unit for sampling). For example, water quality monitoring conducted on a watershed basis would include monitoring physical, chemical, and biological condition of the water body as well as specific watershed characteristics (e.g., stream corridor traits, wetlands, and watershed land use/land cover patterns) that may be related to observed water quality (EPA)

Water Resources Protection Collaborative

A cooperative decision making process comprised of members representing all of the cities, the County, the Santa Clara Valley Water District, citizens, businesses and community groups in Santa Clara County who are developing tools for local governments and the County to protect watershed and water resources.

Wetlands

Lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or where shallow water covers the land and where at least one of the following attributes holds: (1) at least periodically, the land supports aquatic plants predominantly; (2) undrained hydric soils are the predominant substrate; and (3) at some time during the growing season, the substrate is saturated with water or covered by shallow water (Cowardin et al. 1979).

SOURCES OF DEFINITIONS

Sources are provided in parentheses after the definitions. The original sources of the definitions are presented when they were identified. In some cases the original definitions were modified to adapt them for the purpose of the Indicators Workgroup. In cases where a definition was created for this document, no source is indicated.

California Native Plant Society (CNPS). http://www.cnps.org/archives/exotics.htm

CALFED Bay-Delta Program. 2000. Watershed Program Plan. http://baydeltawatershed.org/pdf/prog_plan.pdf

Cowardin, L.M., V. Carter, F.C. Golet, E.t. LaRoe. 1979. *Classification of Wetlands and Deepwater habitats of the United States*. U.S. Department of the Interior. Washington, D.C. 131 pp. http://el.erdc.usace.army.mil/emrrp/emris/emrishelp2/cowardin_report.htm

Goals Project. 1999. *Baylands Ecosystem Habitat Goals: A Report Of Habitat Recommendations Prepared by the San Francisco Bay Area Wetlands Ecosystems Goals Project.* U.S. Environmental Protection Agency, San Francisco, California, S.F. Regional Water Quality Control Board, Oakland, California. 209 pp. and appendices.

National Research Council. 2002. Riparian areas: functions and strategies for management. Committee on Riparian Zone Functioning and Strategies for Management, Water Science and Technology Board, Board on Environmental Studies and Toxicology, Division on Earth and Life Studies, National Research Council. Washington, D.C., 428 pp.

San Francisco Bay Conservation and Development Commission. 1982. "Diked historic Baylands of San Francisco Bay, Findings, Policies and Maps." Adopted October, 1982.

Shilling, F., S. Sommarstrom, R. Kattelmann, B. Washburn, J. Florsheim, and R. Henly. California Watershed Assessment Manual. August, 2004. Prepared for the California Resources Agency. http://cwam.ucdavis.edu/

Society for Ecological Restoration Science & Policy Workgroup 2002. The SER Primer on Ecological Restoration. http://www.eri.nau.edu/education/files/ser_primer.pdf

The Bay Institute. 1987

U.S. Environmental Protection Agency Environmental Monitoring and Assessment Program (EMAP) (http://www.epa.gov/emap/html/pubs/docs/resdocs/mglossary.html#ii)

U.S. Environmental Protection Agency Watershed Academy. http://www.epa.gov/watertrain/stream/glossary.html

U.S. Forest Service (http://www.fs.fed.us/pl/rpa/95rpa/glossary.htm)

Water Resources Protection Collaborative (WRPC). 2004a. Glossary for the Proposed Guidelines and Standards. http://www.concurinc.com/scvwdcupertino/08.05.04/final/4c%20Final%20Stream%20Def.pdf http://www.concurinc.com/scvwdcupertino/08.05.04/final/9%20Final_Glossary_of_Terms.pdf

Water Resources Protection Collaborative (WRPC). 2004b. Chapter 2. Key Definitions. *In: Users Manual. Guidelines and Standards for Land Use Near Streams.*

APPENDIX 2: RESULTS OF INDICATOR SCREENING

INDICATOR CATEGORIES	STATUS	POSSIBLE INDICATORS	DATA AVAILABILITY (DA)					DECISION SUPPORT (DS)					COST EFFECTIVE (CE)					AVERAGE SCORES			
		Screener:	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	Avg DA	Avg DS	Avg CE	Overall Avg
Riparian and wetland habitat condition	CI	Extent of riparian and wetland habitat	2		2	2	1	3	3	3	3	3	1		3	2	3	1.75	3	2.25	2
	CI	Extent of riparian habitat fragmentation	2		2	2	1	3		3	3	3	1		3	2	3	1.75	3	2.25	2
	CI	Extent of development in riparian corridor)	1		3	2	3	3		3	3	3	3		3	2	3	2.25	3	2.75	3
	PI	Riparian community composition and structure	1		1	1	1	2		3	3	3	1		3	1	1	1	2.75	1.5	2
	CI	Extent of invasive riparian and wetland species	2		1	2	1	3		3	3	3	2		3	2	3	1.5	3	2.5	2
Riparian and wetland habitat protected, restored, and/or enhanced	CI	Extent of riparian and wetland habitat protected	3		3	3	3	3		3	3	3	3		3	3	3	3	3	3	3
	CI	Extent of riparian and wetland habitat restored	3		2	3	3	3		3	3	3	3		3	3	3	2.75	3	3	3
	CI	Extent of riparian and wetland habitat enhanced	3		2	3	3	3		3	3	3	3		3	3	3	2.75	3	3	3
Stream Water Quality	CI	Physiochemical Water Quality	3	3	2	2	1	3	1	3	3	3	2	2	3	2	3	2.2	2.6	2.4	2
	CI	Macroinvertebrate assemblages	3	1	2	2	1	3	1	3	3	3	2	1	3	2	2	1.8	2.6	2	2
	CI	Extent of Trash	3	2	2	2	1	2	1	3	1	3	3	1	3	3	1	2	2	2.2	2

INDICATOR CATEGORIES	STATUS	POSSIBLE INDICATORS	DATA AVAILABILITY (DA)					DECISION SUPPORT (DS)					COST EFFECTIVE (CE)					AVERAGE SCORES			
		Screener:	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	Avg DA	Avg DS	Avg CE	Overall Avg
Stream Sediment Characteristics	X	Sediment quality	1		2	1	2	1		2	1	3	1		2	1	2	1.5	1.75	1.5	2
Instream flows	CI	Instream flows	2		2	2	3	3		3	3	3	3		3	2	3	2.25	3	2.75	3
Anadromous fish habitat suitability	CI	Anadromous fish spawning habitat	2		3	2	2	3	3	3	3	3	2		3	2	3	2.25	3	2.5	3
	CI	Anadromous fish passage barriers	2		3	2	3	3		3	3	3	2		3	2	3	2.5	3	2.5	3
	CI	Anadromous fish rearing habitat complexity and diversity	2		3	2	1	3		3	3	2	2		3	2	2	2	2.75	2.25	2
	CI	Shaded Riverine Aquatic cover	2		2	2	2	3		2	3	3	2		2	3	3	2	2.75	2.5	2
Native Fish Assemblages and Recruitment	PI	Anadromous Fish species: Juvenile recruitment	1		2	2	1	3		2	3	3	1		3	1	3	1.5	2.75	2	2
	PI	Anadromous Fish species: Overwintering habitat	1		2	2	2	3		2	3	3	1		3	1	3	1.75	2.75	2	2
	PI	Warmwater Native Fish species assemblages	2		2	2	2	3		2	3	3	1		2	1	3	2	2.75	1.75	2
	PI	Warmwater Non-Native Fish species assemblages	2		1	2	2	3		1	3	3	1		1	1	3	1.75	2.5	1.5	2
Hydrogeomorphic processes	CI	Channel Condition: Stream bank characteristics	1		2	2	3	3	3	3	3	3	2		3	2	3	2	3	2.5	3
	CI	Channel Condition: Stream bed characteristics	1		2	2	2	3		3	3	3	2		3	2	2	1.75	3	2.25	2

INDICATOR CATEGORIES	STATUS	POSSIBLE INDICATORS	DATA AVAILABILITY (DA)					DECISION SUPPORT (DS)					COST EFFECTIVE (CE)					AVERAGE SCORES			
		Screener:	1	2	3	4	5	1	2	3	4	5	1	2	3	4	5	Avg DA	Avg DS	Avg CE	Overall Avg
	CI	Channel Condition: Extent, quality and type of channel modification	2		2	3	3	3		3	3	3	2		3	2	3	2.5	3	2.5	3
	CI	Floodplain connectivity	1		2	2	1	3		3	3	3	2		3	2	2	1.5	3	2.25	2
	CI	Stream hydrograph	2		2	2	1	3	3	3	3	3	2		3	1	3	1.75	3	2.25	2

Key to Status (Results of Indicator Screening)

CI: Candidate Indicator

PI: Preliminary Indicator

X: Delete from Consideration

Pink Highlights: Highest scoring Candidate Indicators within each category*

Criteria:

Data Availability (DA): Data are currently available and likely to be available in the future.

Decision Support (DS): Provides information that informs decision-making; links to conceptual model.

Cost Effective (CE): Apparent reasonable cost to collect data required to support indicator in evaluating condition and to develop the indicator.

* The average scores for the indicators of Stream Water Quality and Native Fish Assemblages and Recruitment did not score high enough overall to consider them top priority candidate indicators using the preliminary ranking method, but are considered important and will be evaluated further.