Assessment of the Health of Santa Ana River Watershed

1. 1.0 Introduction

Human well-being is inextricably tied to the services provided by healthy ecosystems and yet vulnerable to the increased threats posed by major crises or events, which SAWPA has labeled the Six *Horsemen of the Apocalypse.* The crises threaten the future of a sustainable Santa Ana Watershed. The *Six Horseman*[1], or major threats, are:

- Climate Change
- Colorado River Continuing Drought
- Sacramento-San Joaquin Delta Vulnerability
- Population Growth and Development
- Energy
- Fiscal Crises

Climate and ecosystem stressors reduce the reliability of the water supply system, the rivers and beaches are polluted by urban runoff, development of new communities interrupts hydrology and groundwater recharge, wetlands and riparian habitat have been lost with urbanization and the conversion of rivers to reduce flood risks, wildlife habitat continues to decline with development, frequent wildfires threaten to convert native ecosystems to non-native grasses, and people in urban communities have too few parks and little access to wild open spaces.

It is vital that we value and communicate these connections between natural systems and humans in order to cause change. Understanding and communicating about environmental and community conditions over the long-term is a critical aspect of sustainable environmental management and policy formulation. Working with the landscape and its natural processes, using sound science, listening to stakeholders, and integrating actions across multiple priorities yields multiple benefits cost effectively. The approach can only be implemented when agencies and organizations work together towards a shared vision. Developing an integrated assessment for reporting on the state of our environment is the most effective way to describe and encourage the progress towards this vision.

This chapter reports on the methodology of an integrated assessment of the Santa Ana watershed and also provides the findings of a current assessment. The assessment we describe augments the Santa Ana Watershed Project Authority (SAWPA) One Water One Watershed (OWOW) goals and objectives, strategies, and targets. The resulting assessment reports on status and trends of the economic, ecologic and social systems that make up the watershed.

This scientific, data-driven watershed assessment benefits local, regional, state and federal agencies and organizations by conveying a systematic, scientific evaluation of conditions developed for and presented to a wide-ranging audience. Integrated assessment and reporting of environmental and community conditions may promote cooperative management and decision-making by increasing the public's awareness of regional conditions. In addition, this report describes a mechanism for future monitoring and tracking and is designed to meet the IRWM requirements for Plan Performance and Monitoring while also providing OWOW with a mechanism for celebrating successes, drawing resources to challenges, and improving the health of the Santa Ana watershed.

Regional targeted assessments have been deployed elsewhere in the United States and internationally. The report card produced by the Chesapeake Bay Foundation is perhaps the most visible in the US and provides a public accounting for communities and municipalities within the Chesapeake Bay watershed, stimulating restoration of critical habitats.

[1] http://www.sawpa.org/owow/about-owow/

Similar to the Chesapeake Bay, the communities in the Santa Ana River watershed are critical to the economy of California and the nation. The health of the economy and the environment are inextricably linked. Routine, collaborative and structured assessments of conditions of the economy, society, and ecology provide an important feedback into the integrated regional water management. We know that what we measure affects what we do in powerful ways.

2. 2.0 Framework for the Assessment

As a component of the OWOW 2.0 plan, this watershed health assessment provides metrics for understanding the performance of integrated water management in the watershed. Using this assessment tool, SAWPA and the OWOW Pillars can produce an effective, efficient and responsive ongoing monitoring program for the watershed. The current Integrated Regional Water Management guidelines from Department of Water Resources (DWR) require inclusion of performance monitoring in all Integrated Regional Water Management (IRWM) planning efforts.

3. 2.1 Project Process and Methodology

The development and analysis of a framework for indicator assessment was a collaborative process among SAWPA, the Pillars, Council for Watershed Health, and Dr. Fraser Shilling. The methodology was developed using a framework drawn from the California Watershed Assessment Framework (WAF), which is itself a derivative of a U.S. Environmental Protection Agency Science Advisory Board framework (EPA 2002). The techniques and technology of the Framework are well accepted by the California Department of Water Resources (DWR) and are also playing a role in the development of the California Water Plan 2013 Update. The current guidelines from DWR require inclusion of performance monitoring in all Integrated Regional Water Management (IRWM) planning efforts.

A system of ecosystem assessment encourages measuring indicators of these essential watershed attributes such as water temperature, fish populations and concentrations of certain chemicals that contribute to an evaluation of, for example, biotic conditions. Indicators convey the condition of components of the system relative to goals for the system. Over time the report card maintains consistency in the measured indicators, the targets for each indicator, and goals for the system.

The Framework has two key strengths. First, it uses existing watershed management goals as the focus of the assessment. This allows a variety of managers to participate in creation of the assessment, and assures actionable results for implementation. The watershed management goals drive selection of indicators and metrics that can often be drawn from existing datasets or data collection efforts.

Second, the Framework uses "distance to target" as the ethic for describing the condition or state of each indicator. The process identifies a range from best case to worst case for the indicators, which are then described as existing somewhere in that range. This permits indicators that are significantly different to be compared to one another by describing where we are compared to where we want to be. For instance, a measure of per capita wateruse can be compared to the presence of in-stream benthic invertebrate species because both will be scored based on their current condition compared to their target condition.

The process included presentations of the Framework and its application in working sessions orchestrated by SAWPA for the appropriate stakeholders. This learning process included both small-group meetings with SAWPA staff as well as larger-scale stakeholder sessions with the Pillars.

3.1. <u>2.1.1 Goal & Objective Development</u>

Using a facilitated, stakeholder process, we analyzed the goals and objectives in the original OWOW plan and compared them to the OWOW 2.0 Framework to identify and fill gaps. We then used performance targets highlighted in OWOW as the starting point to develop an appropriate suite of indicators and metrics for the Santa Ana watershed that addresses the needs of the community, the ecology, and the IRWM planning requirements. Finally, we populated the indicators set with distance-to-target scores derived from research, data collection and data analysis. This step relied heavily on existing datasets and data collection managed by SAWPA.

3.2. <u>2.1.2 Indicator Selection and Analysis</u>

Thoughtful selection of indicators should be derived from the starting framework of goals and objectives. Most indicators, however, are chosen because information is available or is likely to become available to inform evaluation. Quantitative indicators are typically parameters that are familiar from monitoring programs (e.g., # spawning salmon) that become indicators when they are chosen to represent important parts of social-ecological systems.

Because of the special role that indicators play in public education and decision-making, data sources should be carefully tracked and their provenance recorded through the indicator framework process. Data provenance refers to the described pathway that data for each selected indicator takes to become meaning as part of indicator evaluation. This pathway begins with justification for why a particular dataset is chosen to data management in a retrievable form linked to reporting on indicator condition.

This provenance pathway continues seamlessly with data analysis and reporting, which can be organized using the scientific workflow technique. Scientific workflows offer both a theoretical as well as a practical way for building a comprehensive environment for data management, analysis, and decision support. Scientific workflows combine scientific data and process workflows, and provide a graphical interface to manage the pipeline of steps of a scientific problem (Ludäscher et al 2009). One can think of scientific workflows as similar to a flowchart, where the various nodes represent computational tasks and the lines connecting each step are the informational inputs and outputs for each step. Each step can either be automated, such as an analytical task, or semi-automated, where external input and responses are required to complete the steps.

3.3. <u>2.1.3 Distance to Target</u>

Comparing indicator-parameter values to a reference or target condition is a critical step in the Framework. This is where sustainability meaning is attached to the data. There are a variety of ways to measure and normalize measurement of parameter conditions to target or reference conditions (see Appendix for more detail).

In the Framework, normalization is carried out where each indicator is evaluated compared to a pair of reference or standard values (axiological normalization). Typically, there is a reference for "unwanted condition" (score = 0) and "wanted condition" (score = 100). When this is done for each indicator and each time point, the result is a "distance to target" value that can be on a 0-100 (or similar) scale. An important benefit of comparing indicator condition to targets is that scores can be combined across very different indicators (e.g., water temperature and fish tissue mercury concentrations), whereas otherwise this would not be possible. Because all indicator conditions are quantitatively compared to a target, they will all be normalized to the same scale — distance to target. Once the normalization takes place, the new values, ranging from 0 to 100, mean the same thing and can therefore be compared, or aggregated. Because environmental and socio-economic processes and conditions rarely respond to influences in a linear fashion, evaluating indicators relative to reference conditions must also take into account these non-linear responses. For example, evaluation of water temperature should follow a non-linear function because biological processes may respond non-linearly to changes in temperature (Figure 1). Other processes or attributes may have a linear relationship, or power relationship to sustainability score (Figure 1).

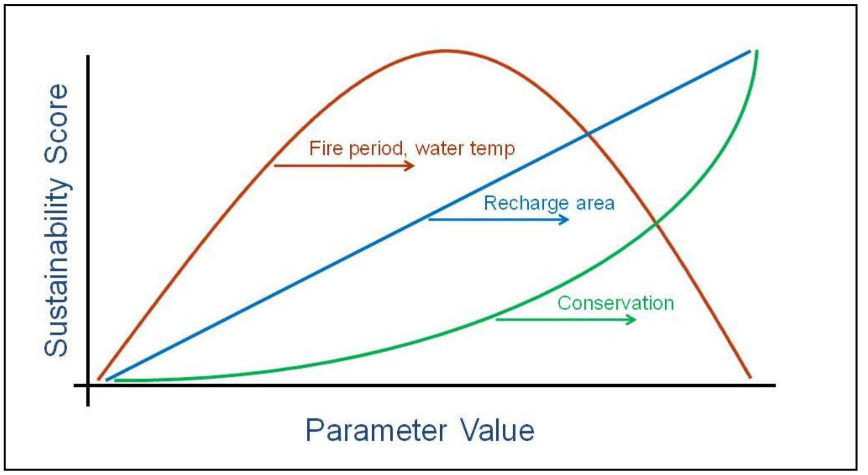

Figure 1: Non-linear relationships between parameters and equivalent sustainability scores

3.4. <u>2.1.4 Variance and Confidence</u>

The degree of certainty in the indicator evaluation results depends on two conceptual questions: whether good indicators were chosen and how well the data presented for each indicator accurately reflect the real status or trend in the metrics. The first of these questions pertains to the indicators themselves and how well they address the objectives or attributes they are meant to represent. Certainty about the indicators depends on four main factors: importance, understanding, rigor, and feasibility.

The second question pertains to statistical confidence in the data presented for each indicator. The available data may contain a variety of sources of uncertainty including: measurement error, uncertain or inappropriate use of the sampling frame, sampling error, and process error. Any of the above sources of uncertainty affects confidence in the estimates of status and reduces the ability to detect trends over time. For some indicators quantification of different sources of uncertainty in the data may be possible, but in many cases there are limitations to providing a qualitative description of the likely sources of error and associated magnitude. Reporting confidence, certainty, and/or variance is important to building trust for the indicators framework.

4. 2.2 Goals

Using the process described in section 2.1.1 above, the Pillars selected five areas for which to develop goals for OWOW 2.0: water supply, hydrology, open spaces, beneficial uses, and effective & efficient management. The goals and objectives for each of these five areas are detailed in this section.

4.1. <u>2.2.1 Water Supply</u>

Goal: Maintain reliable and resilient water supplies and reduce dependency on imported water
Objectives:, increase use of rainfall and snowpack as a resource, increase use of recycled water, decrease water demand, increase water-use efficiency, sustainably develop local water resources, maintain sufficient

storage to overcome multi-year (3 year) drought over a ten year hydrologic cycle, reduce green-house-gas emissions and energy consumption from water resource management.

The Santa Ana River Watershed, among all the services it provides, is the source of a great deal of the water used by human communities, and virtually all of the non-human communities. The supply of good quality water to communities and the environment is foremost in the management effort of the watershed, and this goal seeks to understand the effectiveness and efficiency of the water supply system.

4.2. 2.2.2 Hydrology

Goal: Manage at the watershed scale for preservation and enhancement of the natural hydrology to benefit human and natural communities
Objectives: Preserve and restore hydrologic function of forested and other lands, preserve and restore hydrogeomorphic function of streams and water bodies, safely co-manage flood protection and water conservation, include ecosystem function in new development planning and construction

The physical processes of the watershed exist on the land and in the water. This goal highlights how managers of water and land (and the relationship between the two) are striving to protect and restore natural processes that benefit other goals within the watershed, like supply or habitat augmentation.

4.3. 2.2.3 Open Spaces

Goal: Preserve and enhance the ecosystem services provided by open space and habitat within the watershed
Objectives: Increase the capacity of open space to provide recreational opportunities without degrading its quality or increasing its consumption of water & energy; protect existing and restore native habitats; protect and maintain healthy forests; manage aquatic and riparian invasive species; protect estuarine and marine near-shore habitats; reduce ornamental irrigated landscapes; improve management support for landscaping that utilizes native and drought tolerant vegetation ; protect endangered and threatened species and species of special concern through improved habitat; protect and restore wildlife corridors

Like the Hydrology goal, the desire to protect open spaces reveals efforts to maintain land in a natural condition. Here, however, the focus is more on the habitat and recreational value of the open space. Changing the ethic for managing developed open space, even at the household scale, is also included here, found in the objectives to diminish irrigation and water-intensive ornamental landscapes.

4.4. 2.2.4 Beneficial Uses

Goal: Protect beneficial uses to ensure high quality water for human and natural communities
Objectives: Attain water quality standards in fresh and marine environments to meet designated beneficial uses; protect and improve source water quality; achieve and maintain salt balance in the watershed

Strong Federal and State regulatory authority drives water quality management. This goal acknowledges the need for water quality on the surface and in the ground to be improved through management changes.

4.5. 2.2.5 Effective & Efficient Management

Goal: Accomplish effective, equitable and collaborative integrated watershed management
Objectives: Improve regional integration and coordination; ensure high quality water for all users; balance quality of life and social, environmental and economic impacts when implementing projects; maintain quality of life; provide economically effective solutions; engage with disadvantaged communities to eliminate environmental injustices; engage with Native American tribes to ensure equity; reduce conflict between water resources and protection of endangered species

This goal is at the heart of the OWOW process, saying that only through inclusive collaborative processes can the necessary unity of purpose be achieved. Managing the Santa Ana watershed requires actors at multiple scales and with vastly different authorities and responsibilities. Through an adaptive management process OWOW seeks to achieve the correct organization of decision-makers for the decisions that must be made. Despite this goal being central to the process of OWOW, it was extremely difficult to resolve indicators of its distance to target, as can be read below.

5. 3.0 Findings

As is the case for all watersheds in coastal California, there is degraded water and habitat quality in much of the lower Santa Ana watershed and parts of the upper watershed. High levels of land protection in the upper watershed provide some balance to the lower watershed conditions. Water supply reliability benefits from water use efficiency by users and municipalities, and is challenged by persistent groundwater quality issues, unpredictable effects of climate change, and low (but improving) rates of water recycling. The SAWPA service area has benefited from the open OWOW process and active attempts to recruit community members to meetings. At the same time, the rate of community involvement is very low relative to the very large population impacted by the conditions of the watershed and the decisions of those managing it.

Below is a synopsis of the indicators selected for each goal, and what the analysis told us about the Watershed. Throughout the findings below are found "Incomplete" scores for a number of indicators. This reflects a decision to include indicators that can provide an understanding of the distance to the target goal; however, those indicators either do not have a robust data set or are lacking a rigorous technique for assessing the indicator.

5.1. <u>3.1 Water Supply</u>

Maintain reliable and resilient water supplies and reduce dependency on imported water

The water supply for the communities of the Santa Ana watershed has long been sufficient to the need. However, it has also been reliant on a known climate, the availability of affordable imported water, and an economy and population with small but consistent growth. In this goal, the OWOW 2.0 plan acknowledges that to maintain reliability of water supply the system needs to become more resilient to change, primarily by reducing the most variable and threatened component of the supply: imported water.

Five indicators were analyzed about this goal. They allow an understanding of how effectively the watershed is using local water supplies as compared to imported, and how the community of the watershed is conserving both individually and through policy. Also an indicator of on-hand stored water was studied to describe the region's ability to withstand being cut off from imported supplies. The table below shows these five indicators and how they were scored.

The Santa Ana Watershed does well to use local and recycled water supplies. This is true primarily due to the use of local groundwater and the increasing use of recycled water. Using reported data from water retailers, which includes service to 8.9 million residents; residential per capita water use throughout the watershed is 114 gallons per day per person (gpd), which is below the baseline of 126 but still above the 2020 goal of 104. However, about 1/3 of the residents of the watershed are still using more water per day than the baseline. To achieve the 2020 goal, the watershed needs to reduce total residential usage by about 9%. To-date, slightly more than half of the water retailers have adopted sustainable water rates.

The watershed is well positioned to withstand a three-year local drought, as was calculated by reviewing the expected demands and supplies during dry conditions. When two three-year local droughts back-to-back were considered, groundwater supplies became strained, and imported water demand climbed. In future assessments, this indicator should consider both droughts and the potential challenge of a multi-year imported water interruption from infrastructure failure.

The indicator of energy use in the water resource sector shows a continued increase of energy use and carbon emissions. The low indicator score reflects the 3.4% increase in 2012 over the five-year average.

The World Resources Institute has identified a multi-metric analysis for judging water availability and stress. As a globally applied indicator, it describes the balance of water use to water availability, and describes water supply reliability and source-water protection. This analysis is being used by Department of Water Resources as component of the Water Plan Update 2013, and was downscaled and included within the technical appendix for reference, but was not associated with the scoring below.

Indicator	Unwanted Condition	Wanted Condition	Calculation	Result
Water Supply Source	All Imported	All local & Recycled	Proportion of total water use to local and recycled use	71
Per Capita Water Use	SB x7-7 2010 Baseline	SB x7-7 Goal	Because reported data puts per capita consumption above the 2010 baseline for the South Coast region, this indicator scores a zero grade. Future assessments will describe the progress towards the 2020 goals.	56
Local Reserves	Deficit of supply during local multi-year drought	Sufficient supply available during local multi-year drought	Ultimate demand during sequential three-year droughts as compared to supplies during multi-year drought	
Sustainable Water Rates	No retailers using sustainable rates	All retailers using sustainable rates	Number of water retailers using sustainable rates compared to all water retailers	52
Carbon footprint of energy in water	Energy use greater than 5% over the five year average	Energy use lower than the five year average	Five year average CO_2 emission divided by 2012 emissions as compared to range of conditions	32

5.2. <u>3.2 Hydrology</u>

Manage at the watershed scale for preservation and enhancement of the natural hydrology to benefit human and natural communities

The most effective tool in sustainable local water management is the existing natural systems of the watershed. Rain and snow that fall in the mountains, the native plants and soils that use or hold that water, and the dynamic systems of water and material flow in the streams are all key players in the health of the watershed. And, each of these components together provides the services that both people and other species need to thrive.

Four indicators were examined for this goal. Two are related to the physical processes, one about management response to changing physical processes, and one related to the extent and health of natural habitats. Critical to natural hydrology is the least impactful conversions of landscape to hardscape. At the watershed scale, it takes only a small area if land converted to effective impervious surfaces before negative impacts to the hydrology are experienced. The streams themselves also must be maintained in a natural condition as much as is feasible and safe. Connected habitat in streams stands here as indicating the extent to which the hydrology of the watershed is natural.

The Santa Ana watershed benefits from a strong majority of streams remaining with natural substrates. The watershed itself has significant areas of impervious landscape, however because no dataset exists to understand effective imperviousness, this indicator was not scored. Future assessments must work to understand not simply the existence of impervious landscape, but rather if that landscape is producing the well-understood negative consequences of additional volumes and rates of runoff during storms, and in dry weather.

Coastal impacts from climate change must be considered within the management of a healthy watershed. The Santa Ana watershed is home to communities, industry and other economic assets that will be impacted by rising sea levels. The indicator measured here includes a metric for mitigation of additional green-house-gas emissions, admitting that the Santa Ana watershed has only a proportionally small role in this global challenge. More importantly though is for the watershed to begin managing the coastline to be more resilient to a rising sea.

Aquatic habitat fragmentation reveals the impacts of in-stream infrastructure as a barrier to animal and insect transit, and to a lesser extent the hydrogeomorphic processes of a natural stream. In this case the Santa Ana watershed has challenges of fragmentation in slightly over half of the subwatersheds.

Indicator	Unwanted Condition	Wanted Condition	Calculation	Result
Natural stream beds	All Artificial Beds	All Natural Beds	Percent of stream miles with natural beds	69
Imperviousness of watershed	Greater than 5% effective impervious land cover in watershed	Less than 5% effective impervious land cover in watershed	Analysis of spatial data reflecting impervious. Because effective impervious data is not available, this indicator was calculated but not scored (see appendix)	Incomp lete
Resiliency to Coastal Impacts of Seal Level Rise	No preparedness	A coastline prepared for variable sea level increases	The indicator is proposed as looking forward, therefore no assessment of existing condition was carried out.	N/A
Connected Aquatic Habitat	100% of HUC 12 watersheds >30% fragmentation or any HUC 12 watershed >50% fragmented	All HUC 12 watersheds 0% fragmented	Of 74 HUC 12 watersheds, percent below 30% fragmentation, zero score if any watershed above 50%	57

5.3. 3.3 Open Spaces

Preserve and enhance the ecosystem services provided by open space and habitat within the watershed

Having open spaces for habitat, recreation, and respite are all goals of the statewide integrated water management efforts. A commitment to these goals has long been a component of the managers within the Santa Ana Watershed.

This goal examined four indicators that help understand the breadth of value that healthy open space can bring. An analysis of open space for recreation revealed that different areas of the watershed have different opportunities and challenges for recreation. Several of the large open space recreational facilities count their users, and understanding better if these facilities are either over- or under-subscribed is an important tool for managers. Open space needs to be protected, and kept healthy through the removal of invasive species that damage their ability to provide value. The last two indicators confirm that invasives are being treated, and that critical open space is being sheltered from over-development.

In the Santa Ana watershed, a strong majority of residents have ½ mile access to recreational open space. Within the watershed, invasive plant management has been undertaken, but data was insufficient to express acres of invasives treated or removed. Within the upper watershed the two National Forests account for a large area of protected land, and outside the forest many of the riparian corridors have some sort of habitat designation that provides protection.

Indicator	Unwanted Condition	Wanted Condition	Calculation	Result
Access to open space per capita	No residents within 1/2 mile	All residents within 1/2 mile	Census block centroids within 1/2 mile of recreational open space	70
Invasive Species Management	Invasives unknown and/or untreated	Invasives assessed and being treated	Extent of invasive species assessment and extent of treatment programs	Incomplete
Protected lands	Remaining Native Habitat unprotected from development	All remaining native habitat protected from development	Proportion of open space that has protected status	69

5.4. 3.4 Beneficial Uses

Protect beneficial uses to ensure high quality water for human and natural communities

The Clean Water Act uses the term "Beneficial Uses" to describe the water quality standards for each water body. Depending on the historical, present or potential use of the water, the standards are set for particular pollutants related to those uses. Water bodies that are impaired from meeting their beneficial uses for one or many pollutants are added to a list, termed the 303(d) list (CWA section), and regulatory agencies begin formulating a Total Maximum Daily Load (TMDL) for the pollutant(s) causing the impairment. In this goal the explicit link to regulatory requirements is made related to water quality.

	Beneficial Uses Designated
Santa Ana Basin Plan	Municipal and Domestic Supply; Agricultural Supply; Industrial Service Supply; Industrial Process Supply; Ground Water Recharge; Navigation; Hydropower Generation; Water Contact Recreation; Non-contact Water Recreation; Commercial and Sport Fishing; Warm Freshwater Habitat; Cold Freshwater Habitat; Preservation of Biological Habitat; Wildlife Habitat, Rare Threatened or Endangered Species; Spawning, Reproduction, and/or Early Development; Marine Habitat; Shellfish Harvesting
From the February 2008 Basin Plan Update, www.waterboards.ca.gov/santaana	

Beneficial uses in the Santa Ana watershed are designated by the Santa Ana Regional Water Quality Control Board in the Santa Ana Regional Water Quality Control Board Basin Plan, and monitoring is undertaken by many agencies through permit or other regulatory requirement. For this goal six indicators were analyzed, each addressing a different beneficial use related to groundwater quality, surface water quality, biological aquatic condition, and measures of salinity in the ground and surface water.

Under a multi-agency task force called the Basin Monitoring Program Task Force, administered by SAWPA, annual water quality reports for the Santa Ana River and its main tributaries are prepared that indicate any exceedances in various water quality constituents compared to the Basin Plan Objectives. These data will be used to track surface water quality for "Watershed wide water quality indicator". .

Groundwater salinity within the groundwater management areas of the watershed is evaluated based on another triennial report prepared by the Basin Monitoring Program Task Force called the Triennial Ambient Water Quality Report for the Santa Ana River Watershed. These reports prepared every three years evaluate assimilative capacity, nitrate as nitrogen and total dissolved solid concentrations in each groundwater management zone. The tracking of the TDS levels and assimilative capacity will serve as indicators of overall watershed groundwater quality. Monitoring of water quality at the outfalls from wastewater treatment plants is a key piece of their National Pollutant Discharge Elimination System permits. There are a number of treatment plants that discharge to the surface waters of the Santa Ana watershed. In Santa Ana watershed these discharges account for a significant proportion of water entering the natural system. In future assessments of the Santa Ana River Watershed it is critical that this indicator be considered.

Water-contact recreation is present in many locations in the watershed, and monitoring that water for the presence of bacteria harmful to human health is conducted along the beaches of the watershed, however a comprehensive effort at inland freshwater swimming sites has not been conducted.

Biological condition in streams is a proxy for the quality of the water, as degraded water conditions will be harmful to plants, animals and insects that live in the streams. Using the California Stream Condition Index, about half of the HUC 12 watersheds were scored. Additional monitoring is called for to expand the understanding of in-stream biological condition in the Santa Ana River watershed.

Indicator	Unwanted Condition	Wanted Condition	Calculation	Result
Watershed-wide water quality	Any reach out of compliance with Basin Plan	All reaches in compliance with Basin Plan	Proportion of three reaches and associated tributaries considered in compliance with Basin Plan	75
Groundwater salinity	All gw management zones basins with exceedences	No gw management zones with exceedences	Proportion of management zones with negative assimilative capacity or deteriorating levels for TDS	46
Discharge water quality	One or more exceedences at all monitored outfalls	No Exceedences at monitored outfalls	Wastewater Treatment Plants monitor outfall water quality. Number of exceedences against total number of sampling	Incomplete
Recreational water quality	More than 10% of samples taken showing exceedences	No samples showing exceedences	Number of samples for bacteria taken from locations with known water contact recreation that showed exceedences	Incomplete
Biological Condition in streams	All streams with California Stream Condition Index scores below 0.72	All streams with CSCI scores between 0.72 & 1.21 (max)	Using existing CSCI station scores, what proportion of graded HUC 12 watersheds have lower than 0.72 CSCI scores (18 of 36)	50

5.5. 3.5 Effective & Efficient Management

Accomplish effective, equitable and collaborative integrated watershed management in a cost-effective manner

This goal is the most forward thinking in this assessment, not because the goal is a new idea, but rather that the OWOW group has decided to specifically measure progress towards this goal. The sustainability and equity of integrated water management is important to the long-term successes desired, and with this goal the Santa Ana watershed is asking an important question.

Despite the laudable intent of this goal, the challenge of indicating the effectiveness, equitability, and thoroughness of the collaborative process are extremely challenging. Researchers engaged with colleagues in many related efforts in the state and elsewhere, and found that many are struggling to engage meaningful indicators of effective collaboration.

Below are two tables, one reflecting the draft indicators considered by the Pillars and SAWPA which were not scored, and a table reflecting the concepts about effective management that are being incorporated into the

DWR Water Plan Update 2013. As further data is collected on IRWM processes, these indicators may be refined as possible future indicators for the watershed.

Indicator	Unwanted Condition	Wanted Condition	Calculation	Result
OWOW Participation Statistics	Lack of representation from area, sector, or community	All sectors, areas, and communities represented	Insufficient data	Incomplete
Performance of OWOW 1.0 Projects	No OWOW 1.0 selected projects meeting stated goals	All OWOW 1.0 selected projects meeting stated goals	Insufficient Data	Incomplete
Cost-effectiveness of management	An indicator of the cost-effectiveness of management was discussed at length. The scope and a sufficient dataset could not be identified. Future work should consider further how to express this, as it critical to the selected goal.			

DWR Water Plan Update 2013 concepts for effective management tracking
The ease or barriers to flow of the process from data need, collection, analysis, decision-making, implementation, and results
Local jurisdictions and geographies sufficiency of data for decision-making
Public reporting system for data and results of analysis as well as methods used
Standardized methods for data collection and reporting and minimize collection biases
Data sharing and distribution
Communication of uncertainty in assessments and decision-making
Collaboration between scientists and policy makers to understand data and communication needs
Supports adaptation and resilience to climate change

6. 4.0 Summary

This chapter has described the goals for the Santa Ana River Watershed as highlighted by the OWOW Pillars and SAWPA. For each goal, a series of indicators help describe the movement towards those goals. As is customary in California coastal watersheds, there are signs of challenges and progress within each goal. Conditions are in-general degraded from a natural system, however, management efforts to restore and enhance are found throughout the process.

Among the findings there is a call for future work to gather new or more robust datasets related to watershed management. Most significantly, additional effort is needed to better resolve the performance metrics of the management system itself. The goal of inclusive, equitable, and collaborative management is an important part of OWOW, and resolving how to measure the effort towards that goal is a critical next step.

This assessment can be repeated in a time-interval to include a set of metrics that express trends. This assessment here is a snapshot of the current day in the Santa Ana watershed, and many of the goals are specifically designed to encourage progress. In five years, perhaps sooner, this assessment can be repeated to uncover laudable progress, and spots where efforts should be redoubled.