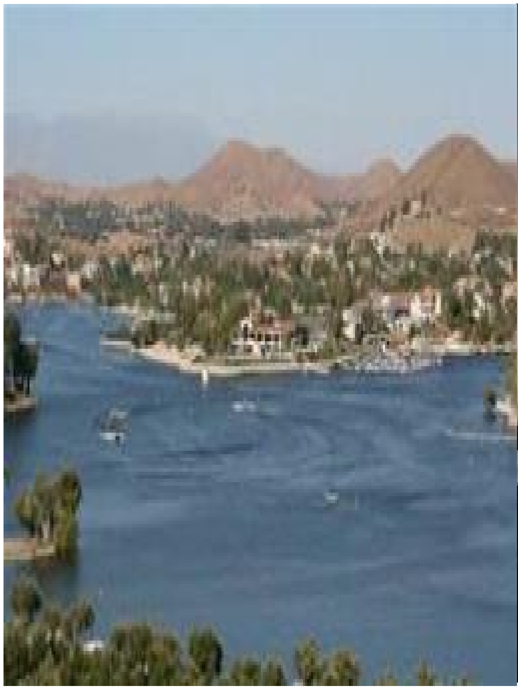
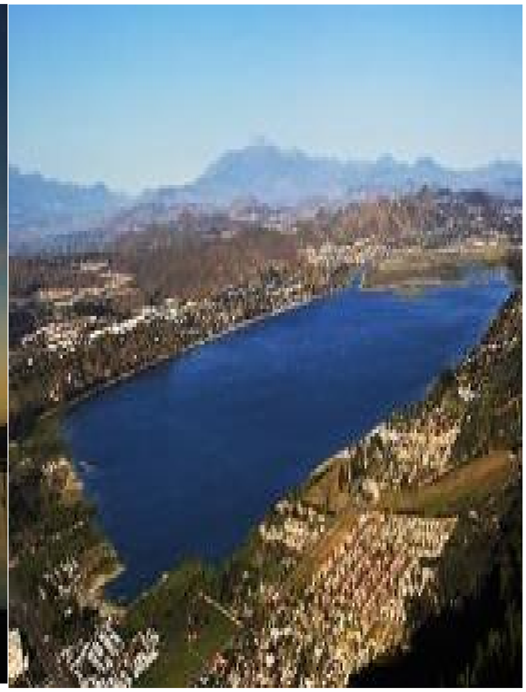
Lake Elsinore & Canyon Lake Nutrient Total Maximum Daily Loads (TMDLs) Comprehensive Monitoring Work Plan

FINAL



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July 27, 2016

Lake Elsinore & San Jacinto Watersheds Authority

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1. BACKGROUND AND INTRODUCTION

The following document presents the Comprehensive Monitoring Plan for compliance with the Lake Elsinore & Canyon Lake Nutrient Total Maximum Daily Loads (TMDLs) and demonstrates progress toward attaining compliance with respective waste load allocations (WLAs) and/or TMDL response targets. This document is intended to describe the overall approach for compliance monitoring in the near term (2014 through 2019). Details regarding sample collection, handling, and analysis protocols are discussed in the Quality Assurance Project Plan for this monitoring program.

Lake Elsinore is a natural freshwater lake in Southern California that provides a variety of natural habitats for terrestrial and aquatic species. The beneficial uses of the lake include water contact recreation (REC1), non-water contact recreation (REC2), warm freshwater habitat (WARM), and wildlife habitat (WILD). Canyon Lake was constructed in 1928 as the Railroad Canyon Reservoir. It is located about 2 miles upstream of Lake Elsinore and water spilled from Canyon Lake is a main source of water for Lake Elsinore. The beneficial uses of Canyon Lake include municipal and domestic water supply (MUN), agricultural supply (AGR), groundwater recharge (GWR), body contact recreation (REC1), non-body contact recreation (REC2), warm freshwater aquatic habitat (WARM), and wildlife habitat (WILD).

Local stakeholders and the Santa Ana Regional Water Quality Control Board (SARWQCB) have been working together since 2000 to identify the sources of nutrients impairing each lake and evaluate the impacts to water quality and beneficial uses incurred from nutrient sources. Stakeholders have participated in watershed-wide annual stormwater quality and flow monitoring along the San Jacinto River and Salt Creek and monitor Lake Elsinore and Canyon Lake water quality with the support of the Elsinore Valley Municipal Water District (EVMWD) and the San Jacinto River Watershed Council. Available grant funding helped stakeholders to develop models of the lakes to better understand their characteristics and a San Jacinto River Watershed model to simulate wash off and nutrient transport to the lakes. The Lake Elsinore & San Jacinto Watersheds Authority (LESJWA) also performed numerous studies of each lake and started to implement projects expected to improve in-lake water quality.

In December 2004, the RWQCB adopted amendments to the Water Quality Control Plan for the Santa Ana River Basin (Basin Plan) to incorporate TMDLs for nutrients in Canyon Lake and Lake Elsinore. The Basin Plan Amendment specifies, among other things, monitoring recommendations to track compliance with TMDLs and associated WLAs and measuring compliance to in-lake numeric water quality targets. Numeric targets have been established and incorporated in the TMDLs for nutrients (total nitrogen, phosphorous, and ammonia), pH, dissolved oxygen, chlorophyll a, and total dissolved solids (TDS); however the ultimate compliance goal for beneficial uses in both lakes is to reduce enhanced eutrophication, which can negatively affect biological communities, result in fish kills, and impact recreational use. The recommendations outlined in SARWQCB Resolution No. R8-2004-0037 (SARWQCB, 2004) required stakeholders to develop management plans and conduct long-term monitoring and implementation programs aimed at reducing nutrient discharges to Lake Elsinore and Canyon Lake.

Beginning in December 2004, the Lake Elsinore and Canyon Lake TMDL Task Force (Task Force) was convened to provide a forum for stakeholder interaction related to the TMDL process. The Task Force consists of representatives from local cities, Riverside County, agriculture and dairy, environmental groups, and the regulatory community. At the request of the RWQCB, The Santa Ana Watershed Project

Authority serves as a neutral facilitator for the TMDL development process for Lake Elsinore and Canyon Lake.

Throughout this time, the Task Force stakeholders were able to develop a priority schedule for addressing data gaps. This enabled them to focus on the most prominent data gaps and limitations to the nutrient TMDL calculation, while performing an agreed upon level of monitoring to remain consistent with the Basin Plan requirements to track compliance with TMDLs and associated WLAs. The Lake Elsinore and Canyon Lake Nutrient TMDL Monitoring Plan was approved by the RWQCB in March 2006 and subsequently implemented by the Task Force in April 2006 through June 2012. This monitoring approach included an intensive study of in-lake processes, an intensive watershed study, and compliance monitoring. The in-lake monitoring efforts were subsequently discontinued temporarily in agreement with the RWQCB to redirect funding towards nutrient reduction actions including lake stabilization efforts, fish management strategies to reduce resuspension of sediments from carp and zooplankton grazing by shad, and adding alum to bind nutrients in Canyon Lake. As stipulated in the agreement with the RWQCB, the Task Force drafted this Compliance Monitoring Work Plan to reassess current conditions and establish a monitoring framework to assess trends towards meeting TMDL targets.

2. OBJECTIVES OF THE NUTRIENT TMDL COMPLIANCE MONITORING WORK PLAN

The following objectives (in order from highest to lowest priority) are being considered in developing the Nutrient TMDL Compliance Monitoring Work Plan:

1. Evaluate the status and trends toward achieving response targets in both lakes;
2. Determine how to quantify the amount of influence natural background has on the status and trend; and
3. Distinguish and quantify the external pollutant loading originating in the upstream watershed above the lakes.

Additional objectives of the monitoring are to support the stormwater compliance activities underway by other entities in the watershed, including the reissuance of the Riverside County Municipal Stormwater National Pollutant Discharge Elimination Systems Permit [Order R8-2010-0033; Municipal Separate Storm Sewer System (MS4) Permit], and land use monitoring requirements related to the Conditional Waiver for Agricultural Discharges.

3. WATERSHED-WIDE MONITORING

The study design for the watershed-wide monitoring is to continue to determine nutrient loading into Canyon Lake and Lake Elsinore from upstream watershed sources and to add to the historical monitoring data set for identifying long-term trends.

3.1 SAMPLING PERIOD

Stormwater runoff will continue to be sampled during three storm events per year during the wet season at all stations when flow is present. Samples will not be collected during dry weather. However, total annual flows measured at the collocated US Geological Survey (USGS) stream gauges will be used to calculate total watershed loading (based on the average event mean concentrations measured during the storm events).

3.2 SAMPLING LOCATIONS FOR WATERSHED-WIDE MONITORING

There are four historical sampling stations located throughout the San Jacinto River watershed, Lake Elsinore, and Canyon Lake area (Table I and Figure 1). The sampling locations were carefully selected to reflect various types of land use and have been monitored since 2006. Three of the four sites were selected because they are indicative of inputs to Canyon Lake originating from the main stem of the San Jacinto River, Salt Creek, and the watershed above Mystic Lake. The fourth site, located below the Canyon Lake Dam, is indicative of loads entering Lake Elsinore from Canyon Lake and the upstream watershed (when the dam is spilling). Many of the sampling stations are located in close proximity to stream gauge stations installed by the USGS or the Riverside County Flood Control & Water Conservation District. The stream gauges provide a general estimate of the total flow in the channel at a location close to each autosampler.

Table I. Watershed-Wide Monitoring Stations

Location Number and Description	Historical Database Station Number
Salt Creek at Murrieta Rd	745
San Jacinto River at Goetz Rd	759
San Jacinto River at Ramona Expressway	741
Canyon Lake Spillway	841

The sampling location along the San Jacinto River at Ramona Expressway is located downgradient of Mystic Lake, an area of land subsidence. Flow has not been observed at this location since a strong El Nino event in the mid-1990s. Because of the active subsidence, this monitoring station is not expected to flow except under extremely high rainfall conditions.

In addition to the historical stations, sampling may be conducted at one additional site that may rotate from year to year as needed to collect data from a new area or to help answer a technical question. Some examples of sites that may be sampled could include a background station, or sites downstream from areas of interest (e.g., downstream of Ortega or Hemet Channel, Salt Creek at State Street, or Kitching Street Channel at Iris Avenue).

3.3 SAMPLING APPROACH

The following sample collection protocols are intended to collect flow-weighted composite samples at the monitoring sites listed in Table I. Samples may be collected either manually by compositing discrete grab samples, or automatically using automatic sampling equipment (e.g., ISCO autosamplers equipped with flow meters). Samples will be collected on both the rising limb (increasing flow) and the falling limb (decreasing flow) of the hydrograph. Eight to twelve discrete samples will be collected for compositing if collected manually (consistent with previous direction from the RWQCB). More detail regarding the sampling approach (e.g., compositing, sample naming conventions) are described in the Quality Assurance Project Plan (QAPP) for this monitoring program. Flow will be estimated based on data from USGS stream gauges collocated on the same streams near the sampling stations.

3.4 FIELD SAMPLING AND MEASUREMENTS

Field measurements (pH, temperature, and turbidity) will be conducted using a portable meter. Analytes and their associated laboratory methods are summarized in Table II.

3.5 SAMPLE BOTTLES AND LABELS

The analytical laboratory will supply bottles to the sampling team prior to the anticipated storm event. The field staff will complete the sample labels and affix them to the sample bottles. Once the samples are collected, the following information will be identified on each sample label prior to delivery to the analytical laboratory:

- Analyses to be performed on the samples;
- Date and time sample collected;
- Sample number identifying the sample location, date, and aliquot type; and
- Initials of the individual who collected the sample.

3.6 FIELD DATA SHEETS

Field data sheets (Appendix A) will be completed in the field and submitted to LESJWA on behalf of the Task Force and placed in the TMDL file.

3.7 CHAIN OF CUSTODY FORMS

The analytical laboratory will supply the chain of custody forms; a sample chain of custody form is included in Appendix A. The field sampling team will complete these forms with the following information:

- Contact person and telephone numbers;
- Name of study;
- Analyses to be performed on the samples;

- Type of sample collected; and
- Number of bottles per sample and preservatives used.

Each sampling team will complete the following information on their chain of custody form:

- Sample number;
- Date and time sample collected; and
- Name of sampling staff and signature.

3.8 ANALYTICAL CONSTITUENTS

Stormwater samples will be analyzed for the same constituents historically monitored for in the watershed-wide monitoring and as noted in Table II below.

Table II. Analytical Constituents and Methods

Parameter	Analysis	Typical Sample Volume	Recommended Containers	Initial Field Preservation	Maximum Holding Time
Turbidity	Field	N/A	N/A, Measure on site	Unpreserved	N/A
Water Temperature	Field	N/A	N/A, Measure on site	Unpreserved	N/A
pH	Field	N/A	N/A, Measure on site	Unpreserved	N/A
Total Organic Nitrogen (Org-N)	CALC	N/A	N/A	N/A	N/A
Nitrite Nitrogen (NO2-N)	SM4500-NO2 B	150 m/L	Poly	Unpreserved	48 hours
Nitrate Nitrogen (NO3-N)	EPA 300.0	300 m/L	Poly	Unpreserved	48 hours
Ammonia Nitrogen (NH4-N)	SM4500-NH3 H	500 m/L	Poly	H2SO4	28 days
Total Kjeldahl Nitrogen (TKN)	EPA 351.3	600 m/L	Poly	H2SO4	28 days
Total Phosphorus (TP)	SM4500-P E	300 m/L	Poly	H2SO4	28 days
Soluble Reactive Phosphorus (SRP / ortho-P)	SM4500-P E	1 L	Poly	Unpreserved	48 hours
Total Suspended Solids (TSS)	SM2540C	1 L	Poly	Unpreserved	7 days

Parameter	Analysis	Typical Sample Volume	Recommended Containers	Initial Field Preservation	Maximum Holding Time
Chemical Oxygen Demand (COD)*	SM5220D	1 L	Poly	H2SO4	28 days
Biochemical Oxygen Demand (BOD)*	SM5210B	4 L	Poly	Unpreserved	48 hours
Total Dissolved Solids (TDS)	EPA 160.1	1 L	Poly	Unpreserved	7 days
Total Hardness	SM 2340C	300 m/L	Poly	HNO2	6 months

* Analyses to be performed on the first discrete sample only.

3.9 SAMPLE TRANSPORTATION

Samples will be transported to the analytical laboratory within holding times for the intended analyses.

4. IN-LAKE MONITORING

4.1 BACKGROUND

Routine in-lake monitoring was initiated in 2006 by local stakeholders in cooperation with the RWQCB at three open water locations in Lake Elsinore and four locations in Canyon Lake. Monitoring was conducted monthly between October and May and twice per month between June and September, with grab samples collected at the surface, within the water column, and/or as depth-integrated samples (depending on the lake and the analyte). In 2011-2012, sampling locations in Lake Elsinore and Canyon Lake were reduced to one and three stations, respectively, following a review of available data that indicated consistent similar nutrient concentrations and physical water quality parameters among the three sampling sites in Lake Elsinore and two sites in east Canyon Lake. This saving also shifted resources towards a number of implementation strategies aimed at reducing nutrient impacts in both lakes as described in RWQCB Resolution No. R8-2011-0023. In-lake monitoring was then suspended temporarily in 2012-2013 to further redirect additional resources toward implementing in-lake best management practices. However, ongoing in-lake sampling will be required to estimate progress toward attaining nutrient TMDL targets and calculating annual and 10-year running averages.

4.2 MANAGEMENT QUESTIONS

Specific questions to be addressed through the Compliance Monitoring Work Plan proposed herein:

1. What is the status and trend of each lake towards achieving TMDL response targets seasonally and over time?
2. How do single point in time in-situ water quality profiles of dissolved oxygen (DO), pH, conductivity, and temperature in Lake Elsinore compare to data derived from real time data sondes currently installed and managed by the EVMWD for TMDL compliance purposes?
3. How do estimated chlorophyll-a concentrations from satellite imagery compare to individual grab samples in each lake? Can the satellite imagery provide a more accurate cost effective means of assessing chlorophyll-a concentrations for compliance purposes?

4.3 LAKE ELSINORE MONITORING

In order to maintain consistency and facilitate the assessment of trends toward meeting compliance goals, the in-lake monitoring design halted in 2012 (LESJWA, 2012) will be resumed using the three former stations outlined in the approved Lake Elsinore and Canyon Lake Nutrient TMDL Monitoring Plan (LESJWA, 2006; Figure 2). One station (Site 2 on Figure 2) will have analytical samples collected and in-situ water quality readings, while the remaining two stations will only have in-situ water quality readings performed. Monitoring in the central portion of the lake at Site 2 will consist of collecting surface-to-bottom depth integrated samples for nitrate, nitrite, ammonia, TKN, total phosphorous, soluble reactive phosphorus (SRP/Ortho-P), and TDS monthly during the summer period (June through September) and every-other month (bi-monthly) during the remainder of the annual cycle (October through May). The enhanced monitoring during the summer months in Lake Elsinore is justified given the current TMDL criteria for chlorophyll-a, which is based on a summer average for this water body as opposed to an annual average for other constituents. This sampling regime will continue to help assess seasonal changes and statistical trends over time using an annual average calculation with each date treated as a replicate data point. This sampling will be coordinated to occur on the same day as satellite imagery discussed in Section 4.5. Depth-integrated samples will be prepared by either combining discreet grab samples collected using a Van Dorn bottle at each 1-meter (m) depth interval throughout the water column, including the surface, or using a peristaltic pump and lowering/raising the inlet tube through the water column at a uniform speed. Two discrete samples will also be collected and analyzed at Site 2 for chlorophyll-a: 1) a surface-to-bottom depth integrated sample; and 2) a 0-2-m depth integrated surface sample. Both chlorophyll-a sample types will be collected in the same manner as analytical chemistry samples. Note that while no WLAs for total ammonia are currently in place for Lake Elsinore, ammonia can be an important driver of toxicity, potentially causing fish kills and decreasing zooplankton survival/reproduction, particularly given the historically high ambient pH values observed in the lake that enhance the more toxic un-ionized fraction of ammonia.

In-situ monitoring using pre-calibrated hand-held YSI field meters or equivalent will also be performed during each sampling event at all three stations (Sites 1, 2, and 3) for pH, DO, temperature, and conductivity field measurements. A complete depth profile at each station will be recorded for each parameter at 1-m intervals. These data will be used to assess spatial variability and compared to data obtained from the currently installed data sondes operated by EVMWD near the center of the lake. Water clarity will also be assessed at all three stations using a Secchi disk. An attempt will be made for a better comparison to existing data by collecting all water samples and field measurements prior to noon during each sampling event to avoid collecting suspended sediments potentially stirred up from the bottom of the lake by frequent afternoon winds. End-of-the-day field measurements (i.e. after ~2:30pm) will also be recorded for pH, DO, temperature, and conductivity at all three stations to assess any potential temporal variability in these parameters throughout the day.

A summary of collection activities for Lake Elsinore and Canyon Lake is outlined in Table III. A summary of analytical parameters and methodologies for routine TMDL compliance monitoring is provided in Table IV.

Data collected by the two currently installed in-situ data sondes used for monitoring the water pump/aeration system in Lake Elsinore will be analyzed to look at daily cycles and trends across each two-month monitoring period. These data could be compared to any other concurrent measurements that might have been performed during their use, as well as historic water quality records in relation to TMDL targets. Such an evaluation could provide valuable insight into: 1) whether the data sondes may provide a more cost effective solution to monitor water quality in the lake; and 2) whether the pump/aeration system is able to provide substantial measurable benefit related to the TMDL targets.

4.4 CANYON LAKE MONITORING

Similar to Lake Elsinore, monitoring efforts and locations in Canyon Lake were selected based on the monitoring conducted between 2006 and 2012 to provide consistency in assessing trends toward meeting compliance goals. The in-lake monitoring design halted in 2012 will therefore be resumed using four stations outlined in the approved Lake Elsinore and Canyon Lake Nutrient TMDL Monitoring Plan (LESJWA, 2006; Figure 3). These include two in the main body of the lake (CL07 near the dam and CL08 in the northern arm) and two in the East Bay (CL09 and CL10). This sampling will be conducted every-other month (bi-monthly) and coordinated to occur on the same day as satellite imagery as described in Section 4.5. Consistent with Lake Elsinore monitoring, surface-to-bottom depth integrated samples will be collected for nitrate, nitrite, ammonia, TKN, total phosphorous, soluble reactive phosphorus (SRP / Ortho-P), and TDS. These analytical samples will be collected at only three of the four monitoring locations (CL07, CL08, and CL10). Station CL10 was selected as the primary monitoring location in the east arm of Canyon Lake for TMDL compliance monitoring in 2011-2012 following the approved reduction from four to three locations as described in Section 4.1. This site is more centrally located within the east arm and past results indicated similar water quality between the two east bay sites overall. The width of the lake at Station CL10 is narrower than that at Station CL09, potentially resulting in an edge interference at this location for the satellite imagery used to quantify chlorophyll-a over a larger area. As a result, a surface water sample will also be collected from this location for chlorophyll-a analysis only to enable a more direct comparison to satellite imagery at Station CL09.

Depth integrated samples at sites CL07, CL08, and CL10 will be prepared by either combining discreet grab samples collected using a Van Dorn bottle at each 1-m depth interval throughout the water column, including the surface, or using a peristaltic pump and lowering/raising the inlet tube through the water column at a uniform speed. Two discrete samples will be collected and analyzed for chlorophyll-a at Stations CL07, CL08, and CL10: 1) a surface-to-bottom depth integrated sample; and 2) a 0-2-m depth integrated surface sample. Both chlorophyll-a sample types will be collected in the same manner as analytical chemistry samples. One 0-2-m depth integrated surface sample will be collected for chlorophyll-a at Station CL09.

In-situ monitoring using pre-calibrated hand-held YSI meters or equivalent will also be performed during each sampling event at all four stations (Sites CL07, CL08, CL09, and CL10) for pH, DO, temperature, and conductivity field measurements. A complete depth profile at each station will be collected for each of these parameters at 1-m intervals. Water clarity will also be assessed at each sampling location using a Secchi disk. An attempt will be made for a better comparison to existing data by collecting all water samples and field measurements prior to noon during each sampling event to avoid collecting suspended sediments potentially stirred up from the bottom of the lake by frequent afternoon winds. End-of-the-day field measurements (i.e., after ~2:30pm) will also be recorded for pH, DO, temperature, and conductivity at all four stations to assess any potential temporal variability in these parameters throughout the day.

Table III. Summary of In-Lake Collection Activities

Lake	Frequency	Location	Analytical Samples Collected (Y/N)[a]	Chlorophyll-a[b]	Field Water Quality Measurements (Y/N)[d]
Lake Elsinore	Monthly & Bi-monthly	Station 1	N	N	Y
		Station 2	Y	Y	Y
		Station 3	N	N	Y
	Continuous	EVMWD Sites (Buoys 1 and 2)	N	N	Y[e]
Canyon Lake	Bi-monthly	Station 7	Y	Y	Y
		Station 8	Y	Y	Y
		Station 9	N	Y[c]	Y
		Station 10	Y	Y	Y

Note: Bi-monthly is sampling every other month (i.e. six times per year). Monthly sampling to occur over summer months only (June-September). Bi-monthly sampling to occur on Lake Elsinore outside of summer period.

[a] Includes depth integrated samples for nitrate, nitrite, ammonia, TKN, total phosphorous, soluble reactive phosphorus (SRP / Ortho-P), and TDS.

[b] Chlorophyll-a: Two samples: 1) a surface-to-bottom depth integrated sample; and 2) a 0-2-m depth integrated surface sample.

[c] A 0-2-m depth integrated surface sample only will be collected for chlorophyll-a at Site CL09 for direct comparison to satellite imagery results at this location.

[d] Includes depth profile field measurements for pH, DO, temperature, and conductivity. Water clarity will be measured using a Secchi disk.

[e] Two stations located near the center of Lake Elsinore are monitored by EVMWD for DO, conductivity, pH, and temperature using permanently installed in-situ YSI data sondes. The primary purpose of these sondes is to monitor vertical DO profiles daily to efficiently determine when aeration pumps should be operated to minimize DO stratification in the lake.

Table IV. In-lake Analytical Constituents and Methods

Parameter	Analysis SOP #	Sampling Method[a,b]	Typical Sample Volume	Recommended Containers	Initial Field Preservation	Maximum Holding Time
Water Clarity	In-situ Field	Secchi disk	N/A	N/A, Measure on site	N/A, Measure on site	N/A
Water Temperature	In-situ Field	Field Meter	N/A	N/A, Measure on site	N/A, Measure on site	N/A
pH	In-situ Field	Field Meter	N/A	N/A, Measure on site	N/A, Measure on site	N/A
Dissolved Oxygen	In-situ Field	Field Meter	N/A	N/A, Measure on site	N/A, Measure on site	N/A
Nitrite Nitrogen (NO_2-N)	SM4500-NO2 B	Depth Integrated	150 mL	Poly	<4°C, H_2SO_4	48 hours
Nitrate Nitrogen (NO_3-N)	EPA 300.0	Depth Integrated	300 mL	Poly	<4°C, H_2SO_4	48 hours
Total Kjeldahl Nitrogen (TKN)	EPA 351.3	Depth Integrated	600 mL	Poly	<4°C, H_2SO_4	28 days
Ammonia Nitrogen (NH4-N)	SM4500-NH_3 H	Depth Integrated	500 mL	Poly	<4°C, H_2SO_4	28 days
Total Phosphorus (TP)	SM4500-P E	Depth Integrated	300 mL	Amber Poly	<4°C, H_2SO_4	28 days
Soluble Reactive Phosphorus (SRP / Ortho-P)	SM4500-P E	Depth Integrated	1 L	Amber Poly	<4°C	48 hours
Chlorophyll-a	SM 10200H	Surface & Depth Integrated	1000 mL	Amber Poly	<4°C	48 hours
Total Dissolved Solids (TDS)	SM 2540 C	Depth Integrated	1000 mL	Poly	<4°C	7 Days

[a] Depth integrated samples of the entire water column as described in Sections 4.3 and 4.4.

[b] Two samples collected for chlorophyll-a: 1) a surface to bottom depth integrated sample; and 2) a 0-2m depth integrated surface sample.

mL – milliliter

L - liter

4.5 SATELLITE IMAGERY

In Fiscal Year 2015-2016, the Task Force contracted with EOMap Americas to conduct remote sensing using Landsat satellite imagery (Figure 4) to estimate chlorophyll-a concentrations in Lake Elsinore and Canyon Lake. Using a resolution of 5 pixels per acre, this effort produced maps of the lake showing graphical, color-coded images of chlorophyll-a and turbidity concentrations at up to approximately 1000 unique data points across Canyon Lake and approximately 11,000 unique data points across Lake Elsinore. This tool provides snapshots of conditions throughout the entire lake at a given point in time, as opposed to the single data points provided at water quality collection locations; however, the satellite imagery only represents approximately the upper 4 feet of the water column and therefore cannot completely replace manual sampling.

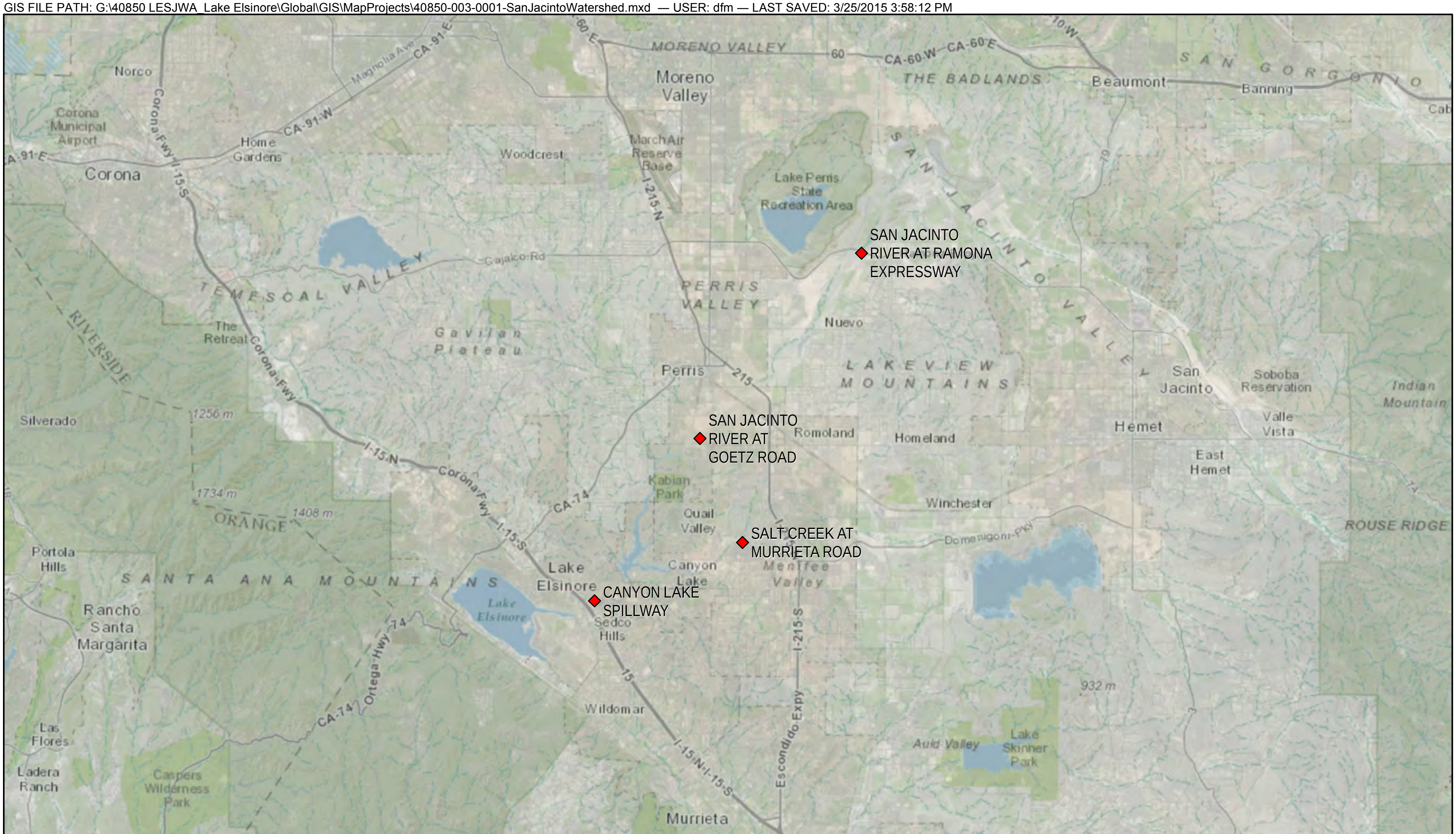
As part of the compliance monitoring, satellite imagery depicting lake-wide chlorophyll-a concentrations in Lake Elsinore and Canyon Lake will be generated for each in-lake monitoring event. In addition to examining lake-wide chlorophyll concentrations, these data can be used to measure chlorophyll-a as a means of collecting data for calculating the annual average concentration and conducting trends analysis. In the future, satellite imagery mapping could also be conducted prior to and following in-lake treatments (such as alum applications) to gauge effectiveness on a lake-wide scale.

5. REPORTING

Assessing current conditions and an integrative analysis of temporal and spatial trends in water quality related to TMDL targets are important components of the overall nutrient TMDL compliance program. All data collected will be summarized in tables and displayed graphically using methods similar to that provided in prior the Annual TMDL Water Quality Reports to evaluate trends in water quality among both watershed monitoring locations and within Lake Elsinore and Canyon Lake. This will become increasingly important as various watershed and in-lake best management practices are implemented to evaluate their effectiveness at achieving TMDL goals. Tables will provide numerical comparisons relative to Basin Plan Objectives and TMDL targets for in-lake monitoring. Supporting in-lake monitoring information will include vertical profile plots with in-situ measurements of pH, DO, conductivity, temperature, and turbidity and a summary of any field observations of note during sampling efforts. Vertical profile plots of DO will also be compared to the continuous in-situ measurements from the existing data sondes in Lake Elsinore to assess their comparability and applicability to support TMDL compliance. Supporting data from the watershed monitoring will include stream hydrographs, rainfall plots, a summary of analytical results, and an estimate of both dry and wet weather loading of nutrients and total suspended solids to Lake Elsinore and Canyon Lake.

6. REFERENCES

1. Santa Ana Regional Water Quality Control Board (2004), Resolution R8-2004-0037. Resolution Amending the Water Quality Control Plan for the Santa Ana River Basin to Incorporate Nutrient Total Maximum Daily Loads (TMDLs) for Lake Elsinore and Canyon Lake.



LEGEND

◆ SAN JACINTO WATERSHED-WIDE MONITORING LOCATION

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE
2. SOURCE: LAKE ELSINORE AND CANYON LAKE NUTRIENT TMDL ANNUAL WATER QUALITY REPORT; LAKE ELSINORE AND SAN JACINTO WATERSHEDS AUTHORITY; AUGUST 2014

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LAKE ELSINORE AND SAN JACINTO WATERSHEDS AUTHORITY
COUNTY OF RIVERSIDE, CALIFORNIA

SAN JACINTO WATERSHED-WIDE MONITORING STATIONS

APRIL 2015

FIGURE 1

GIS FILE PATH: G:\40850 LESJWA_Lake Elsinore\Global\GIS\MapProjects\40850-003-0002-LakeElsinorSamples.mxd — USER: dfm — LAST SAVED: 3/25/2015 2:26:11 PM

LEGEND

◆ LAKE ELSINORE SAMPLING LOCATION

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE
2. SOURCE: APRIL 2007 - MARCH 2008 LAKE ELSINORE WATER QUALITY MONITORING PLAN; MWH ; APRIL 2007; FIGURE 1

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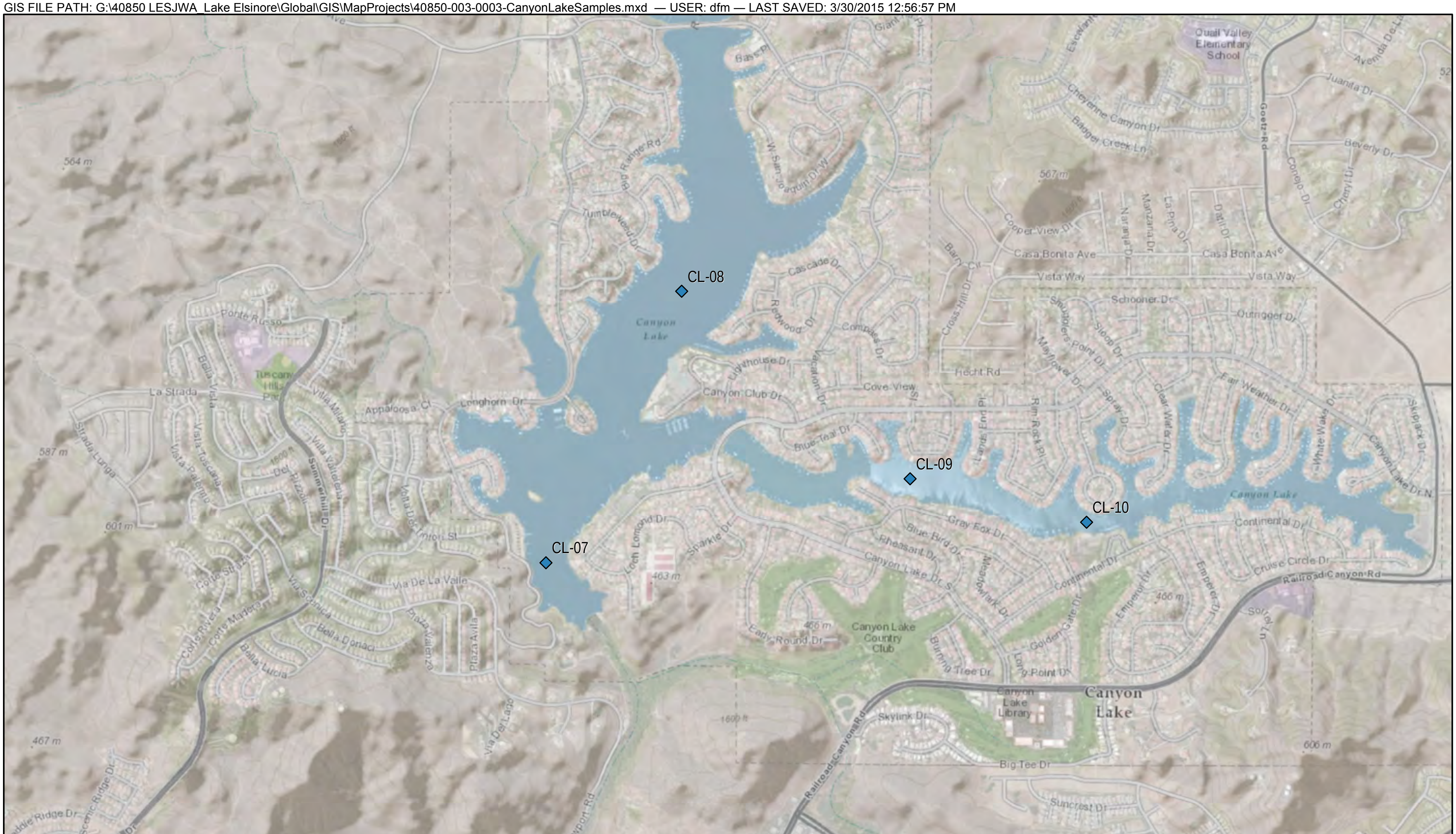
LAKE ELSINORE AND SAN JACINTO WATERSHEDS AUTHORITY
COUNTY OF RIVERSIDE, CALIFORNIA

LAKE ELSINORE IN-LAKE SAMPLING LOCATIONS

APRIL 2015

FIGURE 2



LEGEND

◆ CANYON LAKE SAMPLING LOCATION

NOTES

1. ALL LOCATIONS AND DIMENSIONS ARE APPROXIMATE
2. SOURCE:WATER QUALITY MONITORING PLAN FOR THE CANYON LAKE ALUM APPLICATION PROGRAM; MWH ; AUGUST 2013

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LAKE ELSINORE AND SAN JACINTO WATERSHEDS AUTHORITY
COUNTY OF RIVERSIDE, CALIFORNIA

CANYON LAKE SAMPLING LOCATIONS

APRIL 2015

FIGURE 3

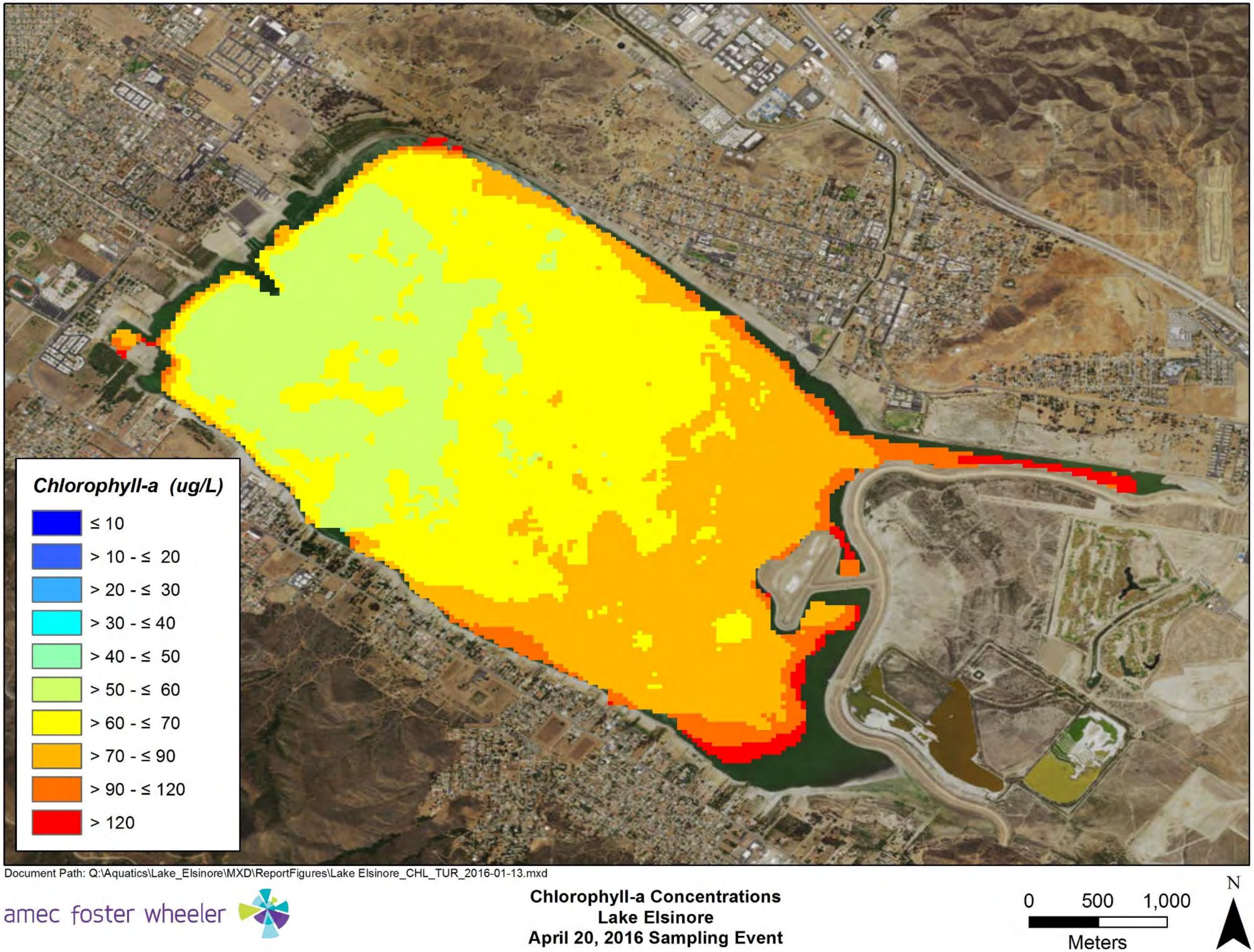

Figure 4. Example Satellite Imagery depicting Chlorophyll-a Concentrations

APPENDIX A

Sampling Forms and Example Chain of Custody

FIELD SAMPLING CHECKLIST

Date:

Lake Elsinore

LE1

- ☐ Morning: In-situ water quality (pH, DO, Temperature, Conductivity)
- ☐ End of Day (after 2 pm): In-situ water quality (pH, DO, Temperature, Conductivity)

LE2

- ☐ Morning: In-situ water quality (pH, DO, Temperature, Conductivity)
- ☐ Depth integrated sample for chemistry
    - Quart Bottle Unpreserved (Nitrite/Nitrate, TDS)
    - Pint Bottle Preserved with H_2SO_4 (TKN, Ammonia, Total Phosphorus)
    - Pint Bottle Preserved with Zinc Acetate & NaOH (Total Sulfide)
    - Half Pint Bottle Unpreserved (Soluble Reactive Phosphorus [Ortho-P])
        - Filtered in field using 1.2 µm and 0.45 µm filters prior to filling bottle
- ☐ Depth integrated samples for Chlorophyll-a
    - Surface-to-Bottom
    - 0-2 m
- ☐ Plankton Sample (Surface-to-Bottom)
- ☐ End of Day (after 2 pm): In-situ water quality (pH, DO, Temperature, Conductivity)

LE3

- ☐ Morning: In-situ water quality (pH, DO, Temperature, Conductivity)
- ☐ End of Day (after 2 pm): In-situ water quality (pH, DO, Temperature, Conductivity)

Lakeshore Sonde

- ☐ Morning: In-situ water quality (pH, DO, Temperature, Conductivity)
- ☐ End of Day (after 2 pm): In-situ water quality (pH, DO, Temperature, Conductivity)

Grand Avenue Sonde

- ☐ Morning: In-situ water quality (pH, DO, Temperature, Conductivity)
- ☐ End of Day (after 2 pm): In-situ water quality (pH, DO, Temperature, Conductivity)

Canyon Lake

CL07

- ☐ Morning: In-situ water quality (pH, DO, Temperature, Conductivity)
- ☐ Depth integrated sample for chemistry
    - Quart Bottle Unpreserved (Nitrite/Nitrate, TDS)
    - Pint Bottle Preserved with H_2SO_4 (TKN, Ammonia, Total Phosphorus)
    - Pint Bottle Preserved with Zinc Acetate & NaOH (Total Sulfide)
    - Half Pint Bottle Unpreserved (Soluble Reactive Phosphorus [Ortho-P])
        - Filtered in field using 1.2 µm and 0.45 µm filters prior to filling bottle

FIELD SAMPLING CHECKLIST

- ☐ Depth integrated samples for Chlorophyll-a
  - Surface-to-Bottom
  - 0-2 m
- ☐ Plankton Sample (Surface-to-Bottom)
- ☐ End of Day (after 2 pm): In-situ water quality (pH, DO, Temperature, Conductivity)

<u>CL08</u>

- ☐ Morning: In-situ water quality (pH, DO, Temperature, Conductivity)
- ☐ Depth integrated sample for chemistry
  - Quart Bottle Unpreserved (Nitrite/Nitrate, TDS)
  - Pint Bottle Preserved with H_2SO_4 (TKN, Ammonia, Total Phosphorus)
  - Pint Bottle Preserved with Zinc Acetate & NaOH (Total Sulfide)
  - Half Pint Bottle Unpreserved (Soluble Reactive Phosphorus [Ortho-P])
    - Filtered in field using 1.2 µm and 0.45 µm filters prior to filling bottle
- ☐ Depth integrated samples for Chlorophyll-a
  - Surface-to-Bottom
  - 0-2 m
- ☐ Plankton Sample (Surface-to-Bottom)
- ☐ End of Day (after 2 pm): In-situ water quality (pH, DO, Temperature, Conductivity)

<u>CL09</u>

- ☐ Morning: In-situ water quality (pH, DO, Temperature, Conductivity)
- ☐ Surface (0-2m) sample for Chlorophyll-a Plankton Sample (Surface-to-Bottom)
- ☐ Plankton Sample (Surface-to-Bottom)
- ☐ End of Day (after 2 pm): In-situ water quality (pH, DO, Temperature, Conductivity)

<u>CL10</u>

- ☐ Morning: In-situ water quality (pH, DO, Temperature, Conductivity)
- ☐ Depth integrated sample for chemistry
  - Quart Bottle Unpreserved (Nitrite/Nitrate, TDS)
  - Pint Bottle Preserved with H_2SO_4 (TKN, Ammonia, Total Phosphorus)
  - Pint Bottle Preserved with Zinc Acetate & NaOH (Total Sulfide)
  - Half Pint Bottle Unpreserved (Soluble Reactive Phosphorus [Ortho-P])
    - Filtered in field using 1.2 µm and 0.45 µm filters prior to filling bottle
- ☐ Depth integrated samples for Chlorophyll-a
  - Surface-to-Bottom
  - 0-2 m
- ☐ Plankton Sample (Surface-to-Bottom)
- ☐ End of Day (after 2 pm): In-situ water quality (pH, DO, Temperature, Conductivity)

FIELD DATASHEET

Date:______________ Location (Circle): Lake Elsinore/Canyon Lake Station:____________

Time on Station:_______________ Time off Station:_______________

Weather Conditions:_________________________ Wind (mph & direction):__________________

Lat:____________________________________ Long:___________________________________

Water Depth (m):_____________ Secchi Depth (m):______________________

Water Chemistry Sample?: Y / N Chl-a Sample?: Y / N Plankton Sample?: Y / N

Surface volume filtered (ml):___________

Depth-Integrated volume filtered (ml):___________

Comments:

Depth (m)	Temp (°C)	Cond (mS/cm)	pH	DO (mg/L)	Depth (m)	Temp (°C)	Cond (mS/cm)	pH	DO (mg/L)
0					**15**				
1					**16**				
2					**17**				
3					**18**				
4					**19**				
5					**20**				
6					**21**				
7					**22**				
8					**23**				
9					**24**				
10					**25**				
11					**26**				
12					**27**				
13					**28**				
14					**29**				

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Chain of Custody & Sample Information Record

Client: Amec Foster Wheeler **Contact:** **Phone No.**

FAX No. **Email:**

Additional Reporting Requests
Include QC Data Package: ☐ Yes ☐ No
FAX Results: ☐ Yes ☐ No
Email Results: ☐ Yes ☐ No
State EDT: ☐ Yes ☐ No
(Include Source Number in Notes)

Project Name: ____________________

Project Location:

Turn Around Time: Routine *3-5 Day Rush *48 Hour Rush *24 Hour Rush

***Lab TAT Approval:** By: *Additional Charges May Apply

Sampler Information

Name: ____________________

Employer: Amec Foster Wheeler

Signature: ____________________

Matrix
DW = Drinking Water
WW = Wastewater
GW = Groundwater
S = Soil
SG = Sludge
L = Liquid
M = Miscellaneous

Sample ID	Date	Time	# of Containers & Preservatives: Unpreserved	H2SO4	HCl	HNO3	Na2S2O3	NaOH	NaOH/ZnAcetate	NH4Cl	MCAA	Frozen		Total # of Containers	Sample Type: *Routine*	*Resample*	*Special*	Analysis Requested: Total Sulfide	Nitrate - Nitrite	TDS	TKN	Ammonia	Total Phosphorus	SRP/Ortho-P	Chlorophyll-a		Matrix	Notes

Relinquished By (sign)	Print Name / Company	Date / Time	Received By (Sign)	Print Name / Company

(For Lab Use Only) Sample Integrity Upon Receipt					Lab Notes
Sample(s) Submitted on Ice?	Yes	No		Temperature	
Custody Seal(s) Intact?	Yes	No	N/A	°C	
Sample(s) Intact?	Yes	No		☐ Cooler Blank	

Lab No. ____________________

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