Edwards Aquifer Habitat Conservation Plan

Expanded Water Quality Monitoring Report

January 2019

(Revised February 27, 2019)

EXECUTIVE SUMMARY

The Edwards Aquifer Habitat Conservation Plan (EAHCP) Expanded Water Quality Monitoring Program was developed in accordance with the directives of the EAHCP to identify and assess potential impairments to water quality within the Comal River and headwaters of the San Marcos River systems. The expanded EAHCP sampling requirements are described in the *Report of the 2016 Expanded Water Quality Monitoring Program Work Group and Report of the 2016 Biological Monitoring Program Work Group* (EAHCP 2016). In years 2013 through 2016, the program included surface water (base flow) sampling, sediment sampling, real-time instrument (RTI) water quality monitoring, stormwater sampling. Passive diffusion sampling was not conducted in 2013 but has been conducted in subsequent years. A groundwater sampling element was also included in the sampling program, which was to be conducted during periods of extremely low spring flow from Comal and San Marcos Springs. Spring flow rates remained above minimum flow rates of 30 cubic feet per second (cfs) at Comal Springs and above 50 cfs at San Marcos Springs from 2013 to 2016; therefore, the groundwater sampling element was not conducted.

In 2016, the EAHCP assembled an Expanded Water Quality Monitoring Program Work Group (Work Group) composed of representatives from throughout the Edwards Aquifer Region. The charge of the Work Group was to carry out a holistic review of the existing program and to evaluate possible changes based on the recommendations of National Academy of Sciences (NAS), the NAS Work Group, the input of the Science Committee, the permittees, and subject matter experts. The Work Group prepared a final report that included the following changes to the program:

- Removing surface water (base flow) monitoring
- Reducing sediment monitoring to once every other year, to be conducted in even years
- Adding one real-time monitoring station per spring system
- Reducing stormwater monitoring to one sampling event per year, with Integrated Pest Management Plan chemicals plus atrazine in odd years, and the full suite of chemicals in even years
- Continuing passive diffusion sampler (PDS) sampling but adding a pharmaceutical and personal care product (PPCP) membrane to the farthest downstream PDS site in each system
- Removing groundwater monitoring
- Adding biotic tissue (e.g., fish tissue) sampling in odd-numbered years

The Edwards Aquifer Authority contracted with SWCA Environmental Consultants (SWCA) to execute the expanded sampling program in 2014, 2015, 2016, 2017, and 2018, with the exception of RTI water quality monitoring and biotic tissue sampling.

The Comal Springs complex has five sample locations along the Comal Springs complex, from the upstream end of Landa Lake (where Blieders Creek empties into the headwaters of Landa Lake) to the south end of the Comal River, upstream of the confluence with the Guadalupe River. The San Marcos Springs complex has seven sample locations, beginning at Sink Creek upstream of the headwaters of Spring Lake on the north end of the system and ending downstream of Capes Dam on the south end of the system.

SWCA collected sediment samples in June 2018 from both the Comal and San Marcos spring systems. No analytes exceeded Probable Effect of Concentration to Benthic Organisms (PEC) values for volatile organic compounds (VOCs), pesticides, herbicides, polychlorinated biphenyls (PCBs), or metals. One sediment sample from the San Marcos spring system had concentrations of five semi-VOC (SVOC) constituents above PEC values.

SWCA conducted two stormwater sampling events. A stormwater event in the Comal Springs complex was sampled on March 28, 2018. SWCA collected samples at five locations: HCS210, HCS240, HCS250, HCS260, and HCS270. The second stormwater event was sampled on May 4, 2018, in the San Marcos Springs complex. SWCA collected samples at seven locations along the San Marcos River: HSM210, HSM230, HSM231, HSM240, HSM250, HSM260, and HSM270.

In stormwater samples, no analytes exceeded the Texas Commission on Environmental Quality (TCEQ) surface water standards for contact recreation and ecological health for VOCs, SVOCs, pesticides, herbicides, or PCBs (2018). Aluminum was detected in three samples at concentrations above the TCEQ acute ecological health freshwater benchmark. Aluminum concentrations exceeded chronic ecological health benchmarks in eight samples. Copper was detected in one sample at a concentration above the TCEQ chronic ecological health benchmark. Lead concentrations exceeded chronic ecological health benchmarks in eight samples. Iron concentrations exceeded chronic ecological health benchmarks in five samples. Metals are naturally occurring in soil, sediment, groundwater, and surface water. The water samples for metals analyses were filtered to reduce the potential for sediment impacting the laboratory results; however, the turbidity of the stormwater samples may have contributed to the concentrations of metals detected.

PDSs were deployed in each spring complex for two-week periods, six times every other month during the year. Polar organic chemical integrative samplers, which are PDSs used for PPCP testing, were deployed at the most downstream sample sites (HCS460 and HSM470) in each spring complex for one-month periods, six times during the year. PDS samples commonly detected two analytes, total petroleum hydrocarbons and tetrachloroethene, in various locations throughout the Comal and San Marcos Springs complexes. The concentrations of these analytes and other less-frequently detected analytes do not exceed the TCEQ surface water standards for contact recreation and ecological health.

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1.0 INTRODUCTION

The Edwards Aquifer Authority (EAA) and its predecessor agency, the Edwards Underground Water District (EUWD), in cooperation with the U.S. Geological Survey (USGS) and the Texas Water Development Board (TWDB) have maintained a water quality sampling program since 1968. The EAA has used the analyses of these data to assess aquifer water quality. This routine or historical sampling program involves the analyses of a broad spectrum of parameters in wells, springs, and streams across the region. The EAA's existing sampling program was expanded with the adoption of the Edwards Aquifer Habitat Conservation Plan (EAHCP) to include collecting additional samples and sample types in the immediate vicinity of Comal and San Marcos Springs. The expanded water quality sampling program was developed in accordance with the directives of the EAHCP to identify and assess potential impairments to water quality within the Comal River and headwaters of the San Marcos River systems. The expanded EAHCP sampling requirements are described in the *Report of the 2016 Expanded Water Quality Monitoring Program Work Group and Report of the 2016 Biological Monitoring Program Work Group* (EAHCP 2016)*,* which herein is referred to as the Work Group Report and is included in Appendix A of this report.

In years 2013 through 2016 the program included surface water (base flow) sampling, sediment sampling, real-time instrument (RTI) water quality monitoring, stormwater sampling. Passive diffusion sampling was not conducted in 2013 but has been conducted in subsequent years. A groundwater sampling element was also included in the sampling program, which was to be conducted during periods of extremely low spring flow from Comal and San Marcos Springs. Spring flow rates remained above minimum flow rates of 30 cubic feet per second (cfs) at Comal Springs and above 50 cfs at San Marcos Springs from 2013 to 2016; therefore, the groundwater sampling element was not conducted.

In 2016, the EAHCP assembled an Expanded Water Quality Monitoring Program Work Group (Work Group) composed of representatives from throughout the Edwards Aquifer Region. The charge of the Work Group was to carry out a holistic review of the existing program and to evaluate possible changes based on the recommendations of National Academy of Sciences (NAS), the NAS Work Group, the input of the Science Committee, the permittees, and subject matter experts. The Work Group prepared a final report that included the following changes to the program:

- Removing surface water (base flow) monitoring
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- Removing groundwater monitoring
- Adding biotic tissue (e.g., fish tissue) sampling in odd-numbered years

The EAA contracted with SWCA Environmental Consultants (SWCA) to execute the expanded sampling program in 2014, 2015, 2016, 2017, and 2018, with the exception of RTI water quality monitoring and biotic tissue sampling.

Prior to the implementation of the EAHCP, the historical sampling program had not specifically addressed surface water quality, sediment quality, real-time changes for basic water quality parameters, or stormwater impacts along the Comal River or headwaters of the San Marcos River. Therefore, this expanded sampling program was designed to gather data specific to all new parameters. This report presents the stormwater, sediment, passive diffusion sampling, and polar organic chemical integrative sampler (POCIS) data collected by SWCA in 2018. The data set represents the seventh year of the program. Table 1 summarizes the analytical parameters by sample type.

For this report, the Comal River may also be referred to as Comal Springs or Comal Springs complex, and the San Marcos River headwaters may also be referred to as San Marcos Springs or San Marcos Springs complex. An overview of surface water and stormwater sample locations for Comal and San Marcos Springs is shown in Figures 1 and 2.

Table 1. Listing of Analytical Parameters by Sample Type

Analytical Parameter	Stormwater Samples	Sediment Samples	PDS	POCIS‡
Volatile Organic Compounds (VOCs)	Yes	Yes	Yes†	No
Semi-volatile Organic Compounds (SVOCs)	Yes	Yes	Yes†	No
Organochlorine Pesticides	Yes	Yes	Yes†	No
Polychlorinated Biphenyls (PCBs)	Yes	Yes	No	No
Organophosphorous Pesticides	Yes	Yes	No	No
Herbicides	Yes	Yes	No	No
Pharmaceuticals and Personal Care Products	No	No	No	Yes
Metals (Al, Sb, As, Ba, Be, Cd, Cr [total], Cu, Fe, Pb, Mn, Hg, Ni, Se, Ag, Tl, and Zn)	Yes	Yes	No	No
General water quality parameters (GWQP), total alkalinity (as CaCO3), bicarbonate alkalinity (as CaCO3), carbonate alkalinity (as CaCO3); Cl, Br, NO3, SO4, Fl, pH, total dissolved solids (TDS), total suspended solids (TSS), Ca, Mg, Na, K, Si, Sr, CO3,	Yes	No TDS or TSS	No	No
Phosphorus (total)	Yes	Yes	No	No
Total Organic Carbon (TOC),	Yes	Yes	No	No
Dissolved Organic Carbon (DOC)	Yes	No	No	No
Total Kjeldahl Nitrogen (TKN)	Yes	No	No	No
Bacteria (*E. coli*)	Yes	No	No	No
Field Parameters (DO, pH, Conductivity, Turbidity, Temperature)	Yes	No	No	No
Caffeine	Yes	No	No	Yes

† Passive diffusion samplers (PDSs) samples are analyzed for a modified set of VOCs, SVOCs, and organochlorine pesticides.

‡ Polar organic chemical integrative samplers (POCIS) samples are analyzed for pharmaceuticals and personal care products.

Figure 1. EAHCP Expanded Water Quality Monitoring Program, Comal Springs and River

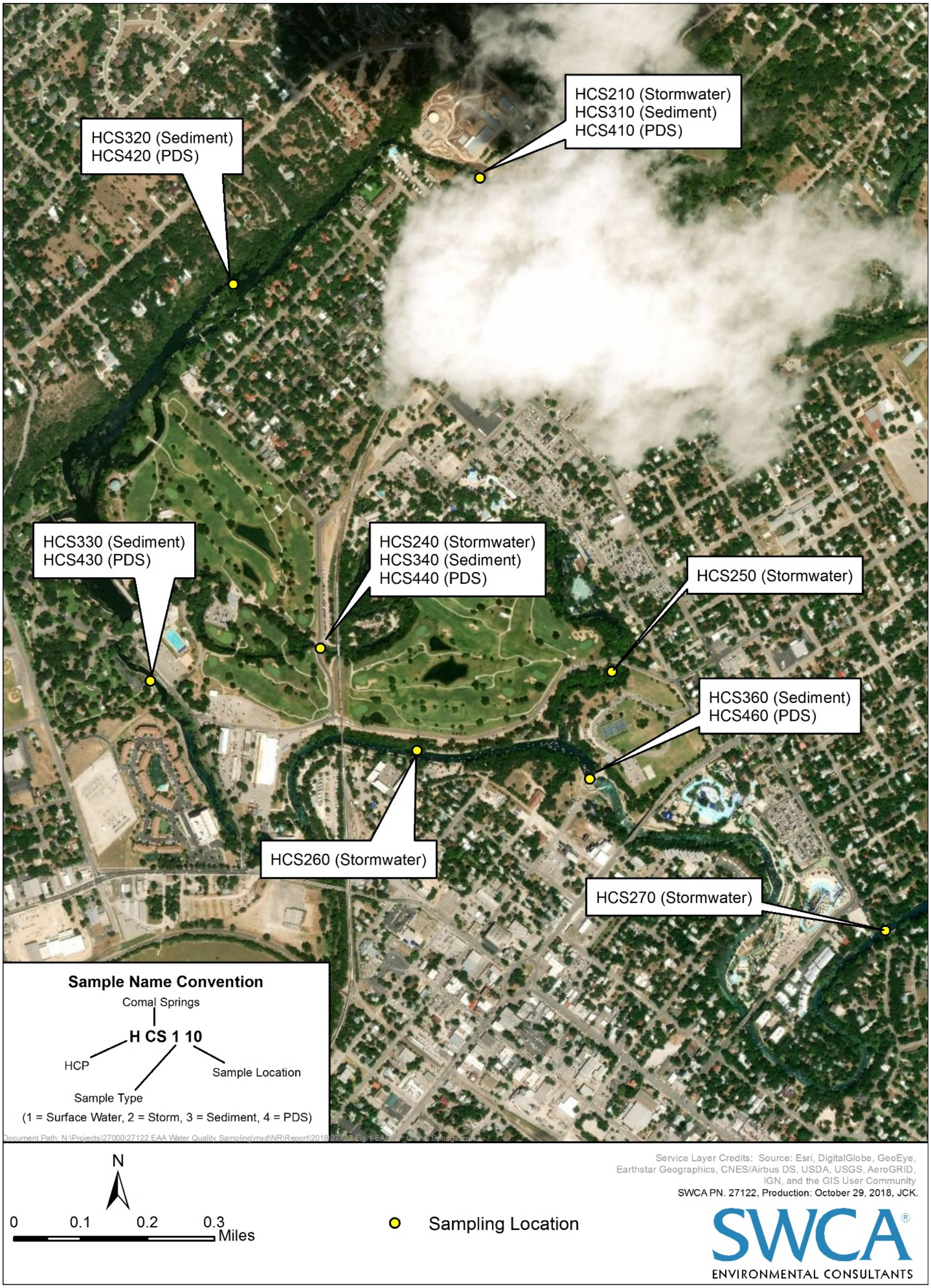

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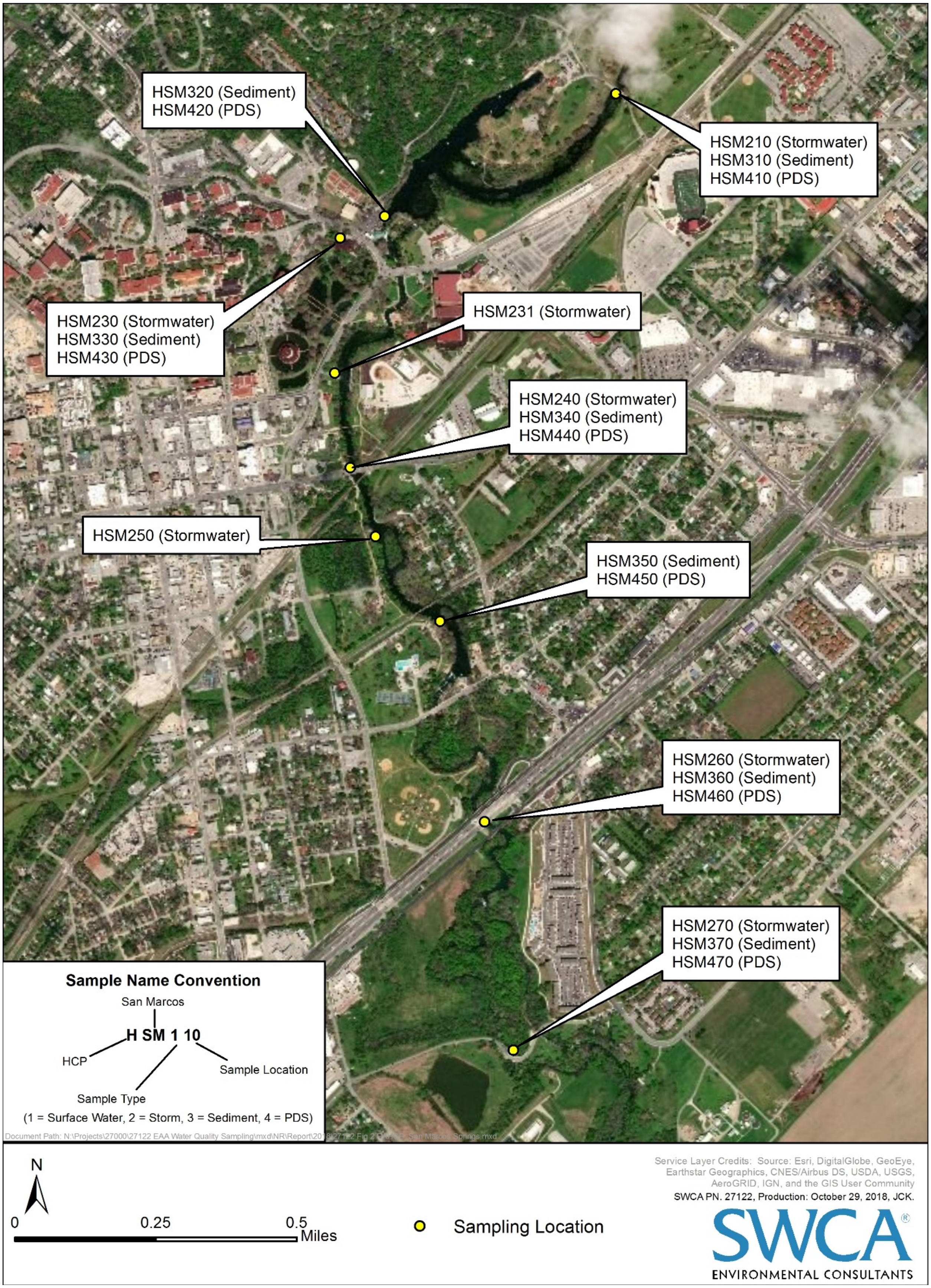
Figure 2. EAHCP Expanded Water Quality Monitoring Program, San Marcos Springs and River



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1.1 Sediment Samples

Collection of sediment samples within each spring system was included in the program to help ascertain potential effects on listed species via direct or indirect exposure to sediments. Specifically, five sediment samples were collected from the Comal Springs area and seven locations were sampled within the San Marcos area. In the first two years of the program, sediment samples were collected from the sediment surface to approximately 18 inches below the surface. The EAHCP Work Plan reduced the sampling depth to three inches below the surface beginning in 2015. Samples were analyzed for the parameters listed in Table 1.

SWCA collected sediment samples as close to each associated surface water sample location as possible. However, for some of the samples, collection points were moved slightly to find adequate sediment or to avoid rocky substrates that prevented collection of adequate sample volume. Appendix C of this report discusses sample locations where any significant deviations from this approach occurred.

Analytical results for sediment samples are compared to the sediment quality guidelines published in *Development and Evaluation of Consensus-Based Sediment Quality Guidelines for Freshwater Ecosystems* (MacDonald et al. 2000). These guidelines are based on determination of probable sediment toxicity in freshwater ecosystems and provide a numerical sediment quality guideline for 28 chemicals of concern. The guidance provides two basic standards for comparison: 1) threshold effect concentration (TEC), and 2) probable effect concentration (PEC). Analytical results with a concentration below the TEC are predicted to be nontoxic (on sediment-dwelling organisms), whereas results with a concentration above the PEC are indicated as having a probable toxic effect on sediment-dwelling organisms. Detected compounds with concentrations between the TEC and PEC are considered equally likely to be toxic or nontoxic. Additional guidelines for chemicals of concern that were not included in MacDonald et al. (2000) were taken from *Conducting Ecological Risk Assessments at Remediation Sites in Texas* developed by the Texas Commission on Environmental Quality ([TCEQ] 2014a) and *Guidance for Assessing and Reporting Surface Water Quality in Texas* (TCEQ 2012). While numerous other guidelines for sediment quality exist, these guidelines provide a good reference for the scope of the current investigation. Future researchers may find other guidelines more specific to particular concerns or interests.

1.2 Stormwater Samples

SWCA collected stormwater samples at five Comal Springs locations and at seven San Marcos Springs locations. The EAA adopted stormwater sample collection as part of the expanded water quality monitoring effort to assess potential contaminants that may be present in surface water runoff generated by storm events. The stormwater sampling effort was designed to assess what changes in water quality occur within each surface water system during a storm event. SWCA collected stormwater samples in association with various surface water inputs along each spring complex within the study area. Appendix C of this report discusses details of each stormwater sample location and any deviations from the EAHCP Work Plan. Stormwater samples were analyzed for the same parameters as surface water (base flow) samples, as outlined in Table 1.

SWCA collected stormwater samples at three points across the storm hydrograph for each stormwater sampling site. Sample collection was targeted for the rising limb, peak, and receding limb of the storm hydrograph. Timing for sample collection was generally determined using the RTI system's conductivity and turbidity parameters rather than the flow measurements from the USGS streamflow gauges. The USGS gauges are only updated on an hourly basis, whereas data from the RTIs was available on 15-minute intervals and provided more timely information. Automated sample collection equipment was not utilized for stormwater sample collection due to sample volume, preservation, and analysis limitations. Therefore, sampling was conducted manually. Each spring group was sampled once for stormwater events during calendar year 2018, in accordance with the EAHCP Work Plan.

Standards for surface water quality vary depending on type of use. For this report, stormwater results are compared with Contact Recreation Water Protective Concentration Levels (PCLs) developed by TCEQ in 2006 and with Surface Water Benchmarks for freshwater organisms established by TCEQ in 2018. The Surface Water Benchmarks were developed for acute and chronic exposures. Other guidelines may be more useful or appropriate for particular research; however, for the scope of this report these standards provide an appropriate and applicable guideline with regard to water quality.

1.3 Surface Water Passive Diffusion Samples

SWCA deployed Amplified Geochemical Imaging (AGI) PDSs in both spring complexes to measure trace organic constituents. Samplers consisted of a sorbent solid phase material that concentrates compounds from the environment. Following collection, the analytes of interest were eluted and analyzed by gas chromatography coupled with a mass spectrometry detector (GC-MS). The increased contact time associated with long-term deployment of the collection material allowed the analytes to be greatly concentrated beyond what is typically found in water samples. Therefore, the PDS provides greater sensitivity to trace level constituents. Analyzed parameters can be found in Table 1.

SWCA deployed PDSs to each of the 12 sample sites for two-week periods in February, April, June, August, October, and December 2018. Sample points coincided with surface water collection points unless prevented by field conditions, and any alterations are discussed in Appendix C.

For this report, PDS results are compared with Contact Recreation Water PCLs developed by TCEQ in 2006 and with Surface Water Benchmarks for freshwater organisms established by TCEQ in 2018. The Surface Water Benchmarks were developed for acute and chronic exposures.

1.4 Polar Organic Chemical Integrative Samples

SWCA deployed Environmental Sampling Technologies (EST) POCISs at HCS460 and HSM470 to evaluate PPCP constituents. POCIS are composed of two sheets of microporous (0.1-micrometer [µm] pore size) polyethersulfone membranes encasing a solid phase sorbent (Oasis Hydrophilic-Lipophilic Balance [HLB]), which retains sampled chemicals. The Oasis HLB is a universal solid-phase extraction sorbent widely used for sampling a large range of hydrophilic to lipophilic organic chemicals from water. The high water solubility of polar organic chemicals makes their extraction and detection difficult using standard sampling and analytical techniques. POCIS provide reproducible methods for the concentration of polar organic chemicals in the parts-per-trillion to parts-per-quadrillion range. The POCIS enables estimation of the aqueous exposure of aquatic organism to dissolved polar organic chemicals and permits determination of their time-weighted average concentration in water over extended periods.

SWCA installed three POCIS inside stainless-steel carriers at each sample location. The POCIS were prepared and provided by EST. Following collection, SWCA returned the POCIS samplers to EST for elution. EST then shipped the eluted samples to Weck Laboratories, Inc., for PPCP analyses.

Due to human tampering of deployment devices, SWCA began using two colanders to serve as an encasement to hold the POCIS sampler. The colander encasement was locked onto the cable above the tube chute at sample location HCS460. In the San Marcos Springs complex, the colander encasement was locked onto the PDS deployment device.

SWCA deployed POCIS at HCS460 and HSM470 for 30-day periods in February, April, June, August, October, and December 2018.

2.0 SAMPLE LOCATION DETAIL

Details of individual sample locations are provided in the following figures. Figures 3–6 show sample location details for the Comal Springs area. Figures 7–10 provide sample location details for the San Marcos Springs area.

Figure 3. EAHCP Comal Springs Detailed Map Indicating Sample Locations 210, 310, 410, 320, and 420

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Figure 4. EAHCP Comal Springs Detailed Map Indicating Sample Locations 330 and 430

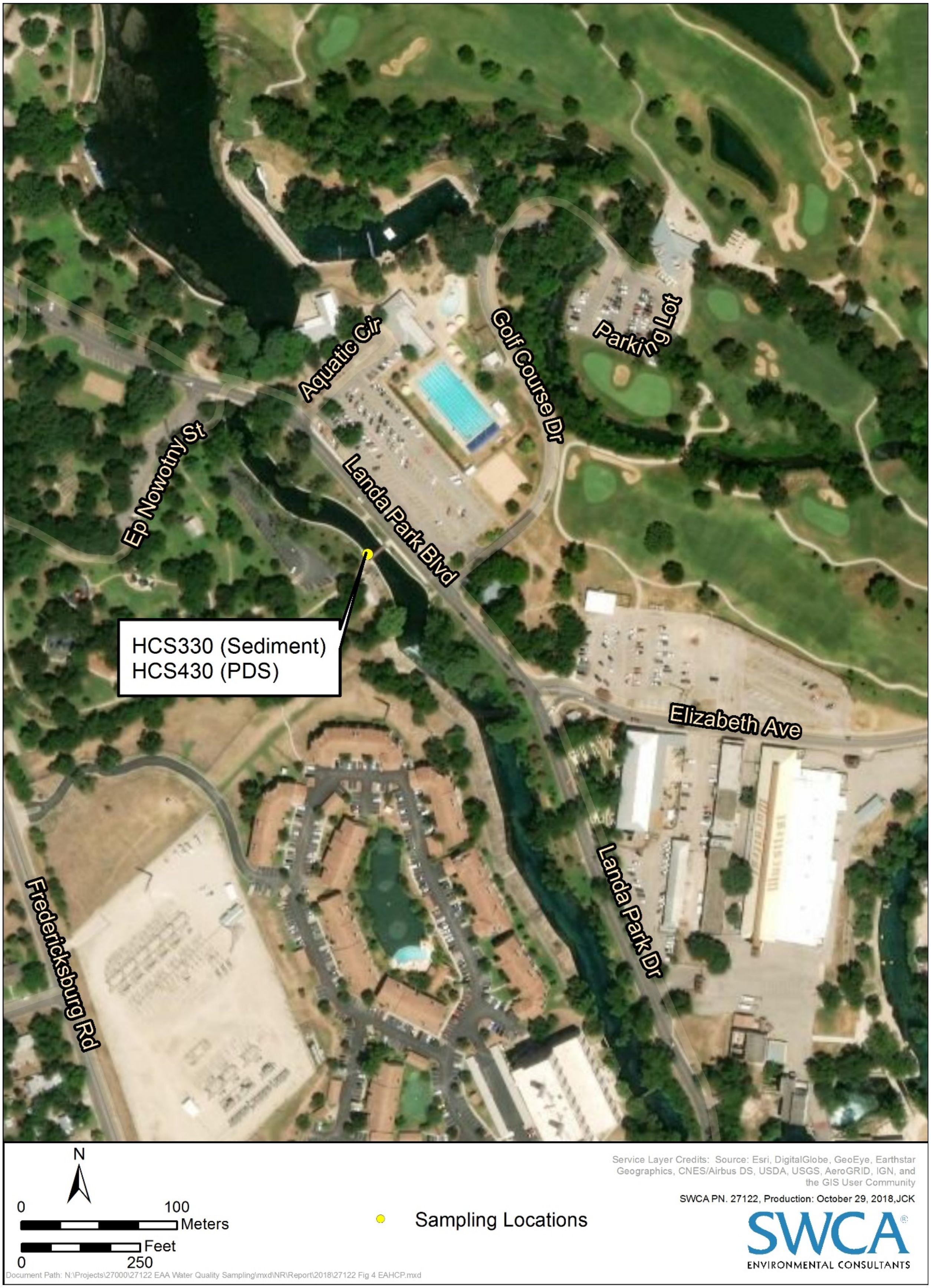

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Figure 5. EAHCP Comal Springs Detailed Map Indicating Sample Locations 240, 340, 440, 250, 260, 360, and 460

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Figure 6. EAHCP Comal Springs Detailed Map Indicating Sample Location 270

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Figure 7. EAHCP San Marcos Springs Detailed Map Indicating Sample Locations 210, 310, 410, 20, and 420

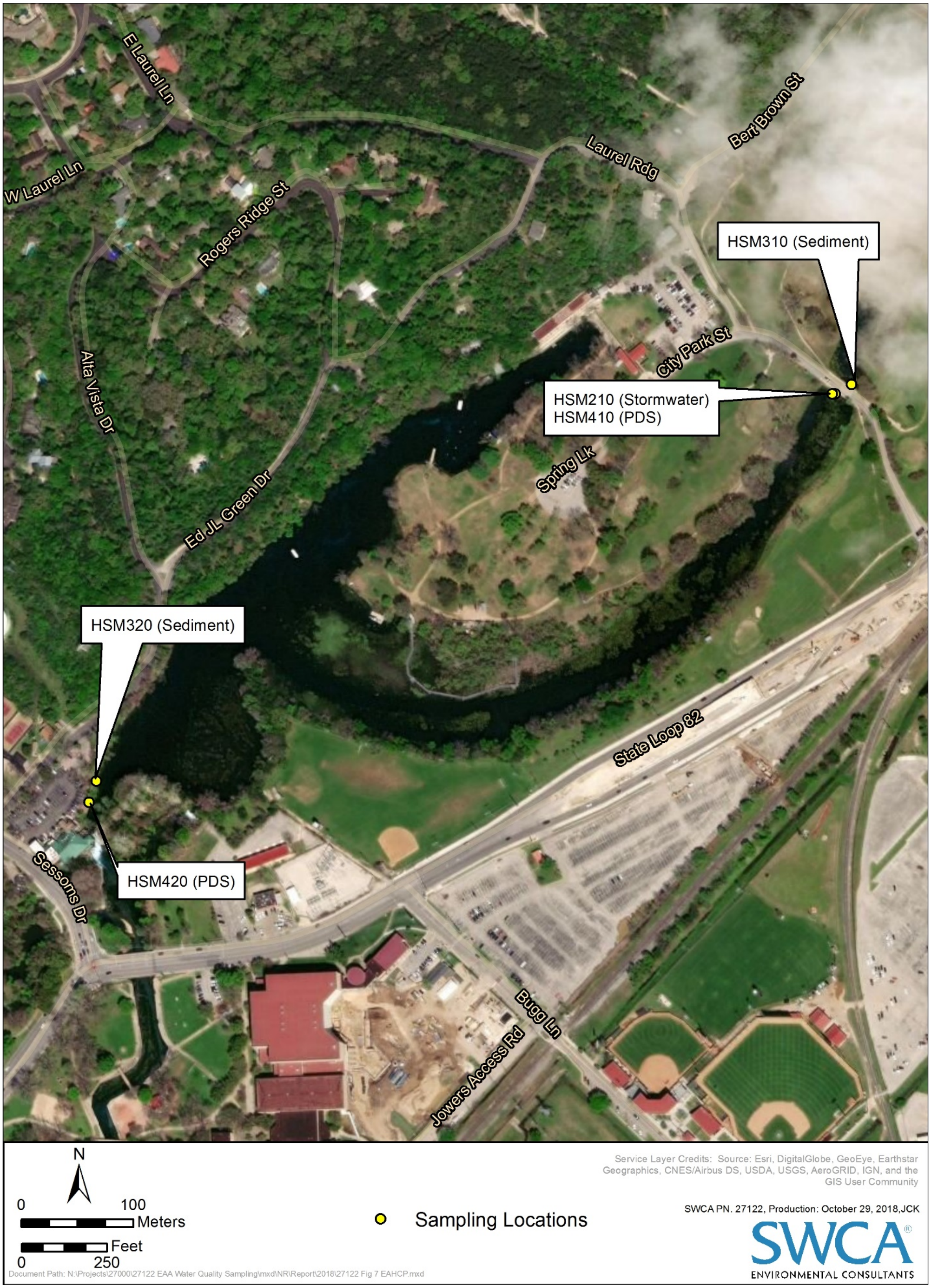

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Figure 8. EAHCP San Marcos Springs Detailed Map Indicating Sample Locations 230, 330, 430, 231, 240, 340, and 440

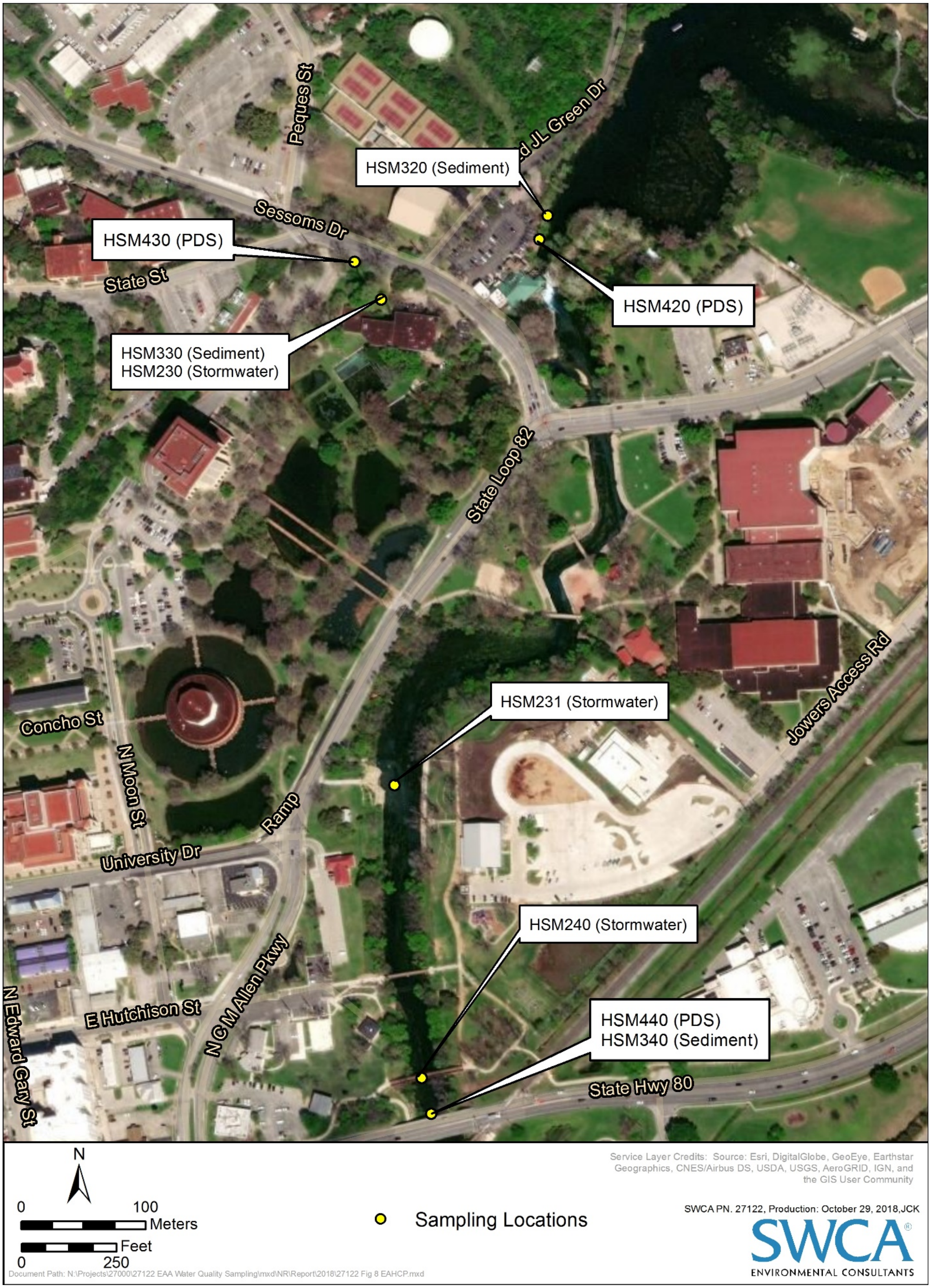

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Figure 9. EAHCP San Marcos Springs Detailed Map Indicating Sample Locations 250, 350, and 450

Figure 10. EAHCP San Marcos Springs Detailed Map Indicating Sample Locations 260, 360, 460, 270, 370, and 470

3.0 LOGISTICS

To accommodate the needs of the EAHCP's expanded water quality monitoring program, a significant number of resources are required. These resources, including sampling equipment, safety gear, trained staff, and sampling schedules, are all key components to the program. Additionally, the development of sampling strategies and planning of each sampling event are required to ensure that resources are used efficiently and that collection is completed within the scheduled time frame. The strategies must account for the unpredictable nature of storm events. Below is a short synopsis of events and tasks undertaken to accomplish the necessary logistics for the EAHCP sampling program.

3.1 Sediment Sampling Program

SWCA acquired sediment sampling equipment in 2014 and 2015 and purchased an additional core sampler extension handle in 2016 to accommodate sampling at site HCS330, because the water depth was greater than in previous years. In May 2018, SWCA staff acquired sample containers from the contract laboratory for the June 2018 sampling event.

3.2 Stormwater Sampling Program

Prior to each sampling event, SWCA acquired laboratory sample kits and prepared them for use in the field. All other sampling and safety supplies were kept stocked and ready for mobilization in the event a storm occurred. SWCA monitored weather forecasts on a regular basis to determine if teams would be mobilized for a potential sampling event. Prior to mobilization, many logistical concerns had to be addressed, including but not limited to personnel availability, safety, staging area reservation, vehicle availability, sonde rental, and laboratory notifications.

3.3 Surface Water Passive Sampling Program

SWCA acquired PDS from the contract laboratory approximately two weeks prior to each sampling event. SWCA constructed sample deployment devices in 2014 and constructed additional deployment devices in 2016, 2017, and 2018 to replace devices lost or damaged in the field. Prior to each deployment, SWCA decontaminated the devices and placed them inside clean plastic bags.

3.4 Polar Organic Chemical Integrated Sampling Program

SWCA acquired POCIS from the contract laboratory approximately one week prior to each sampling event. The POCIS were shipped to SWCA in cans filled with argon gas. SWCA constructed sample deployment devices in January 2017 and constructed additional deployment devices in 2018 to replace devices lost or damaged in the field. Because the deployment device at location HCS460 was tampered with in February and June 2018, SWCA began using two stainless-steel colanders to serve as an encasement to hold the POCIS. The colander encasement was locked onto a chain with buoys that spans the Comal River above the tube chute. In the San Marcos Springs complex, the colander encasement was locked onto the PDS deployment device. Prior to each deployment, SWCA decontaminated the colanders and placed them inside clean plastic bags.

4.0 SAMPLE COLLECTION METHODOLOGY

4.1 Sediment Sampling Program

SWCA collected sediment samples once annually from the first three inches of sediment below the streambed surface at each of the 12 sampling locations. Sediment sample collection points generally coincided with the surface water collection points at each of the 12 sample locations in the spring complexes but varied slightly based on field conditions. Based on the amount of available sediment at each site, the location and area sampled varied. Sample collection location variations are discussed in Appendix C. Sediment sample collection methods were consistent with the guidelines established in the EAA Groundwater Quality Monitoring Plan (Appendix D). SWCA collected the majority of samples using stainless-steel hand trowels. The trowel was inserted into the sediment three inches, and the sample was scooped into sample containers provided by the contract laboratory. SWCA collected three 4-ounce and one 2-ounce jars for volatile organic compound (VOC) analysis at each location. Samples were composed of sediment collected at three locations at each sample point, which was combined and homogenized at the contract laboratory prior to analysis. The water depth at HCS330 made it impossible to collect a sample using hand trowels; instead SWCA collected the sample using a hand core sampler consisting of a two-inch-diameter, 20-inch-long stainless-steel barrel with a plastic tube liner. SWCA extruded the samples from the sample tube and into the sample containers.

In compliance with the EAA Groundwater Quality Monitoring Plan (Appendix D) and consistent with the EAA practices of 2013, SWCA collected two field duplicates and two equipment blanks. One field duplicate sample is required for each spring complex. SWCA collected the field duplicates at the same locations as two of the field samples, using the same methods as the field samples. Two equipment blanks were prepared in the laboratory of SWCA's San Antonio office. To collect one of the blanks, American Society for Testing and Materials (ASTM) Type II Reagent Grade water was poured through a new plastic sampling tube into sample collection containers. SWCA collected the second equipment blank by pouring ASTM Type II Reagent Grade water over a decontaminated trowel into sample collection containers. The samples were containerized in the same manner as a surface water sample using the same types of containers and preservatives. Sample portions for metals analyses requiring field filtration were filtered using a 0.45-micron high capacity cartridge filter and disposable bailer. The equipment blanks were not analyzed for the following analytes: field parameters, turbidity, field alkalinity, and bacteria.

All samples were labeled and put on ice immediately upon collection for later shipment to the contract laboratory. Samples were secured inside locked SWCA vehicles during field operations and appropriate custody was maintained at all times. Representative photographs of field activities are included in Appendix E.

4.2 Stormwater Sampling Program

Stormwater samples are designated by the EAHCP Work Plan (Appendix A) for collection once annually from each spring complex. SWCA collected stormwater samples when rainfall amounts were adequate to initiate at least a 5% rise at the respective USGS gauging locations for each spring complex. SWCA collected samples across the storm-affected stream hydrograph at the rise, peak, and recession limb of the associated stream hydrograph. As with the other sample types, SWCA sampled five locations at Comal Springs and seven locations at San Marcos Springs. In general, the turbidity and conductivity data from the

RTIs at each site were used as a surrogate for the stream hydrograph due to immediate availability of the data. Stream hydrograph data is only updated hourly on the USGS website. The RTI data is updated every 15 minutes, which provides greater resolution regarding the effect of the storm event on the streams and facilitates quicker sampling response times. Graphs showing water quality parameters during each storm event are included in Appendix B.

Due to the inherently unsafe conditions associated with stormwater flow, SWCA field staff used disposable single-use bailers when needed in order to safely obtain water samples during stormwater sampling events. Field parameters were collected first by inserting the sonde probe as close to the sample location as possible. In May 2018, SWCA sampled location HSM240 using disposable bailers. SWCA staff lowered bailers from the bridge above the sample location and used a rope affixed to the bailer for retrieval. SWCA used new bailers and rope for each of the three samples collected at this location. After bailer retrieval, SWCA staff transferred the water to the sample containers. SWCA used only new, disposable equipment for stormwater sampling events.

Stormwater sampling efforts conformed to the protocols outlined in the EAA Groundwater Quality Monitoring Plan (Appendix D) for sample collection, handling, and decontamination. Filtration for methods 6010B (metals), 6020 (metals), DOC and field alkalinity were performed using a 0.45-micron high capacity cartridge filter and peristaltic pump. Preservatives were placed in the bottles (as needed) by the contract laboratory prior to sample collection. SWCA immediately placed all samples into coolers with ice and later shipped samples to the contract laboratory. When not in use or after collection, sampling equipment and/or coolers containing samples were secured inside locked SWCA vehicles to maintain appropriate sample custody and security.

According to the EAA Groundwater Quality Monitoring Plan (Appendix D), SWCA collected two field duplicates for the Comal Springs complex and three for the San Marcos Springs complex per rain event. SWCA sampled field duplicates after collection of the parent sample and in the same manner as the field sample. No equipment blanks were required for stormwater samples as all equipment used was new and disposable.

Analyses for field alkalinity were performed at the field staging area or at SWCA's San Antonio office. The method used for field alkalinity is discussed in detail in the EAA Groundwater Quality Monitoring Plan (Appendix D). Representative photographs of field activities are included in Appendix E. Descriptions of conditions specific to each stormwater sampling event are described in Appendix F—Record of Stormwater Sampling.

4.3 Surface Water Passive Diffusion Samplers

SWCA deployed the PDS at each of the 12 sample locations during the months of February, April, June, August, October, and December 2018. In general, PDS locations corresponded to surface water sampling points unless prevented by field conditions. Lost PDSs, human tampering, and any variations in deployment locations are discussed in Appendix C.

SWCA staff constructed deployment devices at SWCA's San Antonio office in June 2014. Two-inch thick, 18-inch diameter concrete disks were poured and a stainless-steel silverware cup was set approximately one inch deep in the center of the disk. Handles were formed by inserting both ends of an 18-inch length of vinyl-coated stainless-steel cable into each side of the disk. Site numbers were marked in the wet concrete to dedicate each device to a sample location. The concrete was allowed to cure, and each device was decontaminated in accordance with the EAA Groundwater Quality Monitoring Plan guidelines (Appendix D) and placed in a clean plastic bag prior to the first deployment. The same decontamination procedures were followed for subsequent sampling events. SWCA constructed additional deployment devices in 2016, 2017, and 2018 to replace devices lost or damaged in the field. The deployment device is pictured in Figure 11.

Upon arrival at the sample location, the PDS was removed from a dedicated vial and affixed inside of a second stainless-steel silverware cup with a plastic cable tie. This cup was inverted and placed on top of the cup set in the concrete sampling device enclosing the PDS inside the two cups. The two cups were secured to one another with additional plastic cable ties. The device was then gently lowered into the water. Installation date and time and PDS identification numbers were noted in the field notebook and on the PDS vial. To retrieve the PDS, the devices were simply removed from the water and the cable ties cut. The PDS was then immediately placed back in the dedicated vial and retrieval date and time were notated. Deployment devices were secured at SWCA offices when PDSs were not deployed.

SWCA collected field duplicates as directed by the EAA Groundwater Quality Monitoring Plan (Appendix D). To collect field duplicates, a second PDS was installed inside selected deployment devices. Field PDSs were always accompanied by trip blank samplers to monitor for VOC contamination. Deployment devices were dedicated to each sample location to avoid cross contamination and were decontaminated in accordance with the EAA Groundwater Quality Monitoring Plan guidelines (Appendix D) prior to each use. Representative photographs of field activities are included in Appendix E.

Figure 11. Passive Diffusion Sampler Retrieval at Sample Location HCS440

4.4 Polar Organic Chemical Integrative Samplers

SWCA deployed the POCIS at HCS460 and HSM470 during the months of February, April, June, August, October, and December 2018. Lost POCISs, human tampering, and any variations in deployment locations are discussed in Appendix C.

SWCA staff constructed deployment devices at SWCA's San Antonio office in 2017 and 2018. Staff poured two-inch-thick, 18-inch-diameter concrete disks and set a stainless-steel basket approximately one inch deep in the center of the disk. SWCA staff formed handles by inserting both ends of an 18-inch length of vinyl-coated stainless-steel cable into each side of the disk. Site numbers were marked in the wet concrete to dedicate each device to a sample location. The concrete was allowed to cure, and each device was decontaminated in accordance with the EAA Groundwater Quality Monitoring Plan guidelines (Appendix D) and placed in a clean plastic bag prior to the first deployment. The same decontamination procedures were followed for subsequent sampling events. SWCA constructed additional deployment devices in 2018 to replace devices lost or damaged in the field. In February 2018, the deployment device at HCS460 could not be found possibly due to human tampering. SWCA began using two stainless-steel colanders for the month of August to serve as an encasement to hold the POCIS membrane. The colander encasement was locked onto the cable above the tube chute at location HCS460. In the San Marcos Springs complex, the colander encasement was locked onto the Passive Diffusion Sample deployment device.

EST shipped the POCIS to SWCA in two sealed metal containers. Each container held three POCIS already mounted onto a carrier and sealed over argon gas. Upon arrival at each sample location, SWCA staff removed the POCIS carrier from the metal container and then inserted the carrier into a stainless-steel cylindrical basket set in the concrete deployment device. Staff then inverted a second stainless-steel basket and placed it on top of the first basket, thereby enclosing the POCIS inside the two baskets. The two baskets were secured to one another with plastic cable ties and stainless-steel wire. SWCA staff then gently lowered the device into the water. Installation date and time and POCIS identification numbers were noted in the field notebook and on the metal shipping container. To retrieve the POCIS, staff simply removed the devices from the water, cut the cable ties, and removed the stainless-steel wire. Staff then immediately placed the POCIS back in the dedicated metal shipping container and noted the retrieval date and time. Deployment devices were secured at SWCA offices when POCIS were not deployed. Representative photographs of field activities are included in Appendix E.

In August, SWCA began using two stainless-steel colanders to hold the POCIS membrane. Upon arrival at each sample location, SWCA staff removed the POCIS carrier from the metal container and then inserted the carrier into a stainless-steel colander. SWCA staff then inverted a second stainless-steel colander and locked both colanders from both sides using a padlock. The stainless-steel colanders were then locked onto the cable above the tube chute in HCS460. In the San Marcos Springs complex, the colander encasement was locked onto the PDS deployment device.

5.0 SAMPLE RESULTS

Results from the sampling efforts related to the EAHCP sampling program are discussed in the sections that follow. Results are discussed by sample type for Comal Springs, followed by a separate discussion by sample type for San Marcos Springs. Sample events are listed in the order of sediment samples, stormwater samples, PDS, and POCIS. Laboratory analyses and field parameters are provided in Appendix G of this report. SWCA staff reviewed and validated the laboratory data; the results are presented in Appendix H of this report. Each sample location (latitude/longitude), name, and other location information are summarized in Appendix I of this report.

5.1 Comal Springs Sample Results

SWCA collected sediment samples at the Comal Springs complex in June 2018. Sediment analyses results were compared with the standards developed by McDonald et al. (2000) and TCEQ (2012, 2014a). These standards are based on the probability that a detected compound has a toxic effect on sediment-dwelling organisms and are referred to as the TEC and PEC. Detections below the TEC are not considered to be toxic, whereas detections above the PEC are considered to be toxic to sediment dwelling organisms. Detections above the TEC but less than the PEC are considered equally likely to be toxic or nontoxic. No PECs were exceeded in samples collected from the Comal Springs complex.

Stormwater events were sampled at the Comal Springs complex in March and at the San Marcos Springs complex in May 2018. Two samples, HCS210 Lead 2 and HCS210 Lead 3, exceeded the Acute Surface Water Benchmark for freshwater organisms for aluminum. Three samples, HCS210 Peak, HCS260 Lead, and HCS270 Trail, exceeded the Chronic Surface Water Benchmark for freshwater organisms for aluminum. No Surface Water Benchmarks for aquatic life were exceeded for VOCs, semi-VOCs (SVOCs), pesticides, herbicides, or polychlorinated biphenyls (PCBs). No Contact Recreation Water PCLs were exceeded for any analytes.

PDS sampling events were conducted at the Comal Springs complex in February, April, June, August, October, and December 2018. Generally speaking, various VOCs and total petroleum hydrocarbons (TPH) were detected at various sample locations, but only tetrachloroethene was consistently detected. No Surface Water Benchmarks for aquatic life or Contact Recreation Water PCLs were exceeded.

POCIS sampling events were conducted at the Comal Springs and San Marcos Springs complexes in February, April, June, August, October, and December 2018. Of the 43 PPCP constituents analyzed, 13 were detected. However, some of the analytes detected were also detected in the Extraction Blanks analyzed.

5.1.1 Comal Springs Sediment Sampling

5.1.1.1 Sediment – Volatile Organic Compounds

One VOC compound was detected in sediment samples collected at HCS320, FDHCS330, and HCS340 in the Comal Springs system in 2018. No PEC value has been established for acetone. The detections are summarized in Table 2.

Table 2. Sediment Samples – Volatile Organic Compound Detections – Comal Springs Complex

Location	Date Collected	Acetone (µg/kg)
HCS320	6/27/2018	24.6
FDHCS330	6/27/2018	36.5
HCS340	6/27/2018	32.9
TEC		NE
PEC		NE

µg/kg – micrograms per kilogram

NE – Not established

PEC – probable effect concentration

TEC – threshold effect concentration

5.1.1.2 Sediment – Semi-volatile Organic Compounds

Several SVOC compounds were detected in the sediment samples collected in the Comal Springs system in 2018. Many of these detections were "J" flagged, indicating that the detected concentrations were less than the laboratory reporting limits but greater than the method detection limits. Sediment samples from HCS320, HCS330, and HCS340 had detectable concentrations of benzo(b)fluoranthene and benzo(k)fluoranthene. Fluoranthene, indeno(1,2,3-cd)pyrene, phenanthrene, and pyrene were also detected in HCS360. No PEC values have been established for benzo(b)fluoranthene, benzo(k)fluoranthene, and indeno(1,2,3-cd)pyrene. The concentrations of fluoranthene and pyrene detected in the sample from HCS340 did not exceed the PEC values.

The SVOC detections are summarized in Table 3. Polycyclic aromatic hydrocarbon (PAH) compounds exceeding the TEC are shown graphically in Figures 12–15. Total PAH detections are shown in Figure 16, where the total PAH concentrations (sum of all detected concentrations for each sample point) are compared with the TEC and PEC values for total PAH concentration established by MacDonald et al. (2000). Sample HCS360 exceeded the TEC for total PAH concentrations.

No non-PAH compounds were detected in the sediment samples collected in the Comal Springs system in 2018.

Table 3. Sediment Samples – Semi-volatile Organic Compound Detections – Comal Springs Complex

Location	Date Collected	Benzo (b) fluoranthene (mg/kg)	Benzo (k) fluoranthene (mg/kg)	Fluoranthene (mg/kg)	Indeno(1,2,3-cd)pyrene (mg/kg)	Phenanthrene (mg/kg)	Pyrene (mg/kg)	Total PAH (mg/kg)
HCS320	6/27/18	0.153 J	0.067 J	ND	ND	ND	ND	0.22
HCS330	6/27/18	0.0649 J	0.0368 J	ND	ND	ND	ND	0.10
HCS360	6/27/18	0.479 J	0.204 J	0.630 J	0.460 J	0.509	0.557 J	2.84
TEC		NE	NE	0.423	NE	0.204	0.195	1.610
PEC		NE	NE	2.230	NE	1.170	1.520	22.80

J – Detection is greater than the method detection limit, but less than the reporting limit

mg/kg – milligrams per kilogram

ND – Not detected

NE – Not established

PAH – polycyclic aromatic hydrocarbon

PEC – probable effect concentration

TEC – threshold effect concentration

Figure 12. Comal Springs Fluoranthene Detections Compared to Threshold Effect Concentration (TEC) and Probable Effect Concentration (PEC) Values

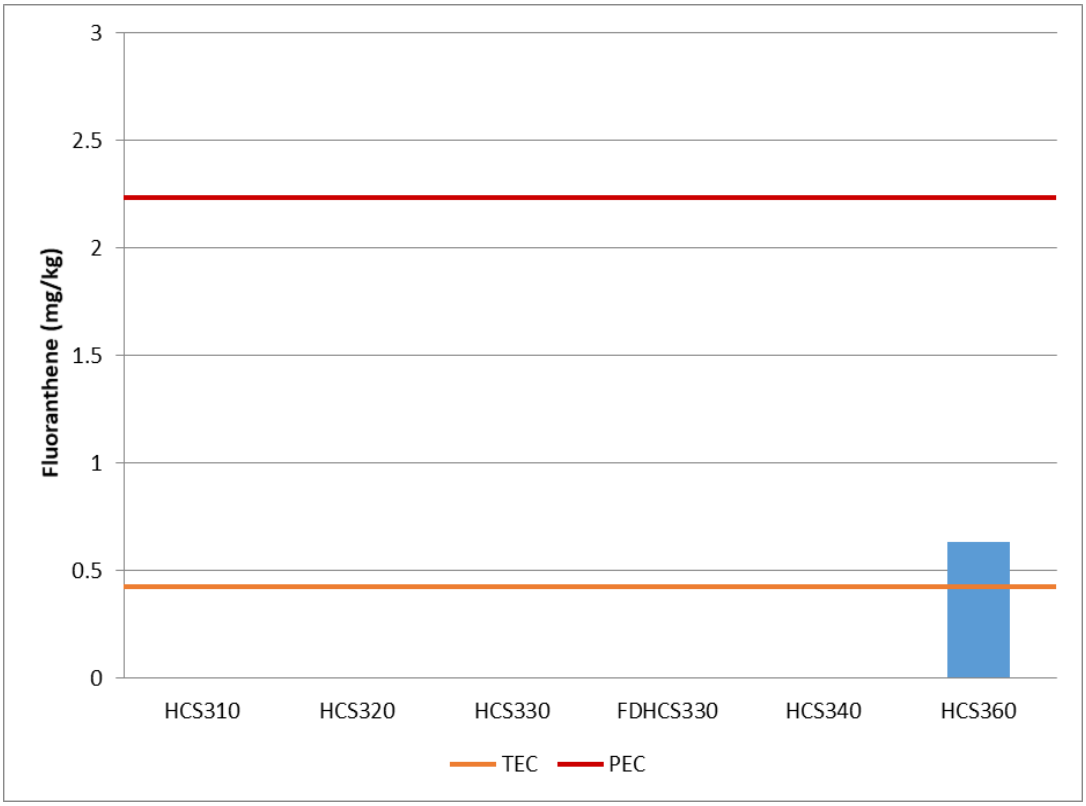


Figure 13. Comal Springs Phenanthrene Detections Compared to Threshold Effect Concentration (TEC) and Probable Effect Concentration (PEC) Values

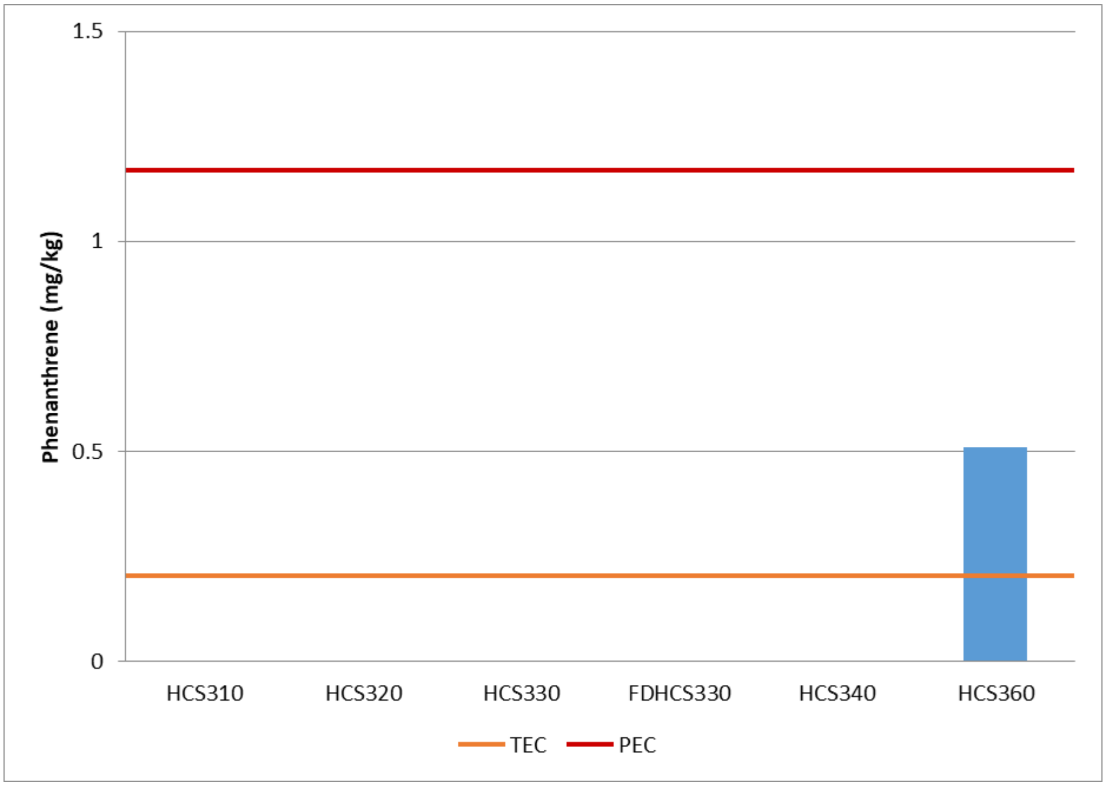


Figure 14. Comal Springs Pyrene Detections Compared to Threshold Effect Concentration (TEC) and Probable Effect Concentration (PEC) Values

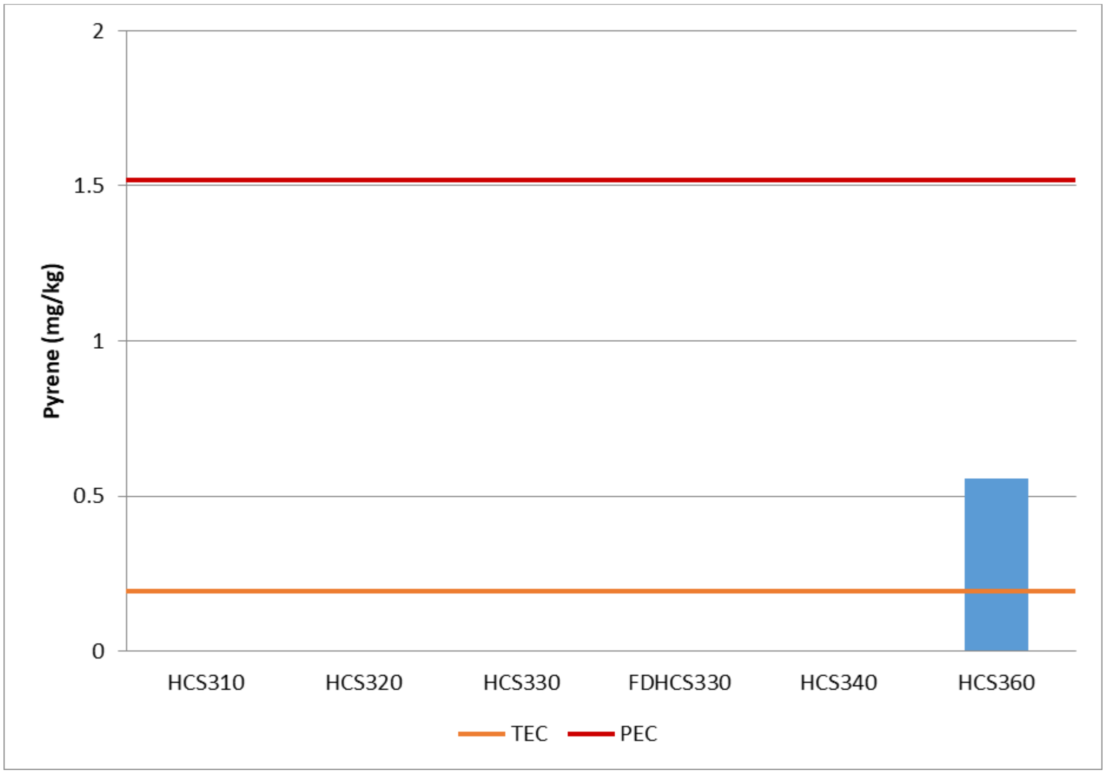
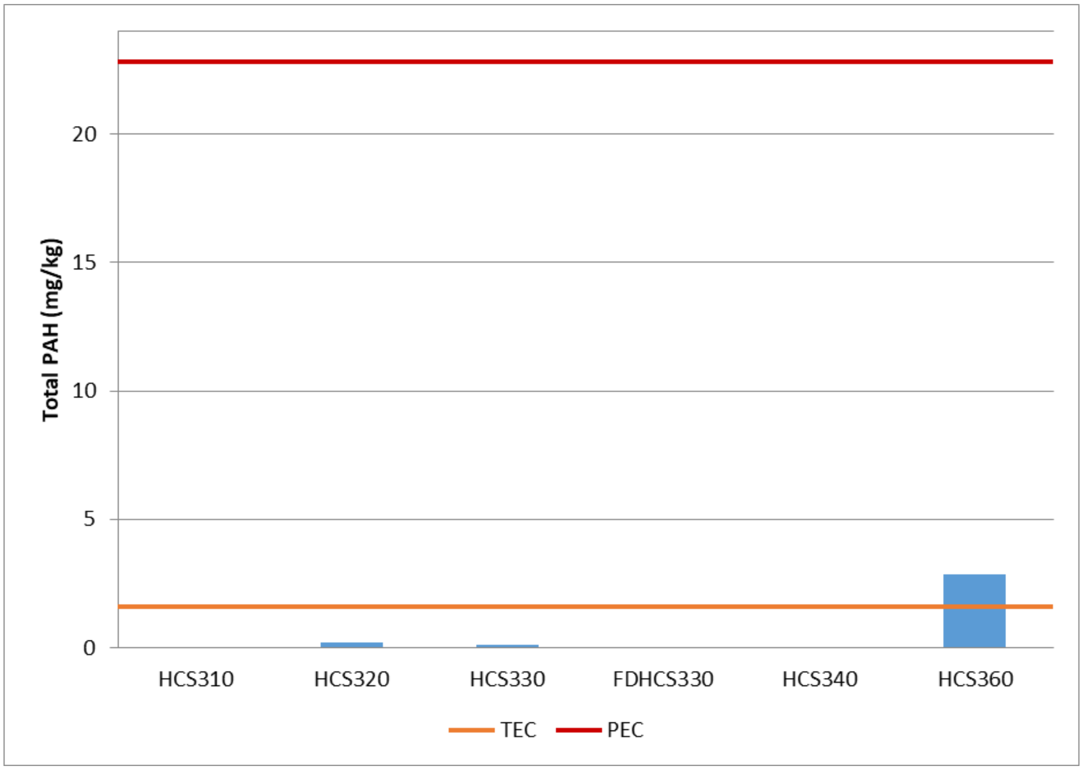


Figure 15. Comal Springs Total Polycyclic Aromatic Hydrocarbon (PAH) Detections Compared to Threshold Effect Concentration (TEC) and Probable Effect Concentration (PEC) Values



5.1.1.3 Sediment – Pesticides

Sediment samples were analyzed for both organochlorine and organophosphorus pesticides. No pesticides were detected in any of the sediment samples collected in the Comal Springs complex.

5.1.1.4 Sediment – Herbicides

Sediments were analyzed for herbicide compounds to further assess sediment quality at the Comal Springs complex. One herbicide compound was detected in one sediment sample collected from the Comal Springs complex. 2, 4-D was detected at a concentration of 8.90 J µg/kg at HCS340. The detection was "J" flagged, indicating that the detected concentration was less than the laboratory reporting limit but greater than the method detection limit. There are no TEC or PEC values established for this compound.

5.1.1.5 Sediment – Polychlorinated Biphenyls

Sediments were analyzed for PCB compounds to further assess sediment quality at the Comal Springs complex. There were no PCB detections in the sediment samples collected from the Comal Springs complex in 2018.

5.1.1.6 Sediment – Metals

Many metals are naturally occurring within soil, rock, and sediment. Sediment sample results for the Comal Springs complex tested positive for several metals, generally at low concentrations. Metals detected above the method detection limit and subsequently evaluated in this report for potential toxic effects using the TEC or PEC standards are as follows: arsenic, cadmium, chromium, copper, lead, mercury, nickel, and zinc. Other metals detected that do not have a TEC or PEC value available were compared with Texas-specific background concentrations (TSBC) (TCEQ 2014b) for soil. These metals are aluminum, antimony, barium, beryllium, iron, manganese, and selenium. Eight metals—aluminum, iron, lead, mercury, nickel, selenium, strontium and zinc—exceeded the TSBC. None of the metals detected exceeded TEC or PEC values.

For the evaluation of antimony levels, TCEQ recommends an Effects Range Low (ERL) of 2 mg/kg (TCEQ 2014a) and an Effects Range Median (ERM) of 25 mg/kg (TCEQ 2012). Antimony detections were "J" flagged, indicating that the detected concentrations were less than the laboratory reporting limit but greater than the method detection limit. Antimony was detected below the TSBC levels.

Sediment studies of selenium concentrations have shown that levels below 4 mg/kg are not likely to bioaccumulate in the food chain or have adverse impacts on the reproduction of fish or aquatic birds (Lemly 1995; Moore et al. 1990; Van Derveer and Canton 1996). Selenium detections did not exceed this amount in the sediment samples from the Comal Springs complex in 2018.

Metal detections are listed in Table 4.

Table 4. Sediment Samples – Metal Detections – Comal Springs Complex

Location	Date Collected	Aluminum (mg/kg)	Antimony (mg/kg)	Arsenic (mg/kg)	Barium (mg/kg)	Beryllium (mg/kg)	Calcium (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Iron (mg/kg)	Lead (mg/kg)	Magnesium (mg/kg)	Manganese (mg/kg)	Mercury (mg/kg)	Nickel (mg/kg)	Potassium (mg/kg)	Selenium (mg/kg)	Sodium (mg/kg)	Strontium (mg/kg)	Thallium (mg/kg)	Zinc (mg/kg)
HCS310	6/27/18	17200	0.800 J	5.50	71.1 B	0.846	55800	0.395 J	15.3	11.3	13000	17.2	2810	120 B	0.0262 J	12.9	3140	0.730	83.7 J	107	ND	63.2 B
HCS320	6/27/18	979	0.404 J	1.10 J	15.0 B	0.0783 J	282000 B	0.0849 J	2.64	1.78	1310	4.53	980	23.6 B	0.0114 J	1.73	333	0.338	217	126	ND	10.1 B
HCS330	6/27/18	1780	0.274	1.57	15.7 B	0.137 J	185000 B	0.119 J	3.22	1.66	2080	6.31	1800	57.6 B	0.0143 J	2.27	1060	0.309	90.8 J	180	ND	10.5 B
FDHCS330	6/27/18	19100	0.581 J	3.66	67.8 B	0.946	70900	0.462	17.3	11.1	15100	16.1	3550	150 B	0.0093	16.1	3450	0.386	79.5 J	141	ND	54.3 B
HCS340	6/27/18	7210 B	0.605 J	2.19	46.9 B	0.486	48.7 J B	0.0651 J	9.18	9.26	5370	10.5	2190	95.9	0.0807	9.17	1260	0.362	70.3 J B	140 B	0.956 J	28.6
HCS360	6/27/18	7990	ND	4.39	64.1 B	0.480 J	171000	0.336 J	11.6	11.1	8130	21.3	2490	95.7 B	0.0744	9.03	1360	0.621	359	280	ND	84.9 B
TEC		NE	NE	9.79	NE	NE	NE	0.99	43.4	31.6	NE	35.8	NE	NE	0.18	22.7	NE	NE	NE	NE	NE	121
PEC		NE	NE	33	NE	NE	NE	4.98	111	149	NE	128	NE	NE	1.06	48.6	NE	NE	NE	NE	NE	459
TSBC		30000	1	5.9	300	1.5	NE	NE	NE	15	15000	15	NE	300	0.04	10	NE	0.3	NE	100	NE	30

B – Compound was found in the laboratory blank and sample

J – Detection is greater than the method detection limit, but less than the reporting limit mg/kg – milligrams per kilogram

ND – Not detected

NE – not established

PEC – probable effect concentration

TEC – threshold effect concentration

TSBC – Texas-specific background concentration

5.1.2 Comal Springs Stormwater Sampling

Stormwater samples were collected during one storm event at the Comal Springs complex. SWCA sampled the event according to the guidelines in the EAHCP Work Plan. The event occurred on March 28, 2018. Total rainfall for the March 2018 event was approximately 2.0 to 2.5 inches (National Oceanic and Atmospheric Administration [NOAA] 2018). Streamflow measurements from the USGS gauge increased from approximately 322 cfs to a peak of 594 cfs (USGS 2018). Rain fell in the area in the early morning of March 28, 2018. The first lead samples were collected beginning at approximately 03:30. The peak samples were collected around 06:00. The trail samples were collected as the river recovered around 09:00 but as a second large wave of thunderstorms approached. Samples were brought back to the SWCA San Antonio office and were packaged for transport to the analytical laboratory. The samples were successfully delivered to Test America Laboratory the following morning, March 29, 2018.

5.1.2.1 Stormwater – Bacteria Detections

Stormwater samples collected and analyzed for bacteria analyses tested positive for bacteria. Bacterial analyses were performed for *E. coli*, using a most probable number method. The 2014 Texas Surface Water Quality Standard for *E. coli* in primary recreation waters is a geometric mean of 126 MPN/100 mL with no individual sample exceeding 399 MPN/100 mL (30 TAC 307.7). The geometric mean for stormwater samples collected from the Comal Springs complex during March 2018 was approximately 6,300 MPN/100 mL. Bacteria counts from March 2018 ranged from 1,600 MPN/100 mL to 16,000 MPN/100 mL, with all samples exceeding the individual sample limit. Individual detections are listed in Table 5 and shown in relation to stream discharge and specific conductivity in Figure 16. Due to the timing of storm events and laboratory working hours, it was not possible to deliver all samples to the laboratory within the sample holding time of 8 hours (see discussion in Appendix C). All sample results were included in the range and geometric mean calculations.

Table 5. Stormwater Samples – Bacteria Counts – Comal Springs Complex

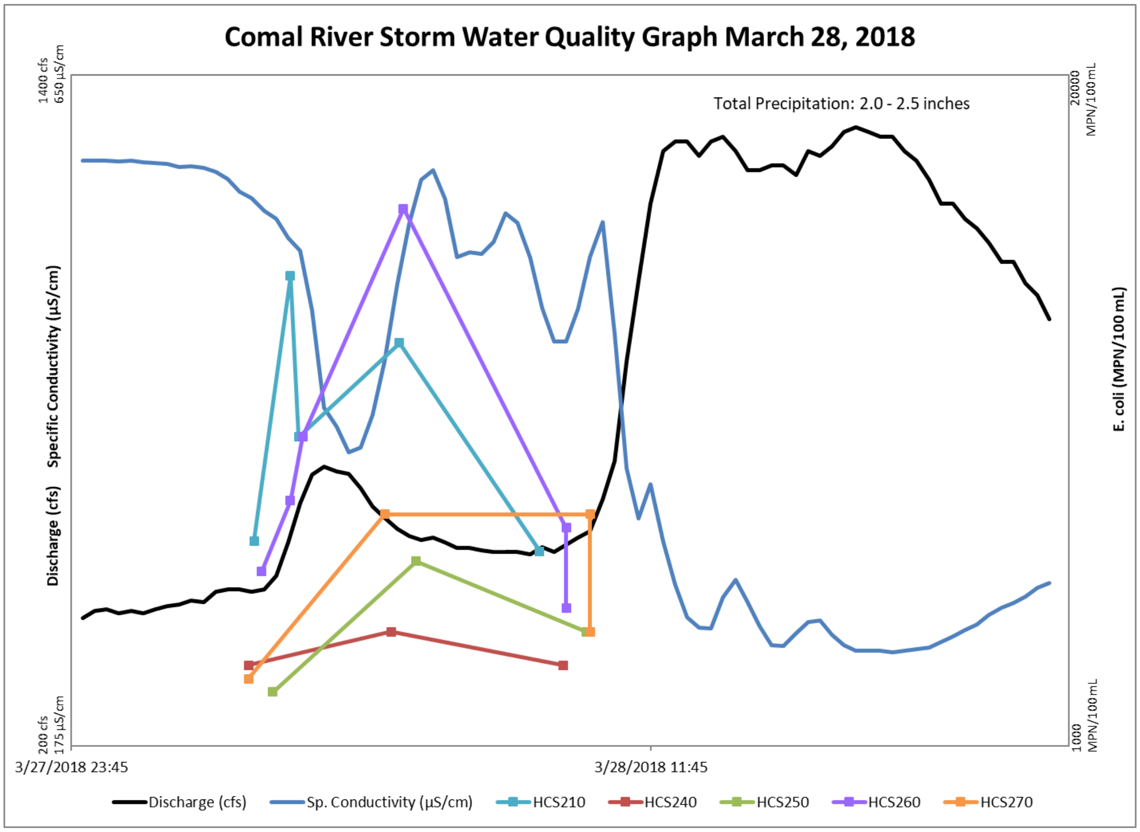
Location	Date	Count (MPN/100 mL)
HCS210 Lead 1	3/28/2018	6100H
HCS210 Lead 2	3/28/2018	14000
HCS210 Lead 3	3/28/2018	9200
HCS210 Peak	3/28/2018	12000
HCS210 Trail	3/28/2018	5800 H
HCS240 Lead	3/28/2018	2400 H
HCS240 Peak	3/28/2018	3400
HCS240 Trail	3/28/2018	2400
FDHCS240 Trail	3/28/2018	2400
HCS250 Lead	3/28/2018	1600 H
HCS250 Peak	3/28/2018	5500
HCS250 Trail	3/28/2018	3400
HCS260 Lead 1	3/28/2018	5200 H
HCS260 Lead 2	3/28/2018	7300
HCS260 Lead 3	3/28/2018	9200
HCS260 Peak	3/28/2018	16000
HCS260 Trail	3/28/2018	6500

Location	Date	Count (MPN/100 mL)
FDHCS260 Trail	3/28/2018	4100
HCS270 Lead	3/28/2018	2000 H
HCS270 Peak	3/28/2018	6900
HCS270 Trail	3/28/2018	6900

H – Analyzed outside hold time; result included for comparison but not considered valid

MPN/100 mL – Most probable number per 100 milliliters of water

Figure 16. Stormwater Samples – March 2018 Bacteria Counts in Relation to Stream Discharge and Specific Conductivity – Comal Springs Complex



5.1.2.2 Stormwater – Volatile Organic Compounds

There was one VOC detection in stormwater samples during the March 2018 storm event. Acetone was detected at a concentration of 5.10 J µg/L in HCS210 Lead 2 and 7.03 J µg/L in HCS210 Peak. Detections are listed in Table 6. None of the concentrations detected exceeded the Surface Water Benchmarks for aquatic life or the Contact Recreation Water PCLs.

Table 6. Stormwater Samples – Volatile Organic Compound Detections – Comal Springs Complex

Location	Date	Acetone (µg/L)
HCS210 Lead 2	3/28/2018	5.10 J

Location	Date	Acetone (µg/L)
HCS210 Peak	3/28/2018	7.03 J
TCEQ Acute Surface Water Benchmark for Aquatic Life†		607,400
TCEQ Chronic Surface Water Benchmark for Aquatic Life†		101,200
Contact Recreation Water PCL‡		780,000

J – Detection is greater than the method detection limit, but less than the reporting limit
µg/L – micrograms per liter
PCL – Protective concentration level
TCEQ – Texas Commission on Environmental Quality
† Aquatic Life Surface Water Benchmark Table (TCEQ 2018)
‡ Contact Recreation Water PCL Table (TCEQ 2006)

5.1.2.3 Stormwater – Semi-volatile Organic Compounds

Generally, SVOCs were analyzed because their detection can indicate the presence of chemicals originating from anthropogenic sources and, therefore, can be used to evaluate potential impacts on water quality. One SVOC, bis(2-ethylehexyl) phthalate (DEHP), was detected in three samples from the March 2018 stormwater sampling event. All the detections were "J" flagged, indicating that the detected concentrations were less than the laboratory reporting limit but greater than the method detection limit. The concentrations detected did not exceed the Surface Water Benchmarks for aquatic life. SVOC detections are listed in Table 7.

Table 7. Stormwater Samples – Semi-volatile Organic Compound Detections – Comal Springs Complex

Location	Date	Bis(2-Ethylhexyl)Phthalate (DEHP) (µg/L)
HCS210 Lead 1	3/28/2018	8.33 J
HCS270 Lead	3/28/2018	8.03 J
HCS210 Peak	3/28/2018	5.153 J
TCEQ Acute Surface Water Benchmark for Aquatic Life†		60
TCEQ Chronic Surface Water Benchmark for Aquatic Life†		20
Contact Recreation Water PCL‡		NE

J – Detection is greater than the method detection limit, but less than the reporting limit
µg/L – micrograms per liter
NE – Not established
PCL – Protective concentration level
TCEQ – Texas Commission on Environmental Quality† Aquatic Life Surface Water Benchmark Table (TCEQ 2018)
‡ Contact Recreation Water PCL Table (TCEQ 2006)

5.1.2.4 Stormwater – Herbicides and Pesticides

One organophosphorus pesticide and one herbicide were detected in stormwater samples from the Comal Springs complex in 2018.

The organophosphorus pesticide detected was Disulfoton at a concentration of 0.000310 J mg/kg in sample HCS270 Peak. The detection was "J" flagged, indicating that the detected concentration was less than the laboratory reporting limit but greater than the method detection limit. The detected concentration was less than the Contact Recreation Water PCL of 0.005 mg/L. No Surface Water Benchmarks for aquatic life have been established for Disulfoton.

The herbicide compound, 2,4-D, was detected during the storm event in the Comal Springs complex sampled during the March 2018 event. The compound was detected in a total of 11 samples. All the detections were "J" flagged, indicating that the detected concentrations were less than the laboratory reporting limit but greater than the method detection limit. None of the detections approach the Contact Recreation Water PCL of 3920 mg/L for 2,4-D. No Surface Water Benchmarks for aquatic life have been established for 2,4-D.

Herbicide detections are summarized in Table 8.

Table 8. Stormwater Samples – Herbicide Detections – Comal Springs Complex

Location	Date	2,4-D (µg/L)
HCS210 Lead 2	3/28/2018	0.109 J
HCS210 Lead 3	3/28/2018	0.0738 J
HCS250 Lead	3/28/2018	0.0627 J
HCS260 Lead 2	3/28/2018	0.0925 J
HCS270 Lead	3/28/2018	0.487 J
HCS260 Peak	3/28/2018	0.0447 J
HCS270 Peak	3/28/2018	0.118 J
HCS210 Trail	3/28/2018	0.108 J
HCS260 Trail	3/28/2018	0.0753 J
FDHCS260 Trail	3/28/2018	0.0995 J
HCS270 Trail	3/28/2018	0.109 J
TCEQ Acute Surface Water Benchmark for Aquatic Life†		NE
TCEQ Chronic Surface Water Benchmark for Aquatic Life†		NE
Contact Recreation Water PCL‡		3920

J – Detection is greater than the method detection limit, but less than the reporting limit

µg/L – micrograms per liter

NE – Not established

PCL – Protective concentration level

TCEQ – Texas Commission on Environmental Quality

† Aquatic Life Surface Water Benchmark Table (TCEQ 2018)

‡ Contact Recreation Water PCL Table (TCEQ 2006)

5.1.2.5 Stormwater – Polychlorinated Biphenyls

Stormwater samples were analyzed for the various Aroclor compounds that are generally referred to collectively as PCBs. None of the stormwater samples from the Comal Springs complex indicated positive detections of PCB compounds during the March 2018 sampling event.

5.1.2.6 Stormwater – Metals

Stormwater samples were analyzed for metals in accordance with the EAHCP Work Plan. Several positive metal detections were noted in the sample set. Two samples, HCS210 Lead 2 and HCS210 Lead 3, exceeded the Acute Surface Water Benchmark for aquatic life for aluminum. Three samples, HCS210 Peak, HCS260 Lead, and HCS270 Trail, exceeded the Chronic Surface Water Benchmark for aquatic life for aluminum. None of the metal concentrations detected exceeded the Contact Recreation Water PCLs. Metal results are presented in Table 9.

Table 9. Stormwater Samples – Metals – Comal Springs Complex

Location	Date Collected	Aluminum (mg/L)	Antimony (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Beryllium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Manganese (mg/L)	Mercury (mg/L)	Nickel (mg/L)	Selenium (mg/L)	Silicon (mg/L)	Silver (mg/L)	Thallium (mg/L)	Zinc (mg/L)
HCS210 Lead 1	28-Mar-18	<0.0500	<0.00161	<0.00109	0.0606	<0.00124	<0.000854	<0.00140	<0.00200	<0.101	<0.000733	<0.0116	<0.000130	<0.00217	0.00163 J	4.24	<0.000941	<0.000693	<0.00355
HCS210 Lead 2	28-Mar-18	3.15	<0.00161	0.00119 J	0.0477	<0.00124	<0.000854	0.00320 J	0.00320 J	2.73	0.00652	0.101	<0.000130	0.00248 J	0.00138 J	8.9	<0.000941	<0.000693	0.0461
HCS210 Lead 3	28-Mar-18	1.67	<0.00161	<0.00109	0.0418	<0.00124	<0.000854	0.00161 J	<0.00200	1.65	0.00303 J	0.0476 J	<0.000130	<0.00217	<0.00108	6.09	<0.000941	<0.000693	0.0205 J
HCS210 Peak	28-Mar-18	0.157	<0.00161	<0.00109	0.0285	<0.00124	<0.000854	<0.00140	<0.00200	0.147 J	<0.000733	<0.0116	<0.000130	<0.00217	<0.00108	2.61	<0.000941	<0.000693	<0.00355
HCS210 Trail	28-Mar-18	<0.0500	<0.00161	<0.00109	0.0325	<0.00124	<0.000854	<0.00140	<0.00200	<0.101	<0.000733	<0.0116	<0.000130	<0.00217	<0.00108	2.7	<0.000941	<0.000693	<0.00355
HCS240 Lead	28-Mar-18	<0.0500	<0.00161	<0.00109	0.0523	<0.00124	<0.000854	<0.00140	<0.00200	<0.101	<0.000733	<0.0116	0.000141 J	<0.00217	0.00135 J	5.39	<0.000941	<0.000693	<0.00355
HCS240 Peak	28-Mar-18	<0.0500	<0.00161	<0.00109	0.0533	<0.00124	<0.000854	<0.00140	<0.00200	<0.101	<0.000733	<0.0116	<0.000130	<0.00217	0.00124 J	5.35	<0.000941	<0.000693	<0.00355
HCS240 Trail	28-Mar-18	<0.0500	<0.00161	<0.00109	0.0502	<0.00124	<0.000854	<0.00140	<0.00200	<0.101	<0.000733	<0.0116	<0.000130	<0.00217	<0.00108	5.35	<0.000941	<0.000693	<0.00355
FDHCS240 Trail	28-Mar-18	<0.0500	<0.00161	<0.00109	0.051	<0.00124	<0.000854	<0.00140	<0.00200	<0.101	<0.000733	<0.0116	<0.000130	<0.00217	<0.00108	5.42	<0.000941	<0.000693	<0.00355
HCS250 Lead	28-Mar-18	<0.0500	<0.00161	<0.00109	0.0512	<0.00124	<0.000854	<0.00140	<0.00200	0.139 J	<0.000733	<0.0116	<0.000130	0.00256 J	0.00333 J	5.32	<0.000941	<0.000693	0.0156 J
HCS250 Peak	28-Mar-18	<0.0500	<0.00161	<0.00109	0.0429	<0.00124	<0.000854	<0.00140	<0.00200	<0.101	<0.000733	<0.0116	<0.000130	<0.00217	<0.00108	4.47	<0.000941	<0.000693	<0.00355
HCS250 Trail	28-Mar-18	<0.0500	<0.00161	<0.00109	0.0475	<0.00124	<0.000854	<0.00140	<0.00200	<0.101	<0.000733	<0.0116	<0.000130	<0.00217	<0.00108	5.12	<0.000941	<0.000693	<0.00355
HCS260 Lead	28-Mar-18	<0.0500	<0.00161	<0.00109	0.0524	<0.00124	<0.000854	<0.00140	<0.00200	0.117 J	<0.000733	<0.0116	<0.000130	<0.00217	0.00149 J	5.14	<0.000941	<0.000693	<0.00355
HCS260 Lead 2	28-Mar-18	0.223	<0.00161	<0.00109	0.0447	<0.00124	<0.000854	<0.00140	<0.00200	0.436	0.000820 J	0.0225 J	<0.000130	<0.00217	<0.00108	4.7	<0.000941	<0.000693	<0.00355
HCS260 Lead 3	28-Mar-18	<0.0500	<0.00161	<0.00109	0.0505	<0.00124	<0.000854	<0.00140	<0.00200	<0.101	<0.000733	<0.0116	<0.000130	<0.00217	<0.00108	5.09	<0.000941	<0.000693	<0.00355
HCS260 Peak	28-Mar-18	<0.0500	<0.00161	<0.00109	0.0497	<0.00124	<0.000854	<0.00140	<0.00200	<0.101	<0.000733	0.0266 J	<0.000130	<0.00217	<0.00108	4.13	<0.000941	<0.000693	<0.00355
HCS260 Trail	28-Mar-18	<0.0500	<0.00161	<0.00109	0.0437	<0.00124	<0.000854	<0.00140	<0.00200	<0.101	<0.000733	0.0173 J	<0.000130	<0.00217	<0.00108	4.29	<0.000941	<0.000693	<0.00355
FDHCS260 Trail	28-Mar-18	0.0577 J	<0.00161	<0.00109	0.0442	<0.00124	<0.000854	0.00147 J	<0.00200	<0.101	<0.000733	0.0195 J	<0.000130	<0.00217	0.00172 J	4.3	<0.000941	<0.000693	<0.00355
HCS270 Lead	28-Mar-18	<0.0500	<0.00161	<0.00109	0.0511	<0.00124	<0.000854	<0.00140	<0.00200	<0.101	<0.000733	<0.0116	<0.000130	<0.00217	0.00108 J	5.26	<0.000941	<0.000693	<0.00355
HCS270 Peak	28-Mar-18	<0.0500	<0.00161	<0.00109	0.041	<0.00124	<0.000854	<0.00140	<0.00200	<0.101	<0.000733	0.0122 J	<0.000130	<0.00217	0.00116 J	3.67	<0.000941	<0.000693	<0.00355
HCS270 Trail	28-Mar-18	0.296	<0.00161	<0.00109	0.0453	<0.00124	<0.000854	<0.00140	<0.00200	0.302	0.000846 J	0.0300 J	<0.000130	<0.00217	0.00193 J	4.85	<0.000941	<0.000693	<0.00355
TCEQ Acute Surface Water Benchmark for Aquatic Life†		0.99	6.6	0.34	96	0.13	0.0044	0.32	0.00739	NE	0.03014	2.37	0.0024	0.26	0.02	NE	0.001	0.54	0.0651
TCEQ Acute Surface Water Benchmark for Aquatic Life†		0.087	2.2	0.15	16	0.0053	0.00015	0.042	0.00524	1.00	0.0017	1.310	0.0013	0.0289	0.0005	NE	0.0001	0.18	0.0657
Contact Recreation Water PCL‡		403	0.199	0.0285	64.9	0.0943	0.0149	126	33.1	NE	NE	40.9	0.00973	11.3	4.13	NE	1.57	0.0661	201

J – Detection is greater than the method detection limit, but less than the reporting limit

mg/L – milligrams per liter

NE – Not established

PCL – Protective concentration level

TCEQ – Texas Commission on Environmental Quality

† Aquatic Life Surface Water Benchmark Table (TCEQ 2018)

‡ Contact Recreation Water PCL Table (TCEQ 2006)

5.1.2.7 Stormwater – Nitrates

Stormwater samples were analyzed for nitrate-nitrite as nitrogen, in accordance with the EAHCP Work Plan. All nitrate results were below the Surface Water Benchmarks for aquatic life and the Contact Recreation Water PCLs. During the March 2018 event, the range of nitrate results was 0.422 J mg/L to 1.71 mg/L, with an average of 1.19 mg/L. Nitrate results are summarized in Table 10.

Table 10. Stormwater Samples – Nitrate Detections – Comal Springs Complex

Location	Date	Concentration (mg/L)
HCS210 Lead 1	3/28/2018	0.713
HCS210 Lead 2	3/28/2018	0.560
HCS210 Lead 3	3/28/2018	0.499 J
HCS210 Peak	3/28/2018	0.473 J
HCS210 Trail	3/28/2018	0.552
HCS240 Lead	3/28/2018	1.69
HCS240 Peak	3/28/2018	1.57
HCS240 Trail	3/28/2018	1.56
FDHCS240 Trail	3/28/2018	1.56
HCS250 Lead	3/28/2018	1.64
HCS250 Peak	3/28/2018	1.32
HCS250 Trail	3/28/2018	1.46
HCS260 Lead 1	3/28/2018	1.71
HCS260 Lead 2	3/28/2018	1.31
HCS260 Lead 3	3/28/2018	1.61
HCS260 Peak	3/28/2018	1.11
HCS260 Trail	3/28/2018	1.17
FDHCS260 Trail	3/28/2018	1.16
HCS270 Lead	3/28/2018	1.70
HCS270 Peak	3/28/2018	1.12
HCS270 Trail	3/28/2018	0.422 J
TCEQ Acute Surface Water Benchmark for Aquatic Life†		1320
TCEQ Chronic Surface Water Benchmark for Aquatic Life†		550
Contact Recreation Water PCL‡		13

J – Detection is greater than the method detection limit, but less than the reporting limit
mg/L – milligrams per liter
PCL – Protective concentration level
TCEQ – Texas Commission on Environmental Quality
† Aquatic Life Surface Water Benchmark Table (TCEQ 2018)
‡ Contact Recreation Water PCL Table (TCEQ 2006)

5.1.2.8 Stormwater – Caffeine

Stormwater was analyzed for caffeine, which can indicate an anthropogenic source. Caffeine may enter surface water from leaking sewer or septic systems, or it may be present in the aquifer from similar sources in the recharge zone (EPA 2012). Potential ecological effects are currently unknown but could include reduced reproductive success of aquatic organisms (EPA 2012). Caffeine detections in stormwater samples from Comal Springs in March 2018 ranged from 6.5 ng/L to 91 ng/L. There is no regulatory standard or expected value for comparison. These results are shown in Table 11.

Table 11. Stormwater Samples – Caffeine Detections – Comal Springs Complex

Location	Date Collected	Caffeine (ng/L)
HCS210 Lead 2	3/28/2018	13
HCS210 Lead 3	3/28/2018	38
HCS210 Peak	3/28/2018	25
HCS210 Trail	3/28/2018	23
HCS250 Lead	3/28/2018	22
HCS250 Peak	3/28/2018	21
HCS250 Trail	3/28/2018	6.5
HCS260 Lead 1	3/28/2018	42
HCS260 Lead 2	3/28/2018	91
HCS260 Lead 3	3/28/2018	37
HCS260 Peak	3/28/2018	31
HCS260 Trail	3/28/2018	32
FDHCS260 Trail	3/28/2018	34
HCS270 Lead 3	3/28/2018	37
HCS270 Peak	3/28/2018	66
HCS270 Trail	3/28/2018	41

ng/L – nanograms per liter

5.1.3 Comal Springs Surface Water Passive Sampling

PDSs were installed in the Comal Springs system in February, April, June, August, October, and December 2018. Any changes to deployment locations or nonrecovered samplers are discussed in Appendix C.

Rain events did occur during some PDS deployment periods during 2018. Figures 17–22 show specific conductivity and discharge for each PDS deployment period.

No suitable set of regulatory standards exists for comparison with the PDS results; rather, the data are a qualitative tool for evaluating the presence of trace concentrations of organic compounds. PDSs were analyzed for a suite of SVOCs, VOCs, and organochlorine pesticides. Few compounds were detected; the most notable are relatively consistent detections of tetrachloroethene. Positive detections are shown in Table 12. The concentrations detected were compared with the Surface Water Benchmarks for aquatic life and the Contact Recreation Water PCLs. None of those comparison values were exceeded by the concentrations detected.

Figure 17. Passive Diffusion Sampling – February 2018 Stream Discharge and Specific Conductivity – Comal Springs Complex

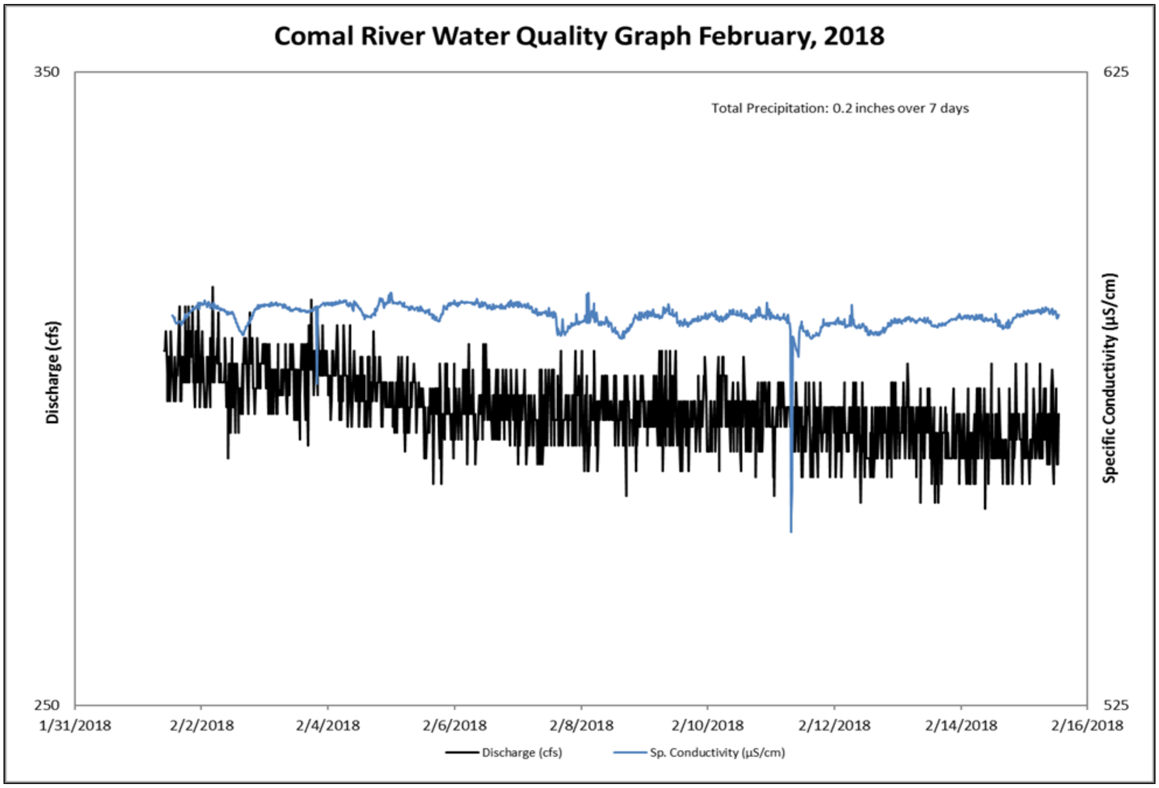


Figure 18. Passive Diffusion Sampling – April 2018 Stream Discharge and Specific Conductivity – Comal Springs Complex

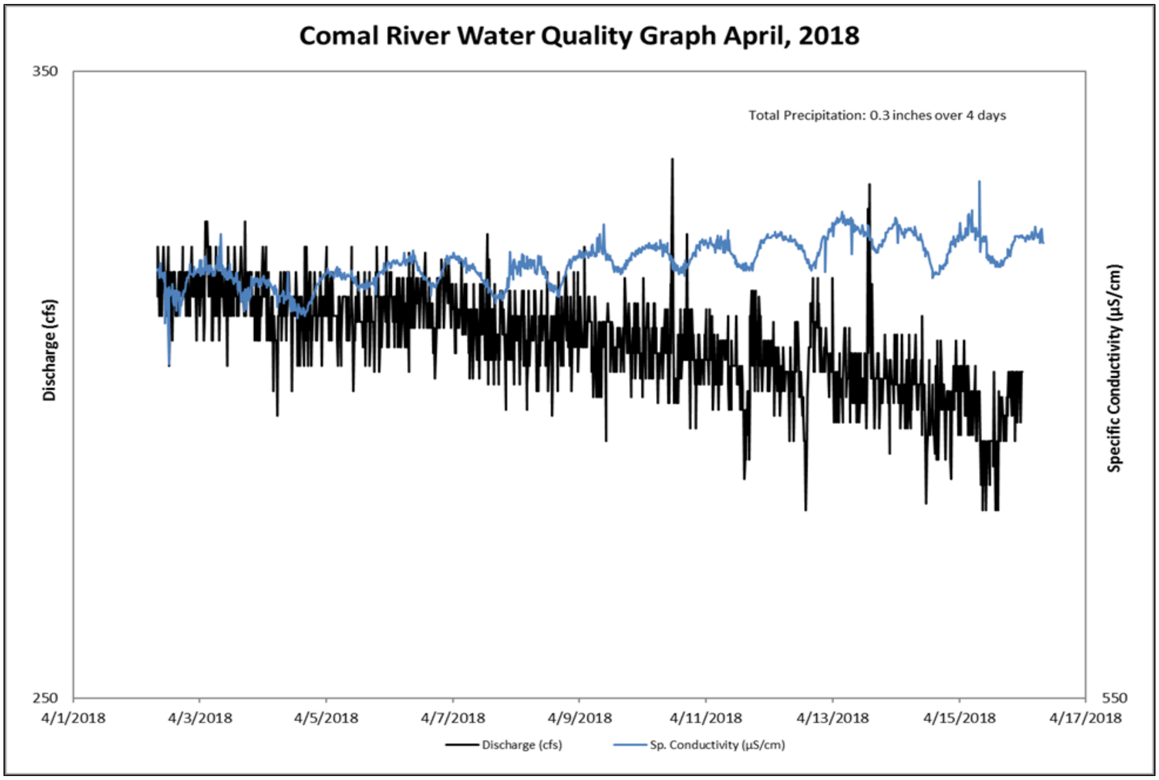


Figure 19. Passive Diffusion Sampling – June 2018 Stream Discharge and Specific Conductivity – Comal Springs Complex

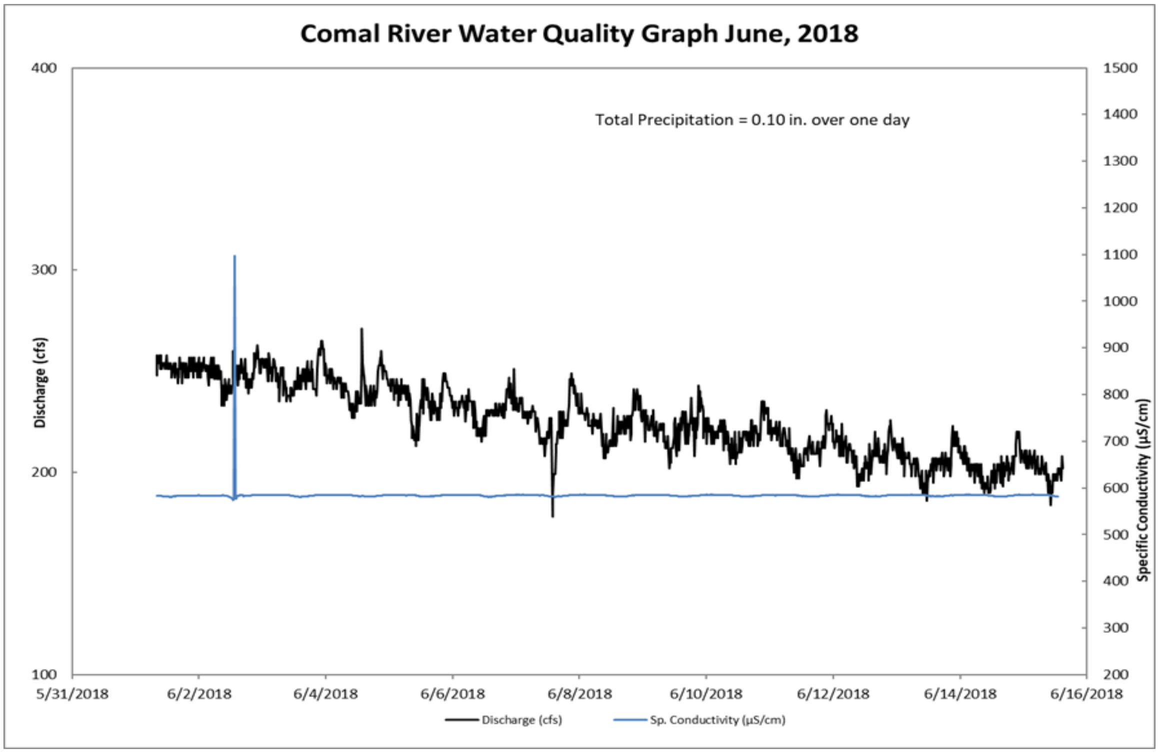


Figure 20. Passive Diffusion Sampling – August 2018 Stream Discharge and Specific Conductivity – Comal Springs Complex

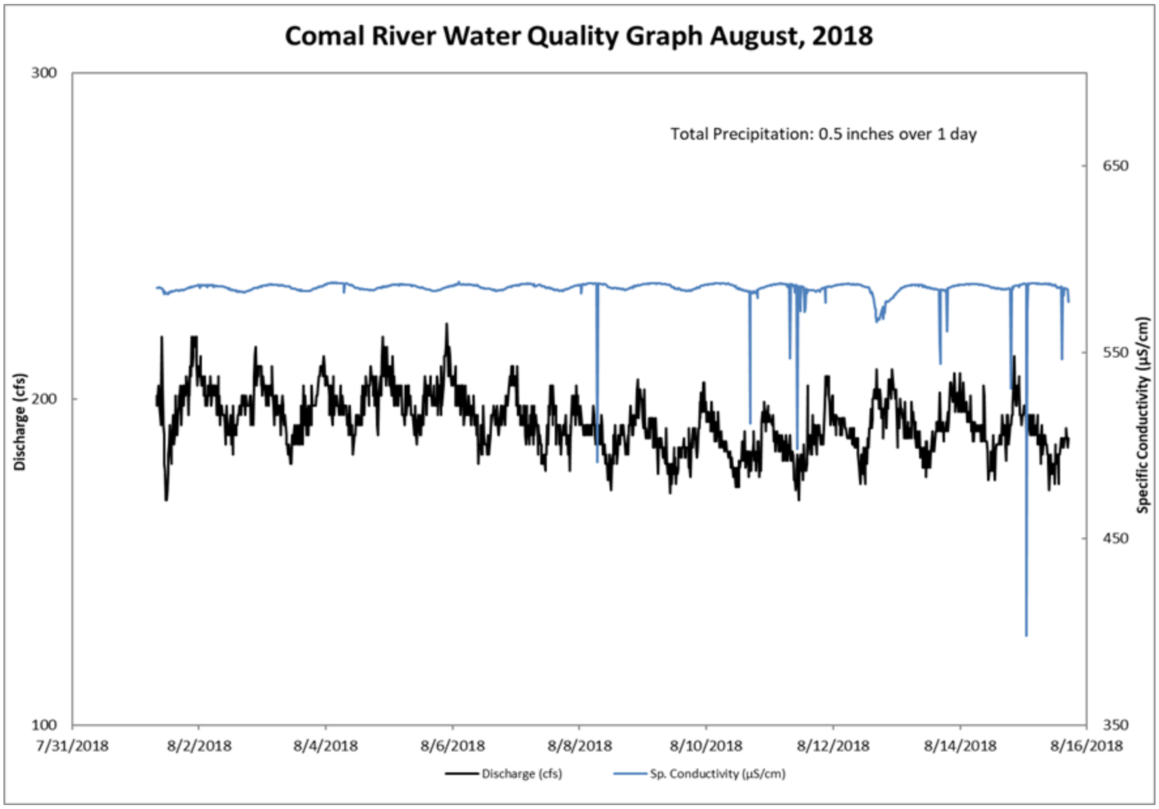


Figure 21. Passive Diffusion Sampling – October 2018 Stream Discharge and Specific Conductivity – Comal Springs Complex

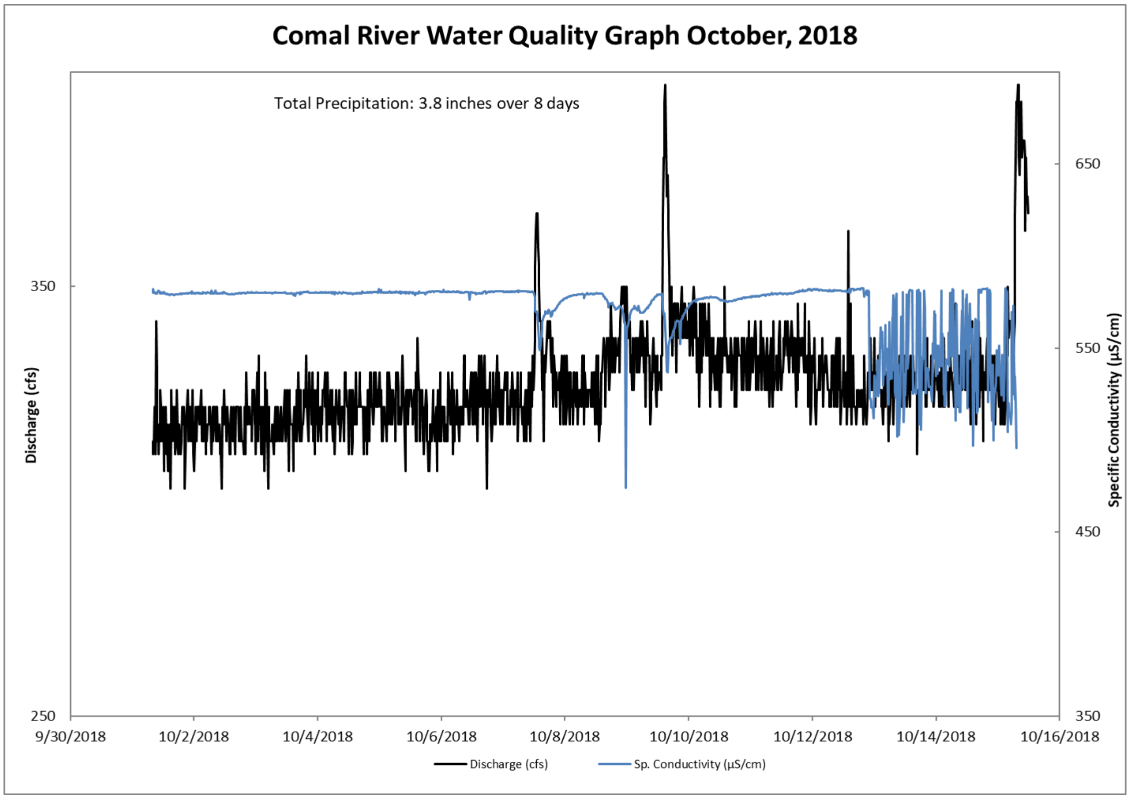


Figure 22. Passive Diffusion Sampling – December 2018 Stream Discharge and Specific Conductivity – Comal Springs Complex

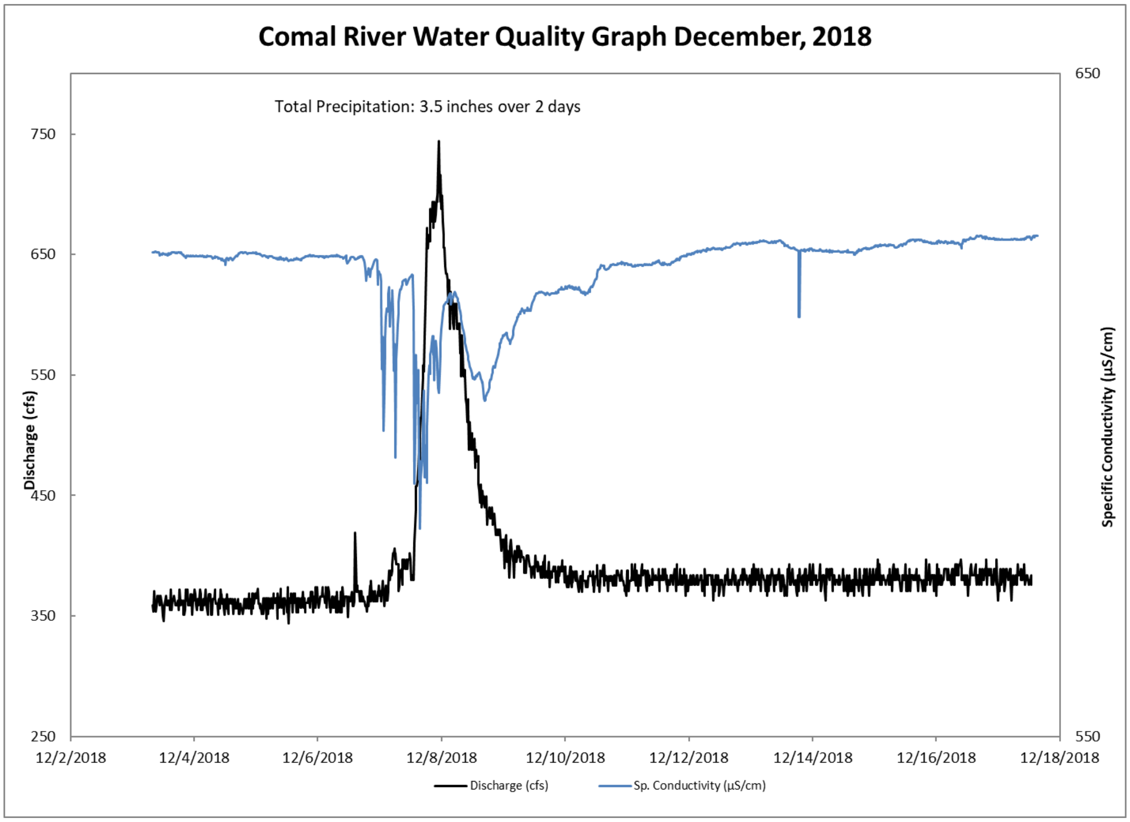


Table 12. Passive Diffusion Sampling –Volatile and Semi-volatile Organic Compound Detections – Comal Springs Complex

Location	Month 2018	Acenaphthene (µg/L)	Acenaphthylene (µg/L)	Chloroform (µg/L)	Fluorene (µg/L)	m-,p-Xylene (µg/L)	Tetrachloroethene (µg/L)	TPH (µg/L)
HCS410	February	<0.014	<0.014	<0.007	<0.014	<0.005	**0.018**	**0.065**
	April	<0.014	<0.014	<0.007	<0.014	<0.005	**0.019**	<0.053
	June	<0.014	<0.014	<0.007	<0.014	<0.005	**0.031**	**0.059**
	August	<0.014	<0.014	**0.016**	<0.014	<0.005	**0.011**	**0.088**
	October	<0.05	<0.05	**0.08**	<0.05	<0.02	**0.07**	**0.66**
	December	<0.05	<0.05	<0.02	<0.05	<0.02	**0.03**	<0.50
HCS420	February	<0.014	<0.014	<0.007	<0.014	<0.005	**0.058**	<0.054
	April	<0.014	<0.014	<0.007	<0.014	<0.005	**0.055**	<0.053
	June	<0.014	<0.014	<0.007	<0.014	<0.005	**0.046**	**0.070**
	August	<0.014	<0.014	<0.007	<0.014	<0.005	**0.035**	**0.063**
	October	<0.05	<0.05	<0.02	<0.05	<0.02	**0.39**	**0.83**
	December	<0.05	<0.05	<0.02	<0.05	<0.02	**0.31**	<0.50
FDHCS420	August	<0.05	<0.05	<0.02	<0.05	<0.02	**0.20**	**0.96**
HCS430	February	<0.014	<0.014	<0.007	<0.014	<0.005	**0.075**	**0.063**
	April	<0.014	<0.014	<0.007	<0.014	<0.005	**0.089**	**0.057**
	June	<0.014	<0.014	<0.007	<0.014	<0.005	**0.060**	**0.070**
	August	<0.014	<0.014	<0.007	<0.014	<0.005	**0.068**	**0.064**
	October	<0.05	<0.05	<0.02	<0.05	<0.02	**0.59**	**3.26**
	December	<0.05	<0.05	<0.02	<0.05	<0.02	**0.43**	<0.50
HCS440	February	<0.014	<0.014	<0.007	<0.014	<0.005	**0.075**	**0.058**
	April	<0.014	<0.014	<0.007	<0.014	<0.005	**0.056**	<0.053
	June	<0.014	<0.014	<0.007	<0.014	<0.005	**0.045**	**0.065**
	August	<0.014	<0.014	<0.007	<0.014	<0.005	**0.055**	**0.069**
	October	<0.05	<0.05	<0.02	<0.05	<0.02	**0.31**	**2.23**
	December	<0.05	<0.05	<0.02	<0.05	<0.02	**0.22**	<0.50

Location	Month 2018	Acenaphthene (µg/L)	Acenaphthylene (µg/L)	Chloroform (µg/L)	Fluorene (µg/L)	m-,p-Xylene (µg/L)	Tetrachloroethene (µg/L)	TPH (µg/L)
FDHCS440	February	<0.014	<0.014	<0.007	<0.014	<0.005	**0.080**	<0.054
	April	<0.014	<0.014	<0.007	<0.014	<0.005	**0.054**	<0.053
	June	<0.014	<0.014	<0.007	<0.014	<0.005	**0.059**	**0.072**
	August	NA	NA	NA	NA	NA	NA	NA
	October	<0.05	<0.05	<0.02	<0.05	<0.02	**0.28**	**0.89**
	December	<0.05	<0.05	<0.02	<0.05	<0.02	**0.26**	<0.50
HCS460	February	<0.014	<0.014	<0.007	<0.014	<0.005	**0.055**	**0.065**
	April	<0.014	<0.014	<0.007	<0.014	<0.005	**0.048**	**0.055**
	June	<0.014	<0.014	<0.007	<0.014	<0.005	**0.045**	**0.102**
	August	<0.014	<0.014	<0.007	<0.014	<0.005	**0.048**	**0.098**
	October	<0.05	<0.05	<0.02	<0.05	<0.02	**0.22**	**1.17**
	December	<0.05	<0.05	<0.02	<0.05	<0.02	**0.17**	<0.50
TCEQ Acute Surface Water Benchmark for Aquatic Life[†]		80	NE	5370	64	320*	3840	NE
TCEQ Chronic Surface Water Benchmark for Aquatic Life[†]		23	NE	1790	11	1.8*	1280	NE
Contact Recreation Water PCL[‡]		2440	3260	2350	2110	2080*	148	28,100**

Note: Field Duplicate for August sampling event was FDHCS420. All other events the Field Duplicate was from sample location FDHCS440.

µg/L – micrograms per liter

NA – Not analyzed

NE – Not established

PCL – Protective concentration level

TCEQ – Texas Commission on Environmental Quality

TPH – Total petroleum hydrocarbons

* Value for m-xylene presented

** Value for C>16-21 Aromatics presented for TPH

† Aquatic Life Surface Water Benchmark Table (TCEQ 2018)

‡ Contact Recreation Water PCL Table (TCEQ 2006)

5.1.4 Comal Springs Polar Organic Chemical Integrative Sampling

POCISs were installed at the farthest downstream sample location, HCS460, in the Comal Springs system in February, April, June, August, October, and December 2018.

Rain events did occur during all POCIS deployment periods during 2018. Figures 23–28 show conductivity and discharge for each POCIS deployment period.

No suitable regulatory standards are available to compare with POCIS results. However, the data may be used qualitatively to evaluate the presence of trace concentrations of PPCP constituents. Of the 43 PPCP constituents analyzed, 14 were detected. Positive detections are shown in Table 13.

Figure 23. Polar Organic Chemical Integrative Sampling (POCIS) – February 2018 Stream Discharge and Conductivity – Comal Springs Complex

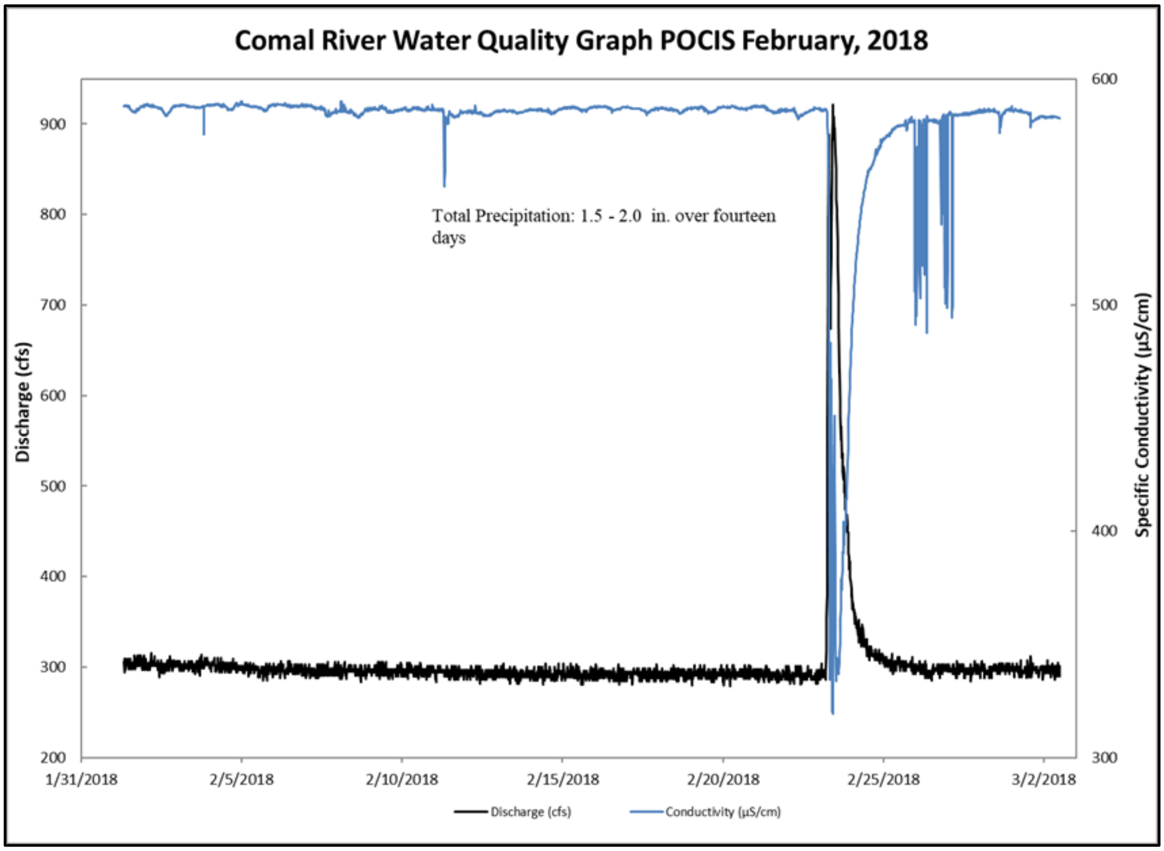


Figure 24. Polar Organic Chemical Integrative Sampling (POCIS) – April 2018 Discharge and Conductivity – Comal Springs Complex

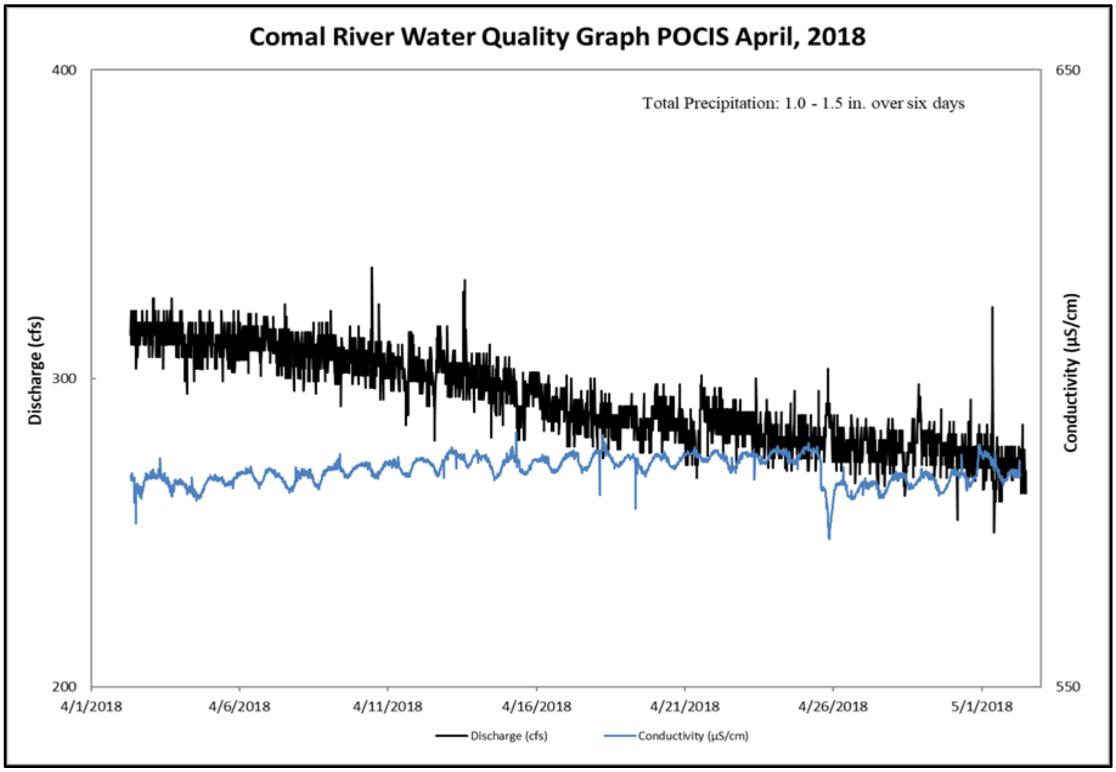


Figure 25. Polar Organic Chemical Integrative Sampling (POCIS) – June 2018 Stream Discharge and Conductivity – Comal Springs Complex

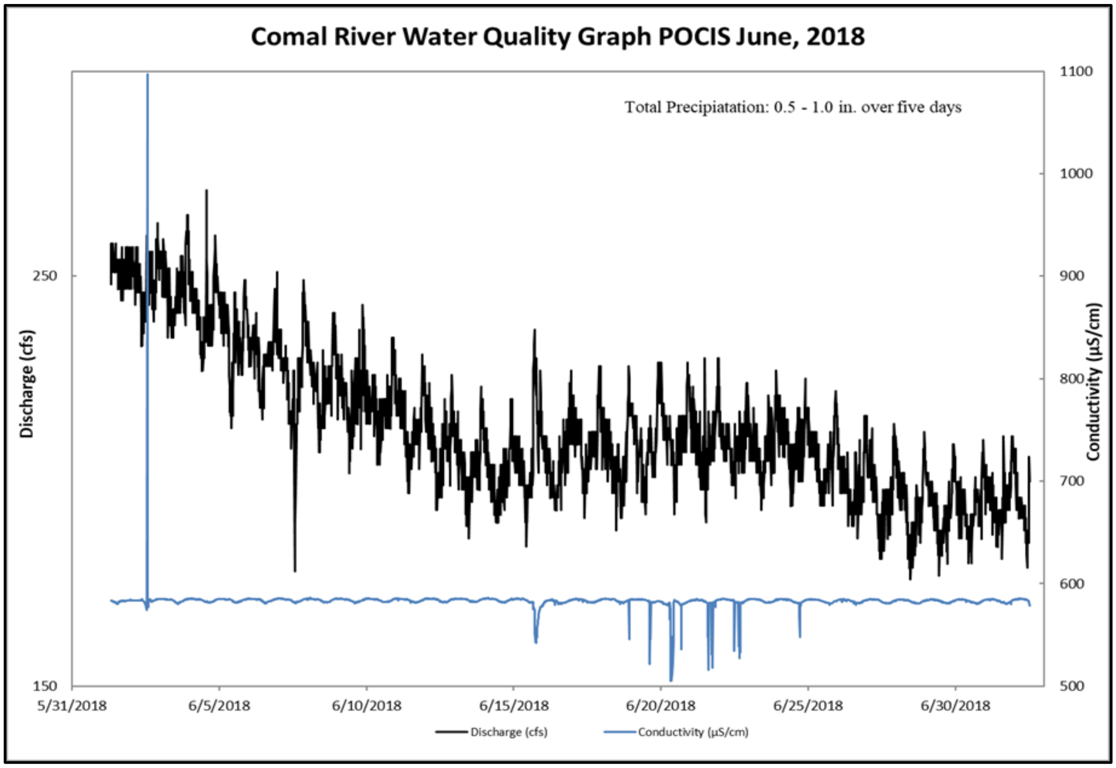


Figure 26. Polar Organic Chemical Integrative Sampling (POCIS) – August 2018 Stream Discharge and Conductivity – Comal Springs Complex

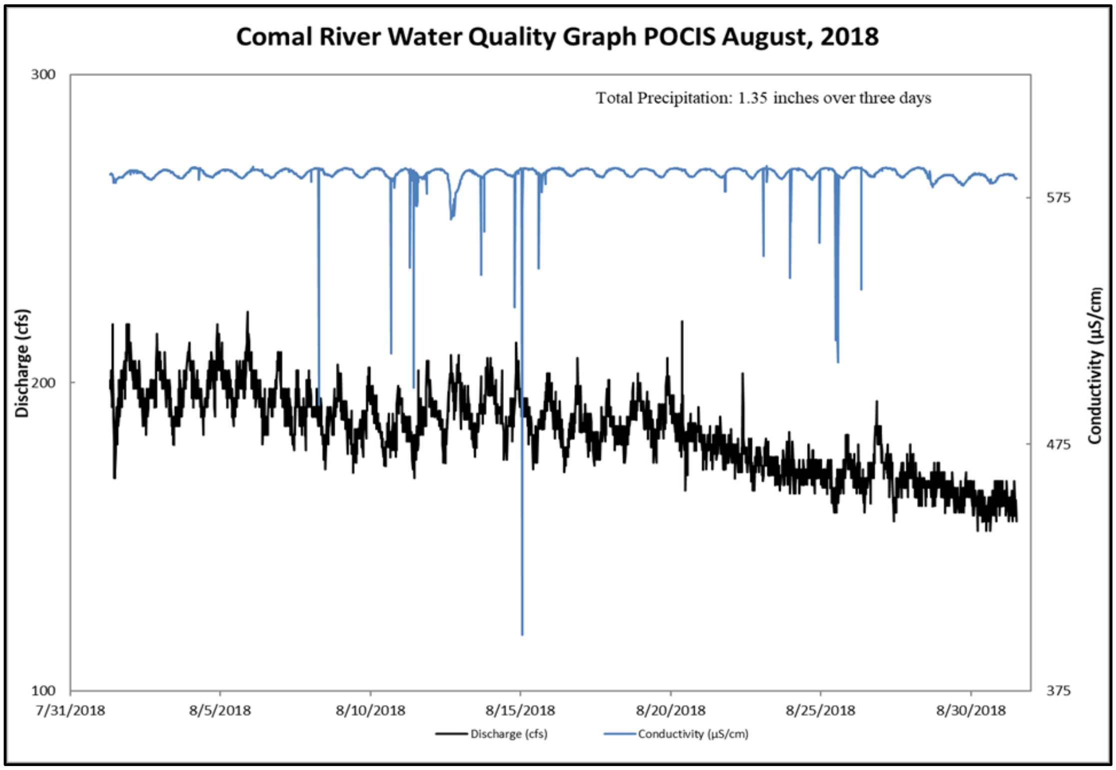


Figure 27. Polar Organic Chemical Integrative Sampling (POCIS) – October 2018 Stream Discharge and Conductivity – Comal Springs Complex

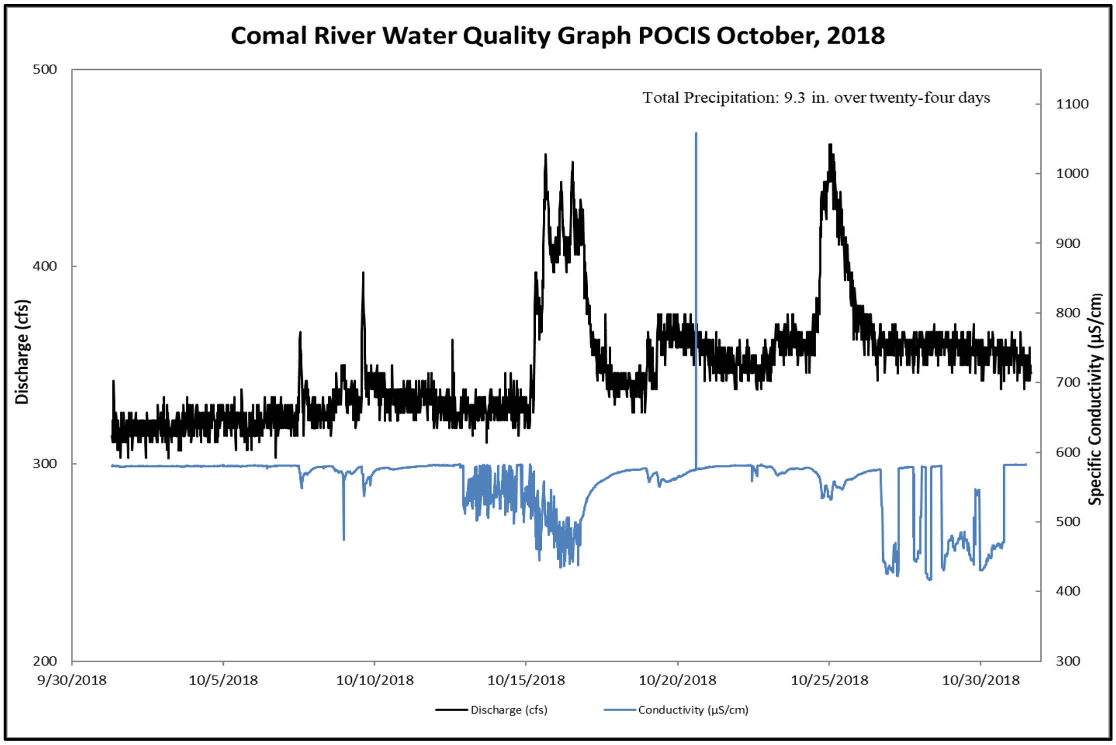


Figure 28. Polar Organic Chemical Integrative Sampling (POCIS) – December 2018 Stream Discharge and Conductivity – Comal Springs Complex

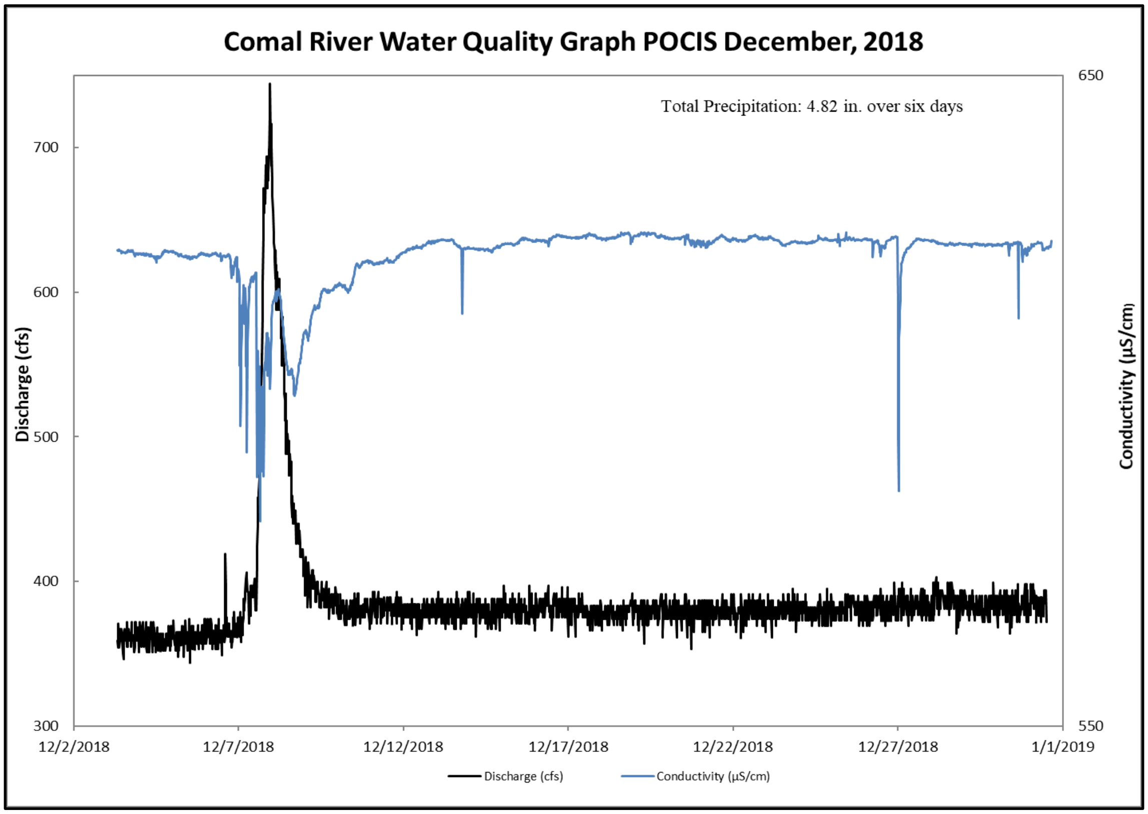


Table 13. Polar Organic Chemical Integrative Sampling – Pharmaceutical and Personal Care Products – Comal Springs Complex

Location	Month 2018	Testosterone (ng/L)	Bisphenol A (ng/L)	Ibuprofen (ng/L)	Naproxen (ng/L)	Triclosan (ng/L)	Caffeine (ng/L)	DEET (ng/L)	Galaxolide (HHCB) (ng/L)	Oxybenzone (ng/L)	Phenytoin (Dilantin) (ng/L)	Quinoline (ng/L)	Sucralose (ng/L)	TCEP (ng/L)	TCPP (ng/L)	TDCPP (ng/L)	Trimethoprim (ng/L)
HCS460	February	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	April	ND	7,700	1,200	NA	28,000	1,700	16,000	83,000	2,200	ND	ND	ND	2,100	150,000	8,600	ND
	June	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	August	ND	ND	26,000	28,000	43,000	4,000	130,000	99,000	49,000	ND	ND	ND	3,000	110,000	320,000	3,600
	October	ND	ND	5,400	5,600	60,000	4,500	11,000	110,000	2,800	ND	1,600	ND	11,000	120,000	58,000	ND
	December	ND	ND	ND	ND	17,000	ND	ND	63,000	1,500	ND	ND	ND	2,000	59,000	3,800	ND
Extraction Blank	February	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	April	ND	ND	ND	ND	16,000	ND	ND	29,000	ND	ND	ND	ND	ND	48,000	1,900	ND
	June	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	August	ND	ND	ND	ND	10,000	ND	ND	28,000	ND	ND	ND	ND	ND	34,000	2,700	ND
	October	ND	2,600	ND	ND	65,000	9,100	3,400	64,000	3,000	ND	10,000	ND	5,800	110,000	22,000	ND
	December	ND	8,800	1,400	ND	51,000	2,000	43,000	160,000	7,000	ND	2,100	ND	8,400	200,000	58,000	ND

DEET – N,N-Diethyl-meta-toluamide

HHCB – 1,3,4,6,7,8-Hexahydro-4,6,6,7,8,8-hexamethylcyclopenta--2-benzopyran

TCEP – Tris(2-carboxyethyl)phosphine

TCPP - Tris (chloropropyl)phosphate

TDCPP – Tris(1,3-dichloroisopropyl)phosphate

ng/L – nanograms per Liter

NA – Not analyzed

ND – Not detected

5.2 San Marcos Springs Sample Results

Sediments at the San Marcos Springs complex were sampled in June 2018. Sediment results were compared with the standards developed by McDonald et al. (2000). These standards are based on the probability of a detected compound having a toxic effect on sediment dwelling organisms and are referred to as the TEC and PEC. Detections below the TEC are not considered to be toxic, whereas detections above the PEC are considered to be toxic to sediment-dwelling organisms. Detections above the TEC but less than the PEC are considered to be equally likely to be toxic or nontoxic. Five SVOC analytes were detected in one sample, HSM320, that exceeded PEC values.

Stormwater events were sampled at the San Marcos Springs complex in May 2018 One sample, HSM270 Peak, exceeded the Acute Surface Water Benchmark for aquatic life for aluminum. Five samples—HSM230 Lead 1, HSM230 Lead 2, HSM240 Lead, HSM250 Lead, and HSM270 Lead—exceeded the Chronic Surface Water Benchmark for aquatic life for aluminum. One sample, HSM270 Trail, exceeded the Chronic Surface Water Benchmark for aquatic life for Copper. Five samples—HSM210 Trail, HSM230 Lead, HSM240 Lead, HSM240 Peak, and HSM270 Peak—exceeded the Chronic Surface Water Benchmark for aquatic life for Lead. Three samples, HSM230 Lead 1, HSM240 Lead, and HSM270 Peak, exceeded the Chronic Surface Water Benchmark for aquatic life for iron. No Surface Water Benchmarks for aquatic life were exceeded for VOCs, SVOCs, pesticides, herbicides, or PCBs. No Contact Recreation Water PCLs were exceeded for any analytes.

PDS sampling events were conducted at the San Marcos Springs complex in February, April, June, August, October, and December 2018. Generally speaking, various VOCs and TPH were detected at various sample locations, but only tetrachloroethene was relatively consistently detected. No Surface Water Benchmarks for aquatic life or Contact Recreation Water PCLs were exceeded.

POCIS sampling events were conducted at the San Marcos Springs complex in conjunction with the PDS sampling events at the downstream location HSM470. Of the 43 PPCP constituents analyzed, 13 were detected. However, some of the analytes detected were also detected in Extraction Blank samples.

5.2.1 San Marcos Springs Sediment Sampling

5.2.1.1 Sediment – Volatile Organic Compounds

VOCs were detected in sediment samples collected at three of the seven sample sites in the San Marcos Springs complex in 2018. Many of these detections were "J" flagged, indicating that the detected concentrations were less than the laboratory reporting limits but greater than the method detection limits. None of the detected compounds have established TEC and PECs. The detections are summarized in Table 14.

Table 14. Sediment Samples – Volatile Organic Compound Detections – San Marcos Springs Complex

Location	Date Collected	Acetone (µg/kg)	2-Butanone (µg/kg)	Carbon Disulfide (µg/kg)
HSM310	6/28/18	141	13.8 J	3.92 J
HSM340	6/28/18	38.3	3.69 J	2.10 J
HSM370	6/28/18	6.19 J	ND	ND
TEC		NE	NE	NE
PEC		NE	NE	NE

J – Detection is greater than the method detection limit, but less than the reporting limit
µg/kg – micrograms per kilogram
ND – Not detected
NE – Not established
PEC – Probable effect concentration
TEC – Threshold effect concentration

5.2.1.2 Sediment – Semi-volatile Organic Compounds

Several SVOC compounds were detected in the sediment samples collected in the San Marcos Springs system in 2018. Many of these detections were "J" flagged, indicating that the detected concentrations were less than the laboratory reporting limits but greater than the method detection limits. The discussion of SVOC detections presented below is divided between non-PAH and PAH compounds.

Non-Polycyclic Aromatic Hydrocarbon Detections

No non-PAH SVOC compounds were detected in any sediment samples during the June 2018 event.

From analysis of 2013 sediment sample laboratory data, the EAA concluded that three detected compounds may have been laboratory artifacts. The compounds were DEHP, di-n-octyl phthalate, and di-n-butyl phthalate. The EAA (2013) noted in the 2013 EAHCP Expanded Water Quality Report that as the data set grows, additional conclusions could be drawn. The 2014 laboratory analyses of sediment samples did not detect di-n-octyl phthalate or di-n-butyl phthalate. However, DEHP was detected in three of the sediment samples (HSM320, HSM330, and HSM350) in 2014 leading SWCA to conclude that it is possible DEHP is present within the sediment and not just a laboratory artifact. DEHP was detected again in three samples in 2015, HSM330, HSM340, and HSM350. In 2016, DEHP was detected in all San Marcos sediment samples except HSM310, with concentrations ranging from 0.0671 J mg/kg to 0.668 J mg/kg. All detections in 2016 were less than the laboratory reporting limit but were greater than the method detection limits. In the 2018 sampling event, DEHP, di-n-butyl phthalate, and di-n-octyl phthalate were not detected within the sediment samples.

Polycyclic Aromatic Hydrocarbon Detections

Nine PAH SVOC compounds were detected in 2018 sediment samples from the San Marcos Springs complex: benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(g,h,i)perylene, benzo(a)pyrene, chrysene, fluoranthene, indeno(1,2,3-cd)pyrene, and pyrene. The SVOC detections are summarized in Table 15. PAH compounds exceeding the TEC are shown graphically in Figures 29–33. Total PAH detections are shown in Figure 34, where the total PAH concentrations (sum of all detected concentrations for each sample point) are compared with the TEC and PEC values for total PAH concentration established by MacDonald et al. (2000). Sample locations HSM320, HSM330, HSM340, and HSM350 exceed the TEC and PEC for total PAH concentrations.

Table 15. Semi-volatile Organic Compounds – San Marcos Springs Complex

Location	Date Collected	Benzo(a)anthracene (mg/kg)	Benzo(a)pyrene (mg/kg)	Benzo(b)fluoranthene (mg/kg)	Benzo(g,h,i)perylene (mg/kg)	Benzo(k)fluoranthene (mg/kg)	Chrysene (mg/kg)	Fluoranthene (mg/kg)	Indeno(1,2,3-cd)pyrene (mg/kg)	Pyrene (mg/kg)	Total PAH (mg/kg)
HSM320	6/28/18	3.88 J	3.86 J	5.62	3.11 J	1.93 J	4.30 J	6.81	4.70 J	5.50	39.71
HSM330	6/28/18	ND	ND	0.743 J	ND	ND	ND	ND	ND	ND	0.743
HSM340	6/28/18	ND	ND	1.53 J	ND	0.667 J	ND	ND	ND	ND	2.197
HSM350	6/28/18	ND	ND	0.340 J	ND	ND	ND	ND	ND	ND	0.340
TEC		0.108	0.150	NE	NE	NE	0.166	0.423	NE	0.195	1.610
PEC		1.050	1.450	NE	NE	NE	1.290	2.230	NE	1.520	22.800

J – Detection is greater than the method detection limit but less than the reporting limit

mg/kg – milligrams per kilogram

ND – Not detected

NE – Not established

PAH – polycyclic aromatic hydrocarbon

PEC – Probable effect concentration

TEC – Threshold effect concentration

Figure 29. San Marcos Springs Sediment Benzo(a)Anthracene Detections Compared to Threshold Effect Concentration (TEC) and Probable Effect Concentration (PEC) Values

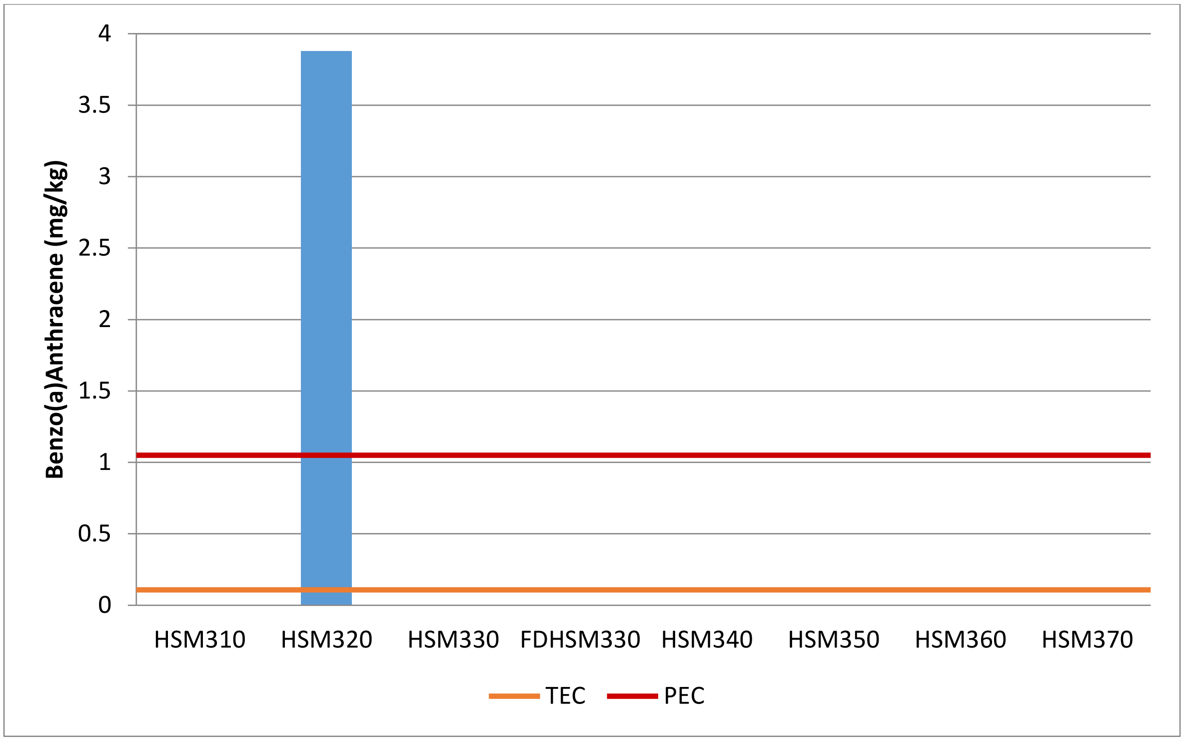


Figure 30. San Marcos Springs Sediment Benzo(a)Pyrene Detections Compared to Threshold Effect Concentration (TEC) and Probable Effect Concentration (PEC) Values

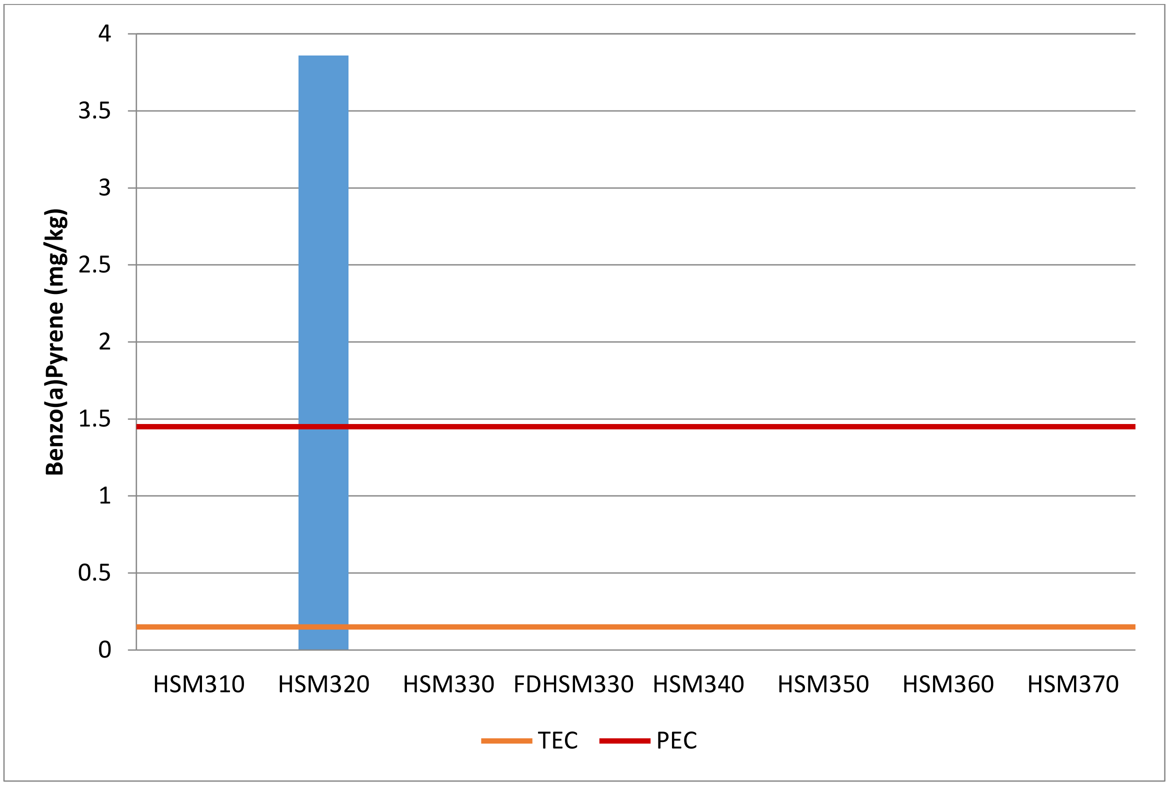


Figure 31. San Marcos Springs Sediment Chrysene Detections Compared to Threshold Effect Concentration (TEC) and Probable Effect Concentration (PEC) Values

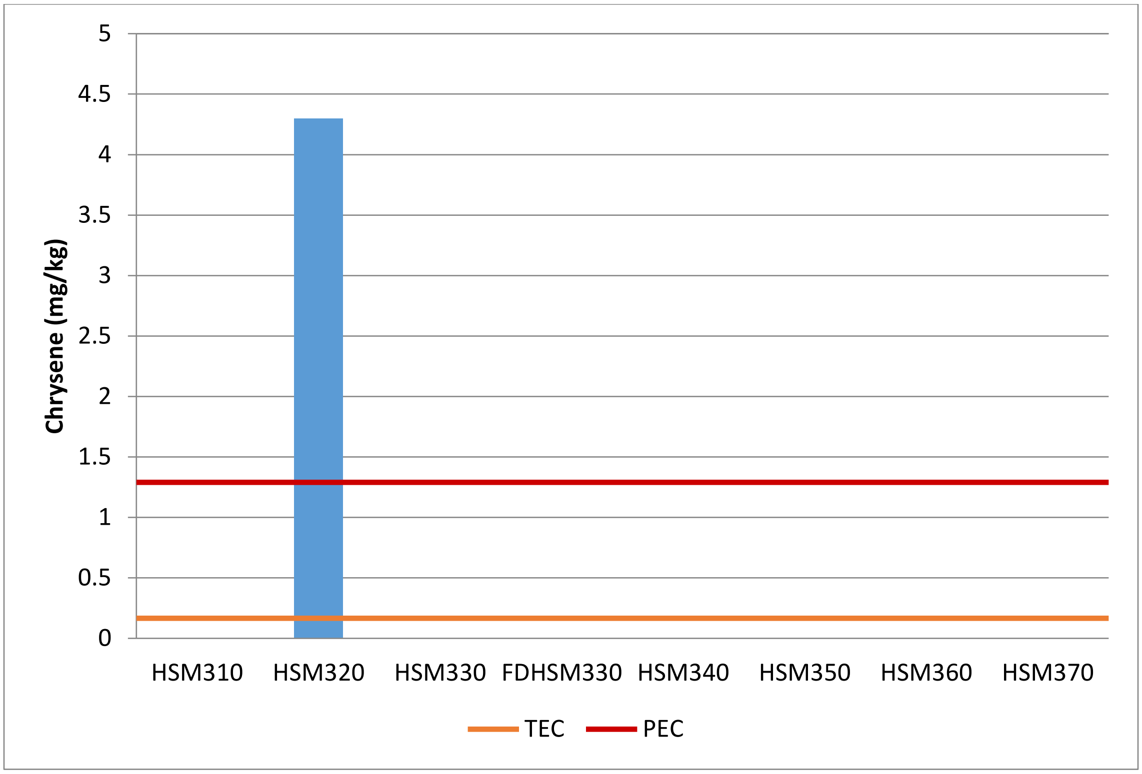


Figure 32. San Marcos Springs Sediment Fluoranthene Detections Compared to Threshold Effect Concentration (TEC) and Probable Effect Concentration (PEC) Values

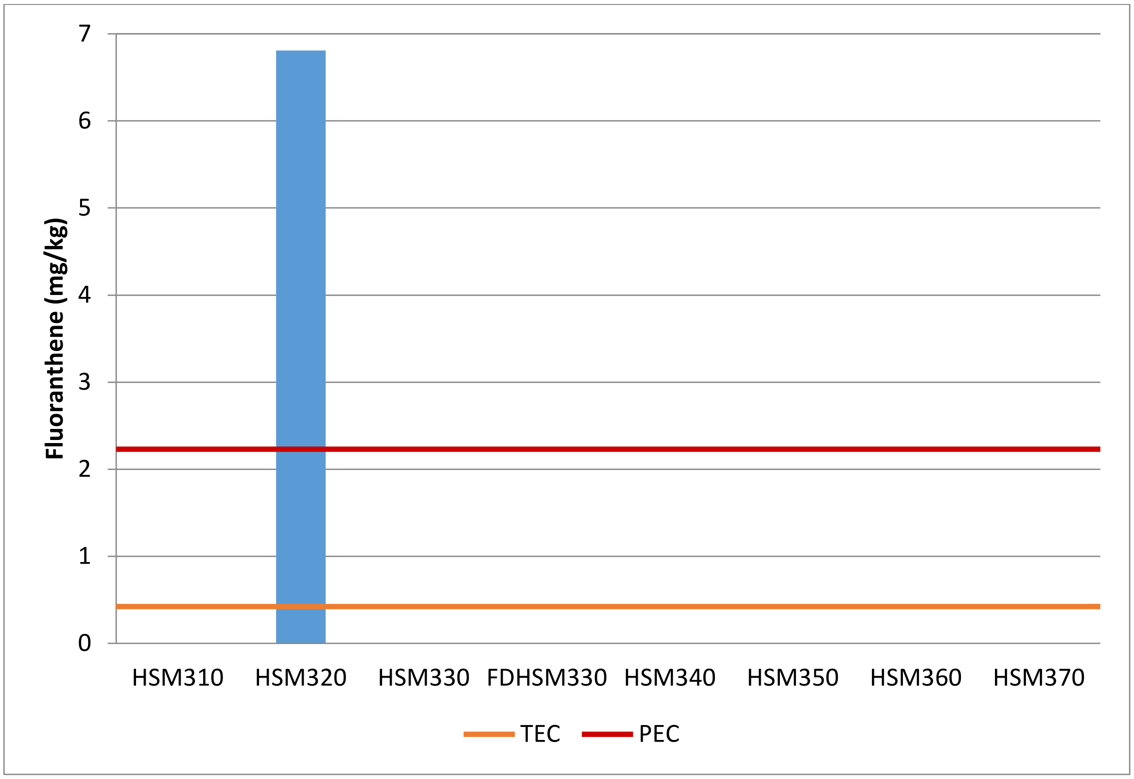


Figure 33. San Marcos Springs Sediment Pyrene Detections Compared to Threshold Effect Concentration (TEC) and Probable Effect Concentration (PEC) Values

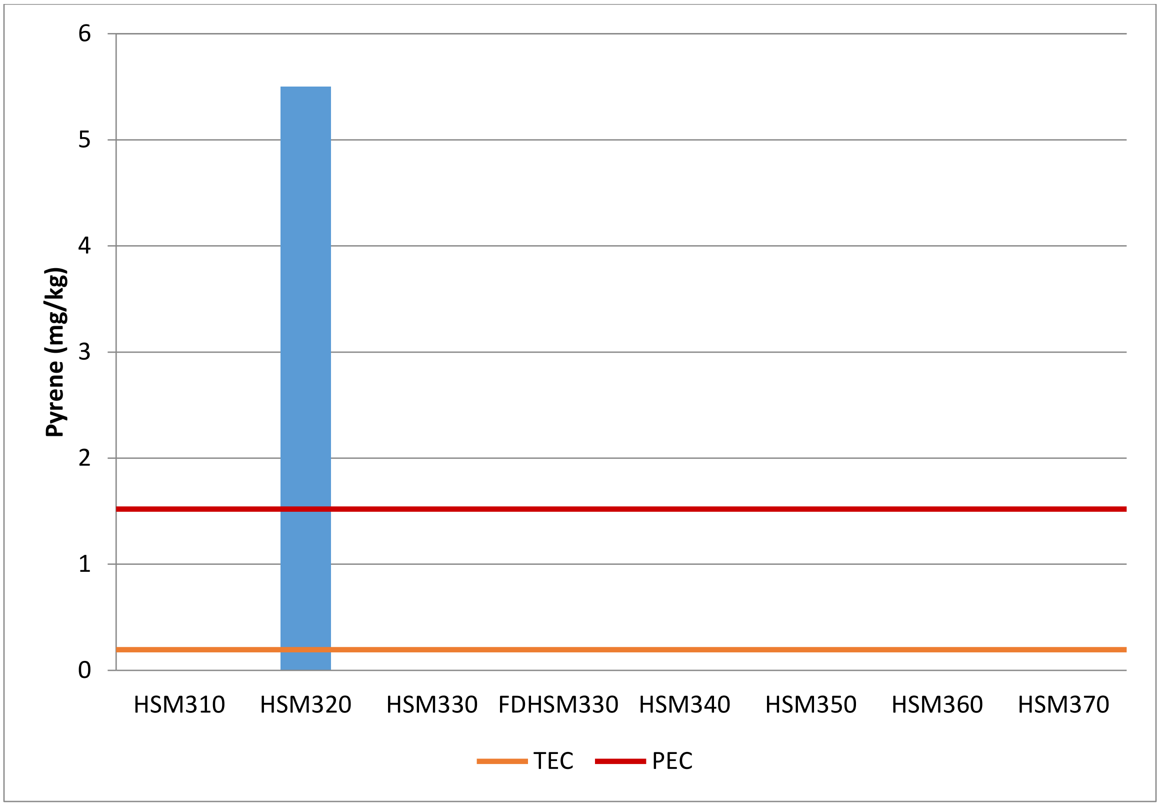
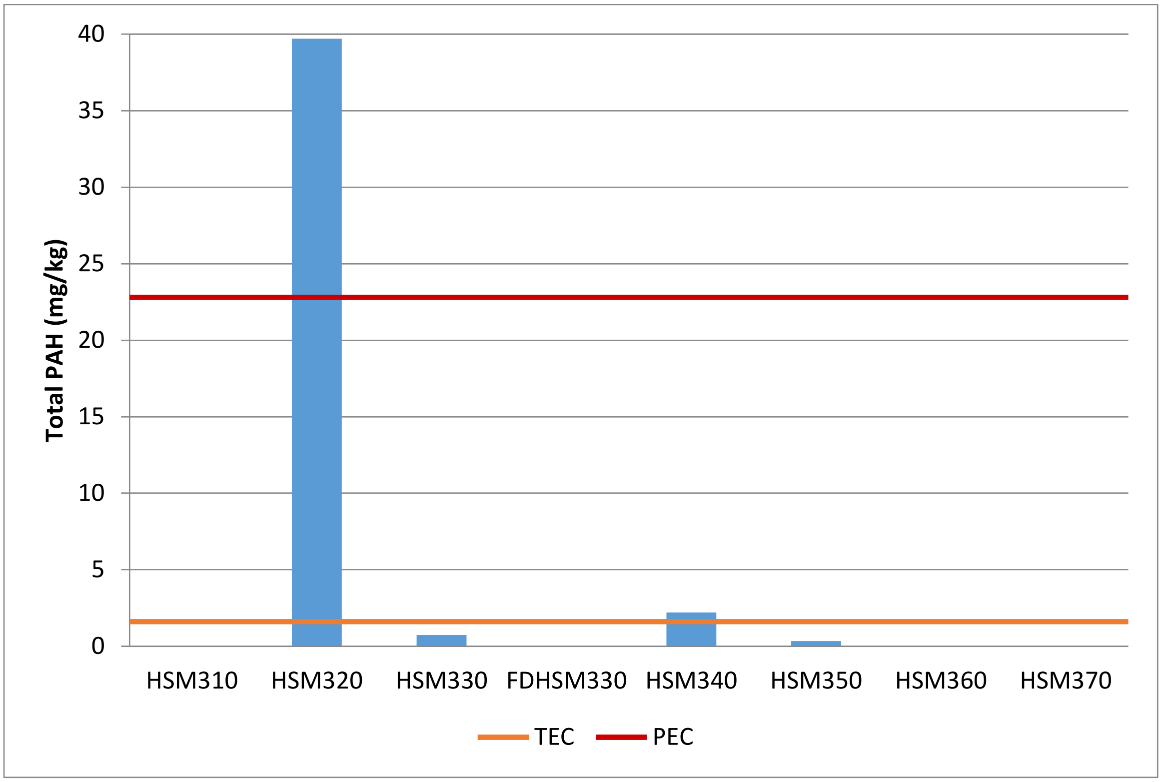


Figure 34. San Marcos Springs Sediment Total Polycyclic Aromatic Hydrocarbon (PAH) Detections Compared to Threshold Effect Concentration (TEC) and Probable Effect Concentration (PEC) Values



5.2.1.3 Sediment – Pesticides

Sediment samples were analyzed for both organochlorine and organophosphorus pesticides. Organochlorine pesticides were detected in the San Marcos Springs sediment samples in 2018 at HSM340. The TEC for 4,4-DDE was exceeded at HSM340. Concentrations are listed in Table 16. TEC and PEC exceedances are shown graphically in Figures 35 and 36.

Table 16. Sediment Samples – Pesticide Detections – San Marcos Springs Complex

Location	Date Collected	4,4-DDD (µg/kg)	4,4-DDE (µg/kg)
HSM340	6/28/18	3.92 J	6.13
TEC		4.88	3.16
PEC		28	31.3

J – Detection is greater than the method detection limit but less than the reporting limit

µg/kg – micrograms per kilogram

PEC – Probable effect concentration

TEC – Threshold effect concentration

Figure 35. San Marcos Springs Sediment 4,4-DDD Detections Compared to Threshold Effect Concentration (TEC) and Probable Effect Concentration (PEC) Values

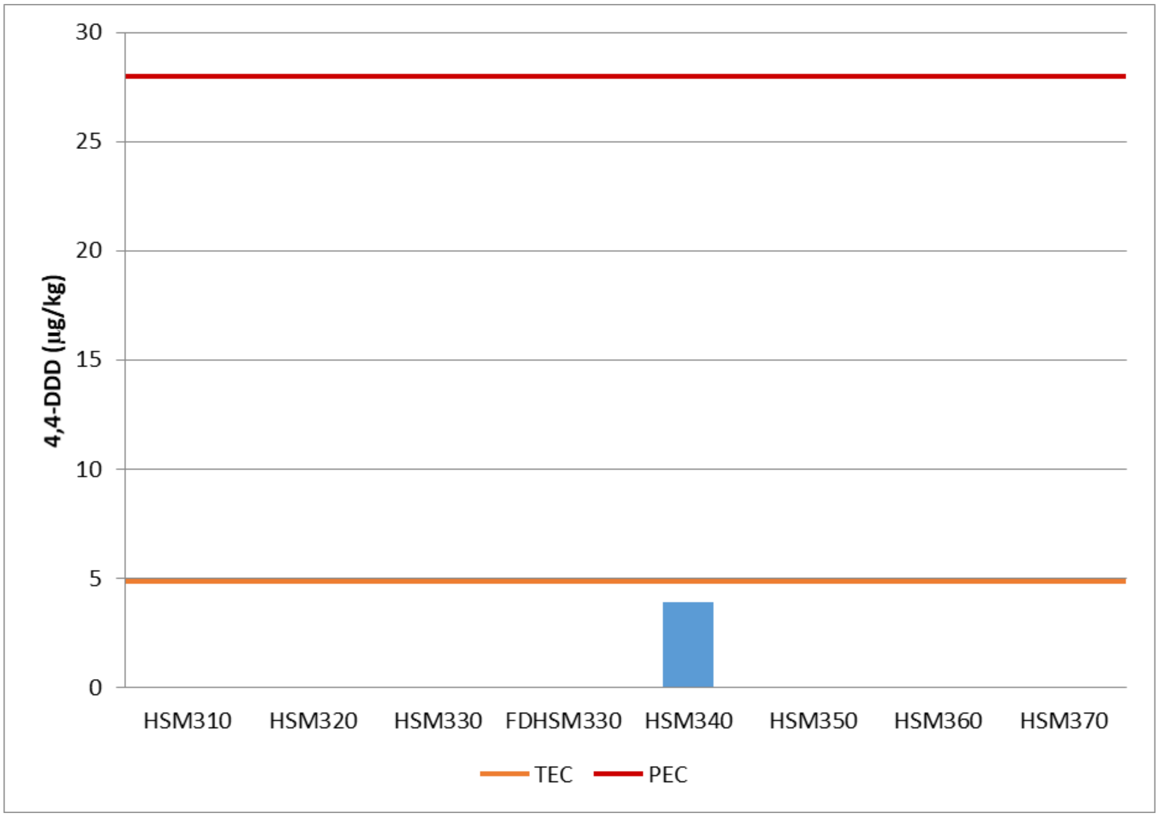
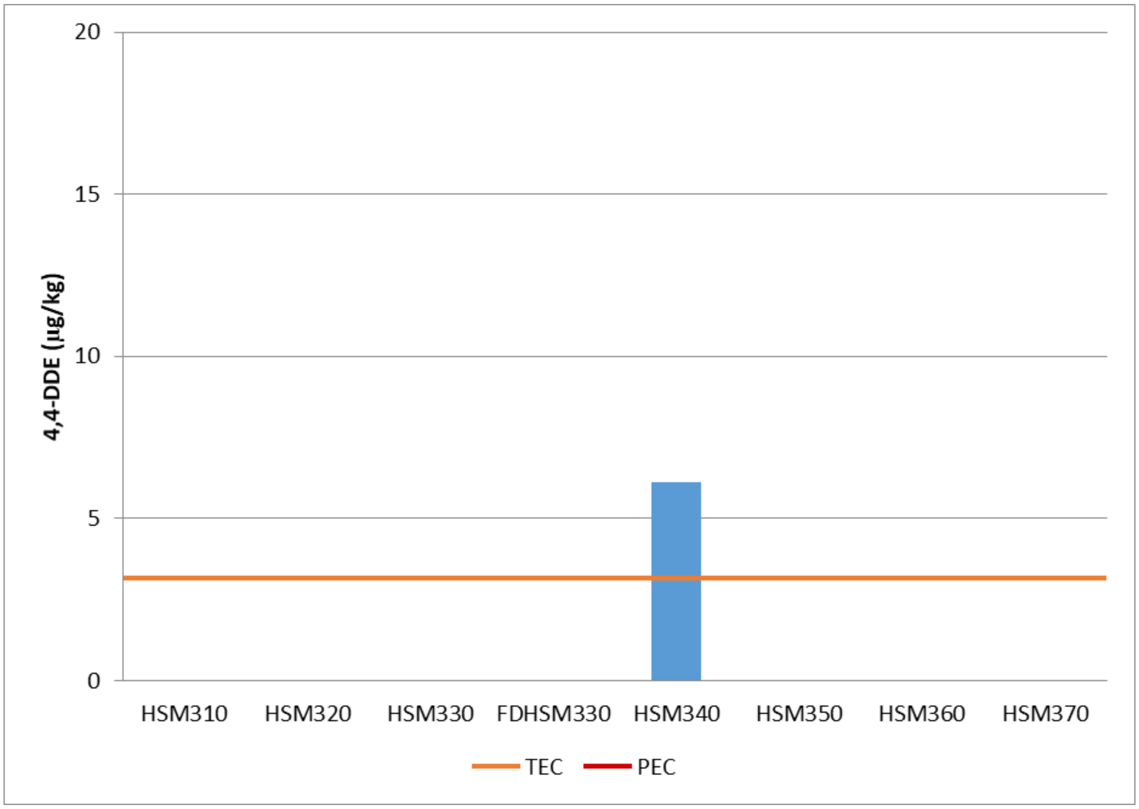


Figure 36. San Marcos Springs Sediment 4,4-DDE Detections Compared to Threshold Effect Concentration (TEC) and Probable Effect Concentration (PEC) Values



5.2.1.4 Sediment – Herbicides

Sediments were analyzed for herbicide compounds to further assess sediment quality at the San Marcos Springs complex. No herbicides were detected in any of the sediment samples from the seven sites in the San Marcos Springs complex.

5.2.1.5 Sediment – Polychlorinated Biphenyls

Sediments were analyzed for PCB compounds to further assess sediment quality at the San Marcos Springs complex. No PCBs were detected in any of the sediment samples from the seven sites in the San Marcos Springs complex.

5.2.1.6 Sediment – Metals

Many metals are naturally occurring within soil, rock, and sediment. Sediment sample results for metals at the San Marcos Springs complex tested positive for several metals, generally at low concentrations. Metals detected above the method detection limit and subsequently evaluated in this report for potential toxic effects using the TEC and PEC standards are as follows: arsenic, cadmium, chromium, copper, lead, manganese, mercury, nickel, and zinc. Other metals detected that do not have a TEC or PEC value available are aluminum, antimony, barium, beryllium, iron and selenium which were compared with TSBC (TCEQ 2014b). Several samples exceeded one or more of these limits in 2018. Lead detections exceeded the TSBC in samples FDHSM330, HSM340, and HSM370. The manganese detection exceeded the TSBC at HSM370. The zinc concentration exceeded the TSBC in samples HSM310, HSM320, HSM340, and HSM370.

All selenium detections, except those from samples HSM330 and FDHSM330, were above the TSBC level of 0.3 mg/kg. Sediment studies of selenium concentrations have shown that levels below 4 mg/kg are not likely to bioaccumulate in the food chain or have adverse impacts on the reproduction of fish or aquatic birds (Lemly 1995; Moore et al. 1990; Van Derveer and Canton 1996). Selenium detections did not exceed 4 mg/kg in 2018 San Marcos sediment samples.

Metal detections are listed in Table 17. Metals with detections above an established TEC, TSBC, or PEC value for arsenic, lead, manganese, mercury, selenium, and zinc are displayed graphically in Figures 37–42, respectively.

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Table 17. Sediment Samples – Metal Detections – San Marcos Springs Complex

Location	Date Collected	Aluminum (mg/kg)	Antimony (mg/kg)	Arsenic (mg/kg)	Barium (mg/kg)	Beryllium (mg/kg)	Calcium (mg/kg)	Cadmium (mg/kg)	Chromium (mg/kg)	Copper (mg/kg)	Iron (mg/kg)	Lead (mg/kg)	Manganese (mg/kg)	Magnesium (mg/kg)	Mercury (mg/kg)	Nickel (mg/kg)	Potassium (mg/kg)	Selenium (mg/kg)	Sodium (mg/kg)	Strontium (mg/kg)	Thallium (mg/kg)	Zinc (mg/kg)
HSM310	6/28/18	7610	0.434	5.18	39.8 B	0.541	60000	0.423 J	12.7	8.26	9640	12.7	261 B	1800	0.0459	9.02	1700	1.78 J	87.5 J	104	ND	38.4 B
HSM320	6/28/18	3590	0.722 J	2.60	31.1 B	0.285 J	74800	0.214 J	5.34	8.06	6510	14.6	136 B	1460	0.023 J	5.11	1430	0.681 J	116 J	127	ND	38.2 B
HSM330	6/28/18	422	0.955 J	5.60	12.0 B	0.102 J	312000 B	0.142 J	2.24	2.36	6240	4.49	120 B	2060	0.00425 J	4.03	275	0.293	87.4 J	177	ND	11.2 B
FDHSM330	6/28/18	1360 B	0.393 J	5.96	23.5 B	0.212 J	273000 B	0.199 J	6.65	5.99	8610	6.22	260	2510	0.00705 J	5.42	241	ND	93.7 J B	120 B	0.657 J	27.0
HSM340	6/28/18	1490	0.568 J	9.79	12.4 B	0.134 J	270000 B	0.238 J	6.44	4.03	5950	26.1	108 B	4540	0.019 J	5.71	361	0.316	136	147	ND	33.8 B
HSM350	6/28/18	2310 B	ND	3.15	19.3 B	0.181 J	171000 B	0.179 J	5.65	4.24	4390	12.4	219	1510	0.167	4.81	444	0.395	135 J B	132 B	ND	19.0
HSM360	6/28/18	2800	ND	3.38	19.9 B	0.191 J	260000 B	0.299	5.57	2.59	6420	127	185 B	3050	0.00413	4.24	509	0.310	151	153	ND	26.1 B
HSM370	6/28/18	6750	0.448 J	5.78	35.7 B	0.360	223000 B	0.418	8.37	4.26	8550	19.7	330 B	1910	0.0157 J	8.43	1010	0.333	135	159	ND	37.8 B
TEC		NE	NE	9.79	NE	NE	NE	0.99	43.4	31.6	NE	35.8	460	NE	0.18	22.7	NE	NE	NE	NE	NE	121
PEC		NE	NE	33	NE	NE	NE	4.98	111	149	NE	128	1100	NE	1.06	48.6	NE	NE	NE	NE	NE	459
TSBC		30000	1	5.9	300	1.5	NE	NE	NE	15	15000	15	300	NE	0.04	10	NE	0.3	NE	100	NE	30

B – Compound was found in the laboratory blank and sample

J – Detection is greater than the method detection limit, but less than the reporting limit

mg/kg – milligrams per kilogram

NE – Not established

ND – Not detected above laboratory minimum detection limit

PEC – Probable effect concentration

TEC – Threshold effect concentration

TSBC – Texas-specific background concentration

Figure 37. San Marcos Springs Sediment Arsenic Detections Compared to Texas-specific Background Concentration (TSBC), Threshold Effect Concentration (TEC), and Probable Effect Concentration (PEC) Values

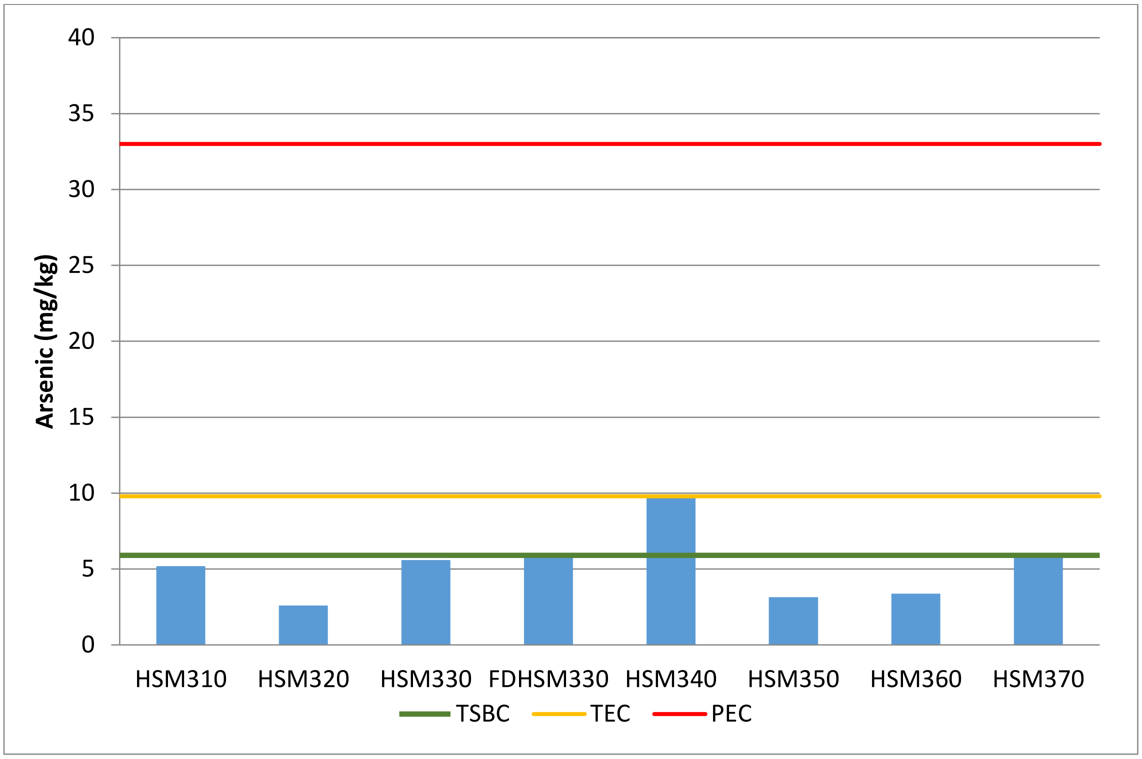


Figure 38. San Marcos Springs Sediment Lead Detections Compared to Texas-specific Background Concentration (TSBC), Threshold Effect Concentration (TEC), and Probable Effect Concentration (PEC) Values

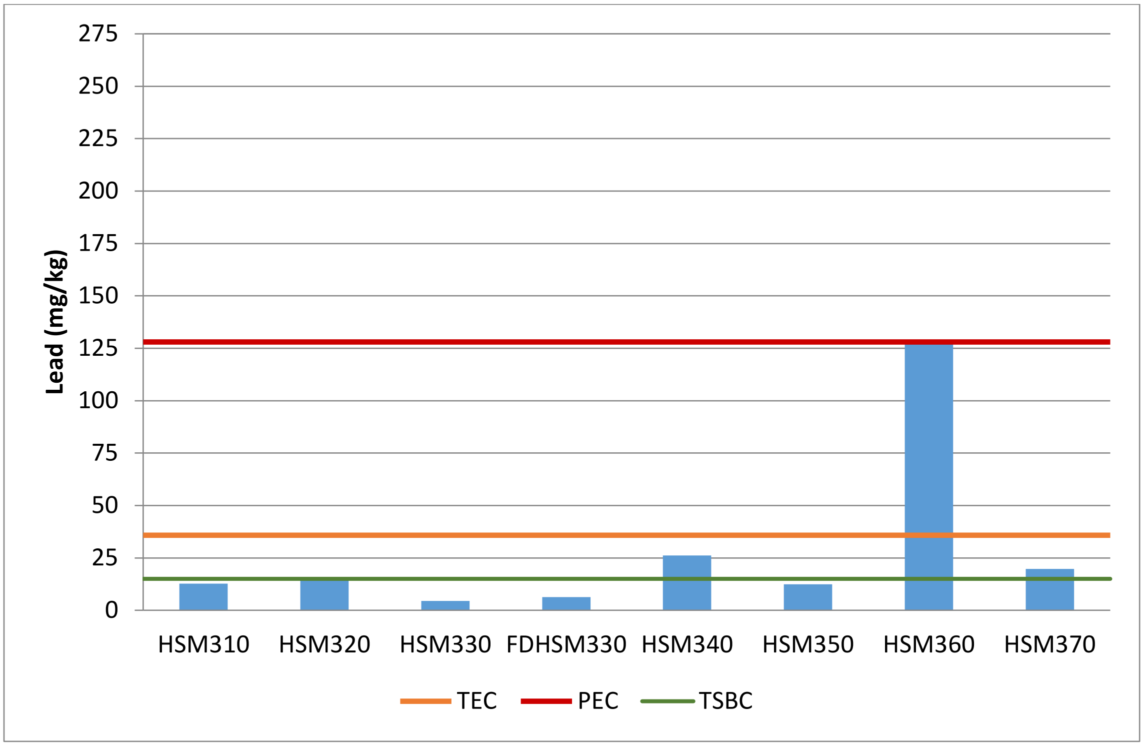


Figure 39. San Marcos Springs Sediment Manganese Detections Compared to Texas-specific Background Concentration (TSBC), and Threshold Effect Concentration (TEC), and Probable Effect Concentration (PEC) Values

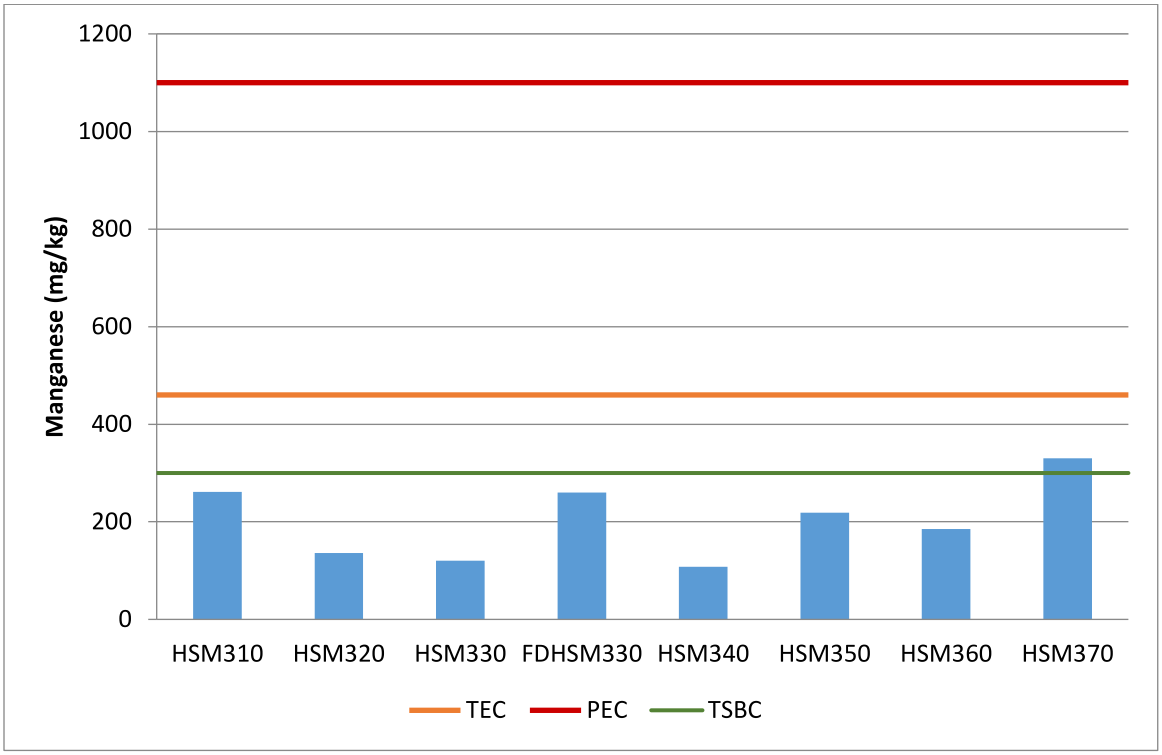


Figure 40. San Marcos Springs Sediment Mercury Detections Compared to Texas-specific Background Concentrations (TSBC), Threshold Effect Concentration (TEC), and Probable Effect Concentration (PEC) Values

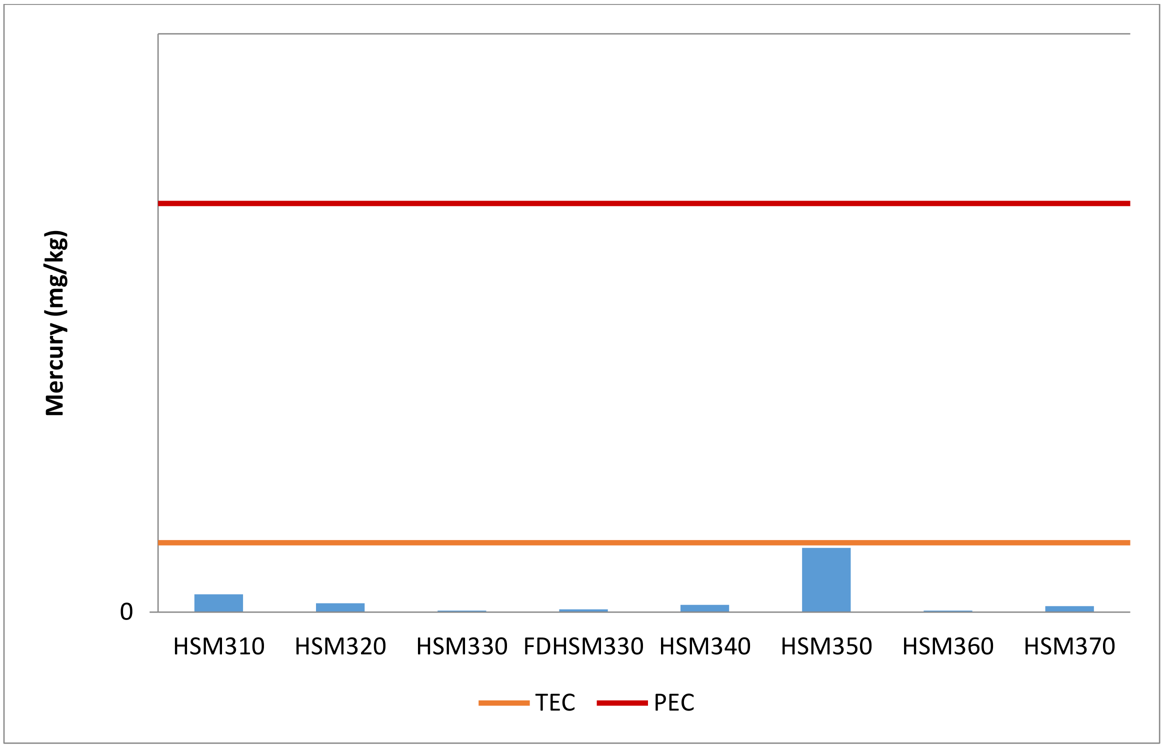


Figure 41. San Marcos Springs Sediment Selenium Detections Compared to Texas-specific Background Concentration (TSBC) and Possible Bioaccumulation Level

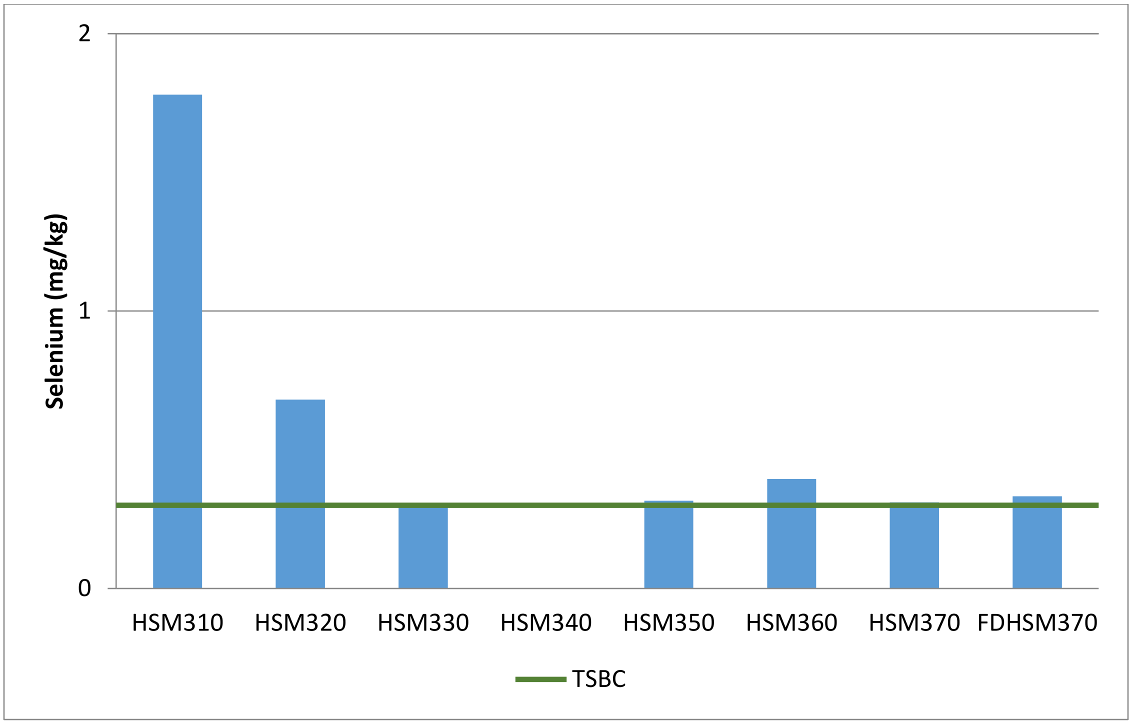
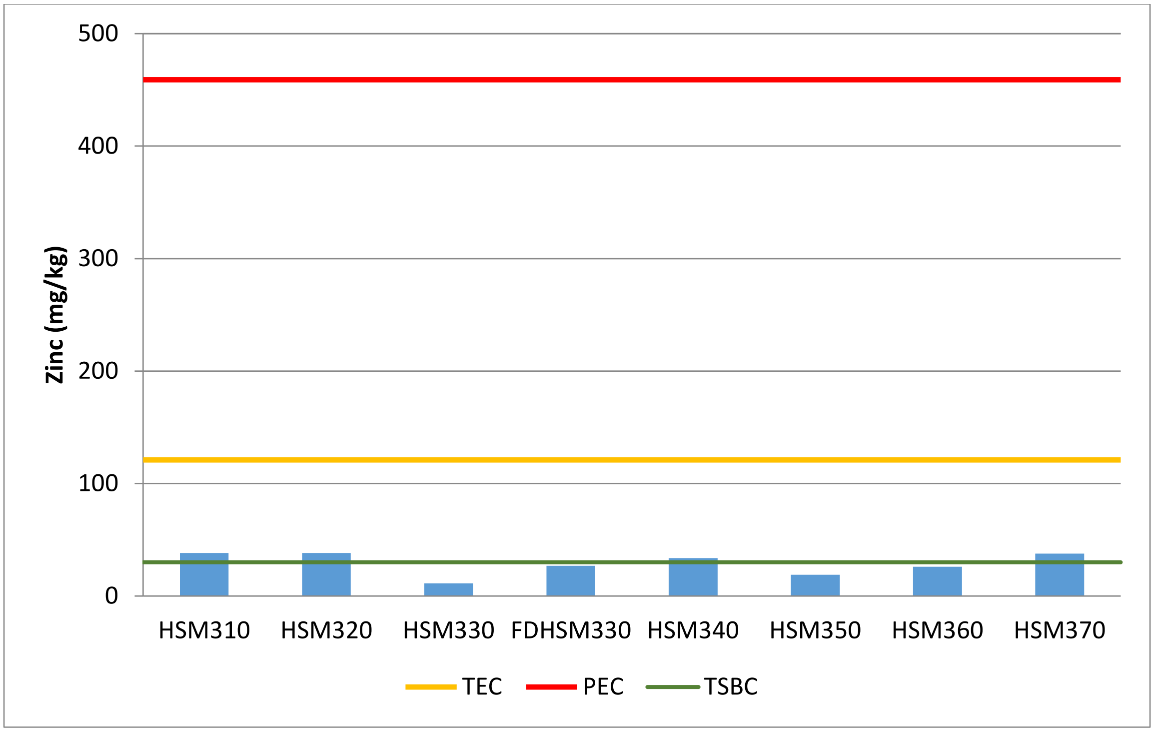


Figure 42. San Marcos Springs Sediment Zinc Detections Compared to Texas-specific Background Concentration (TSBC), Threshold Effect Concentration (TEC), and Probable Effect Concentration (PEC) Values



5.2.2 San Marcos Springs Stormwater Sampling

Stormwater samples were collected during one storm event at the San Marcos Springs complex in 2018. The event was sampled according to the guidelines in the EAHCP Work Plan. The sampling event occurred on May 4, 2018. Total rainfall for the event was approximately 1.0 to 1.5 inches (NOAA 2018). The streamflow measured at USGS Gauge 08170500 increased from 170 cfs to 310 cfs during the event (USGS 2018).

5.2.2.1 Stormwater – Bacteria Detections

Stormwater samples collected and analyzed for bacteria analyses generally tested positive for high levels of bacteria. The 2014 Texas Surface Water Quality Standard for *E. coli* in primary recreation waters is a geometric mean of 126 MPN/100 mL, with no individual sample exceeding 399 MPN/100 mL (30 TAC 307.7). The geometric mean for stormwater samples collected from the San Marcos Springs complex in May 2018 was approximately 6,717 MPN/100 mL. Bacteria counts ranged from 100 MPN/100 mL to 37,000 MPN/100 mL, with the majority of samples exceeding the individual sample limit. Individual detections are listed in Table 18 and shown in relation to stream discharge and specific conductivity in Figure 43. Due to the timing of storm events and laboratory working hours, it was not possible to deliver all samples to the laboratory within sample holding times (see discussion in Appendix C). Samples exceeding hold times were included in the range and geometric mean calculations.

Table 18. Stormwater Samples – Bacteria Counts – San Marcos Springs Complex

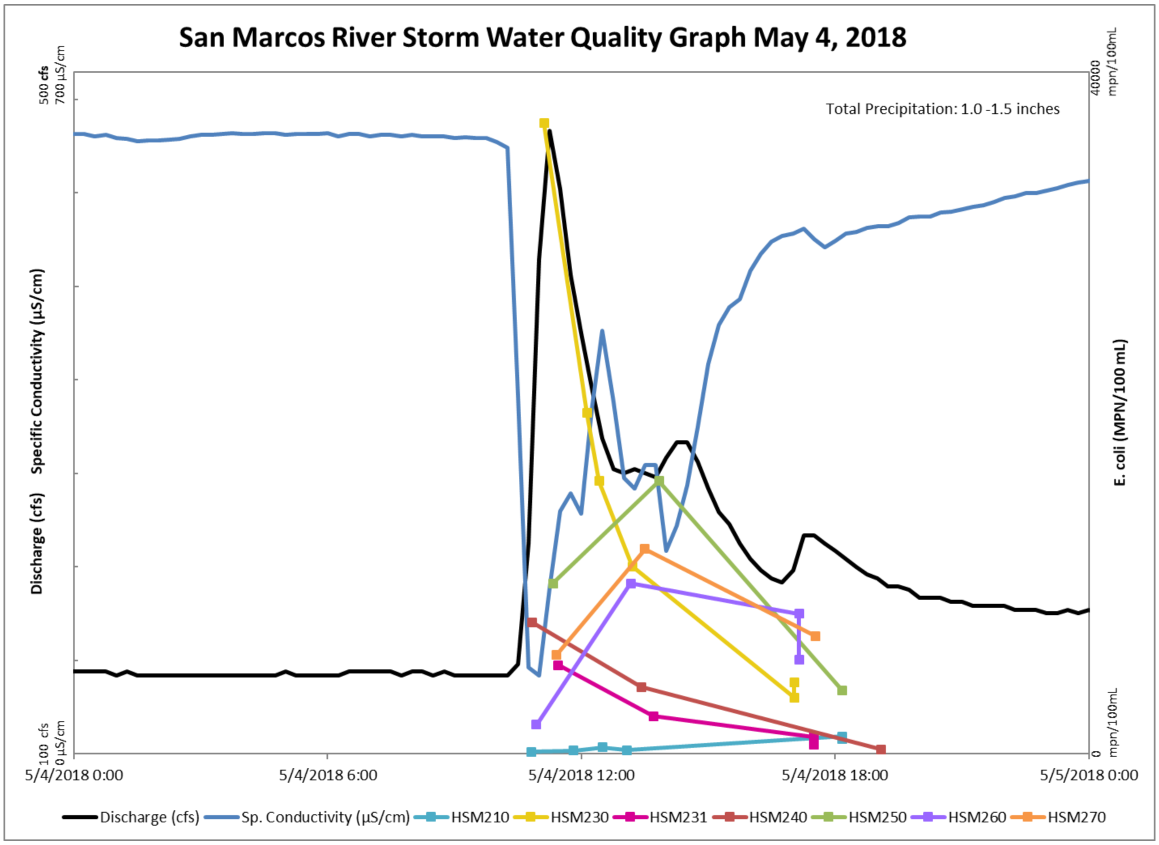
Location	Date	Concentration (MPN/100 mL)
HSM210 Lead 1	5/4/2018	100
HSM210 Lead 2	5/4/2018	190
HSM210 Lead 3	5/4/2018	380
HSM210 Peak	5/4/2018	210
HSM210 Trail	5/4/2018	1000 H
FDHSM210 Trail	5/4/2018	870 H
HSM230 Lead 1	5/4/2018	37000
HSM230 Lead 2	5/4/2018	20000
HSM230 Lead 3	5/4/2018	16000
HSM230 Peak	5/4/2018	11000
HSM230 Trail	5/4/2018	3300 H
FDHSM230 Trail	5/4/2018	4200 H
HSM231 Lead	5/4/2018	5200
HSM231 Peak	5/4/2018	2200
HSM231 Trail	5/4/2018	980 H
FDHSM231 Trail	5/4/2018	520 H
HSM240 Lead	5/4/2018	7700
HSM240 Peak	5/4/2018	3900
HSM240 Trail	5/4/2018	250 H
HSM250 Lead	5/4/2018	10000
HSM250 Peak	5/4/2018	16000

Location	Date	Concentration (MPN/100 mL)
HSM250 Trail	5/4/2018	3700 H
HSM260 Lead	5/4/2018	1700
HSM260 Peak	5/4/2018	10000
HSM260 Trail	5/4/2018	8200 H
FDHSM260 Trail	5/4/2018	5500 H
HSM270 Lead	5/4/2018	5800
HSM270 Peak	5/4/2018	12000
HSM270 Trail	5/4/2018	6900 H

H – Analyzed outside hold time; result included for comparison but not considered valid

MPN/100 mL – Most probable number per 100 milliliters of water

Figure 43. Stormwater Samples – May 2018 Bacteria Counts in Relation to Stream Discharge and Specific Conductivity – San Marcos Springs Complex



5.2.2.2 Stormwater – Volatile Organic Compounds

One VOC compound, acetone, was detected in several stormwater samples from the May 2018 sampling event. All these detections were less than the Surface Water Benchmarks for aquatic life and the Contact Recreation Water PCLs. HSM231 had three detections, 0.179 ug/L of 1,2-dichloroethane, 5.61 ug/L of methylene chloride, and 21.6 ug/L of acetone. All the detections were less than the Surface Water Benchmarks for aquatic life and the Contact Recreation Water PCLs.. The detections are summarized in Table 19.

Table 19. Stormwater Samples – Volatile Organic Compound Detections – San Marcos Springs Complex

Location	Date	Acetone (ug/L)	1,2-Dichloroethane (ug/L)	Methylene Chloride (ug/L)
HSM210 Lead 1	5/04/2018	36.1	ND	ND
HSM210 Lead 2	5/04/2018	22.4	ND	ND
HSM210 Peak	05/04/2018	34.4	ND	ND
FDHSM210 Trail	05/04/2018	5.18 J	ND	ND
HSM230 Lead 1	05/04/2018	10.3	ND	ND
HSM230 Lead 2	5/04/2018	26.1	ND	ND
HSM230 Lead 3	5/04/2018	6.72 J	ND	ND
HSM230 Peak	05/04/2018	35.2	ND	ND
HSM230 Trail	05/04/2018	14.7	ND	ND
FDHSM230 Trail	05/04/2018	26.2	ND	ND
HSM231 Lead	5/04/2018	6.16 J	ND	ND
HSM231 Peak	05/04/2018	34.0	ND	ND
HSM231 Trail	05/04/2018	21.6	0.179 J	5.61 J B
HSM240 Lead	5/04/2018	30.2	ND	ND
HSM240 Peak	5/04/2018	29.3	ND	ND
HSM250 Lead	5/04/2018	36.4	ND	ND
HSM250 Peak	5/04/2018	29.4	ND	ND
HSM250 Trail	5/04/2018	5.13 J	ND	ND
HSM260 Lead	5/04/2018	12.8	ND	ND
HSM260 Peak	5/04/2018	35.0	ND	ND
HSM260 Trail	5/04/2018	32.9	ND	ND
FDHSM260 Trail	5/04/2018	26.4	ND	ND
HSM270 Lead	5/04/2018	21.6	ND	ND
HSM270 Peak	5/04/2018	8.05 J	ND	ND
HSM270 Trail	5/04/2018	37.5	ND	ND
TCEQ Acute Surface Water Benchmark for Aquatic Life†		607,400	37,680	66,000
TCEQ Chronic Surface Water Benchmark for Aquatic Life†		101,200	12,560	22,000
Contact Recreation Water PCL‡		780,000	196	3,370

B – Compound was found in the laboratory blank and sample

J – Detection is greater than the method detection limit, but less than the reporting limit

µg/L – micrograms per liter

ND – Not detected

PCL – Protective concentration level

TCEQ – Texas Commission on Environmental Quality

† Aquatic Life Surface Water Benchmark Table (TCEQ 2018)

‡ Contact Recreation Water PCL Table (TCEQ 2006)

5.2.2.3 Stormwater – Semi-volatile Organic Compounds

Stormwater samples were collected and analyzed for SVOCs. One SVOC, DEHP, was detected in FDHSM230 Trail at a concentration of 17.9 J µg/L, HSM250 Trail at a concentration of 14.0 J µg/L, and

HSM260 Peak at 5.98 J ug/L. These detections were less than the laboratory reporting limit but greater than the established PCL of 6 µg/L. The concentrations were less than Surface Water Benchmarks for aquatic life and Contact Recreation Water PCLs. The detections are summarized in Table 20.

Table 20. Stormwater Samples – Bis(2-Ethylhexyl)Phthalate Detections – San Marcos Springs Complex

Location	Date	Concentration (µg/L)
FDHSM230 Trail	5/04/2018	17.9 J
HSM250 Trail	5/04/2018	14.0 J
HSM260 Peak	5/04/2018	5.98 J
TCEQ Acute Surface Water Benchmark for Aquatic Life†		60
TCEQ Chronic Surface Water Benchmark for Aquatic Life†		20
Contact Recreation Water PCL‡		NE

µg/L – micrograms per liter
NE – Not established
PCL – Protective concentration level
TCEQ – Texas Commission on Environmental Quality
† Aquatic Life Surface Water Benchmark Table (TCEQ 2018)
‡ Contact Recreation Water PCL Table (TCEQ 2006)

5.2.2.4 Stormwater – Herbicides and Pesticides

Stormwater samples were collected and analyzed for organochlorine pesticides, organophosphorous pesticides, and herbicides. One herbicide, 2,4-D, and one pesticide, Merphos, were detected during the May 2018 stormwater event. Both compounds were detected in laboratory blank samples, and all but one of the detections were "J" flagged, indicating that the concentrations detected were greater than the method detection limits but less than the reporting limits. No Surface Water Benchmarks for aquatic life have been established for either analyte. A Contact Recreation Water PCL does exist for 2,4-D, but it was not exceeded. These detections are summarized in Table 21.

Table 21. Stormwater Samples – Merphos and 2,4-D Detections – San Marcos Springs Complex

Location	Date	Merphos (mg/L)	2, 4-D (ug/L)
HSM210 Lead 1	5/04/2018	0.000325 J H B	0.0372 J B
HSM210 Lead 2	5/04/2018	0.000307 J H B	ND
HSM210 Lead 3	5/04/2018	0.000328 J H B	ND
HSM210 Peak	5/04/2018	0.000221 J H B	ND
HSM210 Trail	5/04/2018	0.000296 J H B	0.0368
HSM230 Lead 1	5/04/2018	0.000302 J H B	ND
HSM230 Lead 2	05/04/2018	0.000874 J H B	0.306 J B
HSM230 Lead 3	5/04/2018	0.000354 J H B	ND
HSM230 Peak	5/04/2018	0.000400 J H B	ND
HSM231 Lead	5/04/2018	0.000352 J H B	ND
HSM231 Peak	5/04/2018	0.000474 J H B	ND

Location	Date	Merphos (mg/L)	2, 4-D (ug/L)
HSM231 Trail	5/04/2018	0.000423 J H B	0.0855 J B
HSM240 Lead	05/04/2018	0.000623 J H B	ND
HSM240 Peak	5/04/2018	0.000291 J H B	ND
HSM250 Lead	05/04/2018	0.000452 J H B	ND
HSM250 Peak	5/04/2018	0.000334 J H B	0.236 J B
HSM250 Trail	5/04/2018	0.000404 J	ND
HSM260 Lead	5/04/2018	0.000409 J H B	ND
HSM260 Peak	5/04/2018	0.000395 J H B	0.0653 J B
HSM260 Trail	5/04/2018	0.000257 J	0.0566 J
FDHSM260 Trail	5/04/2018	0.000267 J	0.0813 J
HSM270 Lead	5/04/2018	0.000250 J H B	ND
HSM270 Peak	5/04/2018	0.000263 J H B	0.171 J B
HSM270 Trail	5/04/2018	ND	0.0827 J
TCEQ Acute Surface Water Benchmark for Aquatic Life[†]		NE	NE
TCEQ Chronic Surface Water Benchmark for Aquatic Life[†]		NE	NE
Contact Recreation Water PCL[‡]		NE	3,920

B – Compound was found in the laboratory blank and sample

H – Analyzed outside hold time; result included for comparison but not considered valid

J – Detection is greater than the method detection limit, but less than the reporting limit

mg/L – milligrams per liter

µg/L – micrograms per liter

ND – Not detected

NE – Not established

PCL – Protective concentration level

TCEQ – Texas Commission on Environmental Quality

† Aquatic Life Surface Water Benchmark Table (TCEQ 2018)

‡ Contact Recreation Water PCL Table (TCEQ 2006)

5.2.2.5 Stormwater – Polychlorinated Biphenyls

Stormwater samples were analyzed for the various Aroclor compounds that are generally referred to collectively as PCBs. None of the stormwater samples from the San Marcos Springs complex indicated positive detections of PCB compounds during the May 2018 sampling event.

5.2.2.6 Stormwater – Metals

Stormwater samples were analyzed for metals in accordance with the EAHCP Work Plan. One sample, HSM270 Peak, exceeded the Acute Surface Water Benchmark for aquatic life for aluminum. Five samples—HSM230 Lead 1, HSM230 Lead 2, HSM240 Lead, HSM250 Lead, and HSM270 Lead—exceeded the Chronic Surface Water Benchmark for aquatic life for aluminum. One sample, HSM270 Trail, exceeded the Chronic Surface Water Benchmark for aquatic life for copper. Five samples—HSM210 Trail, HSM230 Lead, HSM240 Lead, HSM240 Peak, and HSM270 Peak—exceeded the Chronic Surface Water Benchmark for aquatic life for lead. Three samples, HSM230 Lead 1, HSM240 Lead, and HSM270 Peak, exceeded the Chronic Surface Water Benchmark for aquatic life for iron. No Surface Water Benchmarks for aquatic life were exceeded for VOCs, SVOCs, pesticides, herbicides, or PCBs. No Contact Recreation Water PCLs were exceeded for any analytes. The results are summarized in Table 22.

Table 22. Stormwater Samples – Metals – San Marcos Springs Complex

Location	Date Collected	Aluminum (mg/L)	Antimony (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Beryllium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Manganese (mg/L)	Mercury (mg/L)	Nickel (mg/L)	Selenium (mg/L)	Strontium (mg/L)	Thallium (mg/L)	Zinc (mg/L)
HSM210 Lead 1	05/04/2018	<0.0500	<0.00161	0.00138 J	0.0376	<0.00124	<0.000854	<0.00140	<0.00200	<0.101	<0.000733	0.0986	<0.000130	<0.00217	0.00162 J B	<0.000941	<0.000693	<0.00355
HSM210 Lead 2	05/04/2018	<0.0500	<0.00161	0.00186 J	0.0385	<0.00124	<0.000854	<0.00140	<0.00200	0.134 J	<0.000733	0.103	<0.000130	<0.00217	0.00402 J B	<0.000941	<0.000693	<0.00355
HSM210 Lead 3	05/04/2018	<0.0500	<0.00161	0.00135 J	0.0360	<0.00124	<0.000854	<0.00140	<0.00200	<0.101	<0.000733	0.101	<0.000130	<0.00217	0.00217 J B	<0.000941	<0.000693	<0.00355
HSM210 Peak	05/04/2018	<0.0500	<0.00161	0.00120 J	0.0389	<0.00124	<0.000854	<0.00140	<0.00200	<0.101	<0.000733	0.0942	<0.000130	<0.00217	<0.00108	<0.000941	<0.000693	<0.00355
HSM210 Trail	05/04/2018	<0.0500	<0.00161	0.00178 J	0.0394	<0.00124	<0.000854	<0.00140	<0.00200	0.308	0.00227 J	0.102	<0.000130	<0.00217	0.00351 J B	<0.000941	<0.000693	0.0165 J
FDHSM210 Trail	05/04/2018	<0.0500	<0.00161	0.00247 J	0.0337	<0.00124	<0.000854	<0.00140	<0.00200	0.176 J B	<0.000733	0.0640	<0.000130	<0.00217	0.00111 J	<0.000941	<0.000693	<0.00355
HSM230 Lead 1	05/04/2018	0.940	<0.00161	0.00150 J	0.0122	<0.00124	<0.000854	0.00159 J	0.00280 J	4.86	0.00291 J	0.129	<0.000130	<0.00217	0.00248 J B	<0.000941	<0.000693	0.0210 J
HSM230 Lead 2	05/04/2018	0.165	<0.00161	<0.00109	0.0114	<0.00124	<0.000854	<0.00140	<0.00200	0.624	<0.000733	0.0511	<0.000130	<0.00217	0.00238 J B	<0.000941	<0.000693	0.0118 J
HSM230 Lead 3	05/04/2018	0.0744 J	<0.00161	<0.00109	0.0142	<0.00124	<0.000854	<0.00140	<0.00200	0.284	<0.000733	0.0708	<0.000130	<0.00217	0.00131 J B	<0.000941	<0.000693	0.00621 J
HSM230 Peak	05/04/2018	0.0648 J	<0.00161	0.00113 J	0.00974	<0.00124	<0.000854	<0.00140	<0.00200	0.181 J	<0.000733	0.0430 J	0.000137 J	<0.00217	<0.00108	<0.000941	<0.000693	0.0114 J
HSM230 Trail	05/04/2018	<0.0500	<0.00161	0.00197 J	0.0197	<0.00124	<0.000854	<0.00140	0.00252 J	<0.101	<0.000733	0.0167 J	<0.000130	<0.00217	<0.00108	<0.000941	<0.000693	0.0118 J B
FDHSM230 Trail	05/04/2018	<0.0500	<0.00161	0.00242 J	0.0190	<0.00124	<0.000854	<0.00140	0.00446 J	<0.101	<0.000733	0.0151 J	<0.000130	<0.00217	<0.00108	<0.000941	<0.000693	0.0234 J B
HSM231 Lead	05/04/2018	<0.0500	<0.00161	<0.00109	0.0261	<0.00124	<0.000854	<0.00140	<0.00200	0.184 J	<0.000733	0.0652	<0.000130	<0.00217	0.00294 J B	<0.000941	<0.000693	<0.00355
HSM231 Peak	05/04/2018	0.0743 J	<0.00161	0.00185 J	0.0332	<0.00124	<0.000854	<0.00140	<0.00200	0.276	<0.000733	0.0200 J	<0.000130	<0.00217	<0.00108	<0.000941	<0.000693	<0.00355
HSM231 Trail	05/04/2018	<0.0500	<0.00161	0.00161 J	0.0383	<0.00124	<0.000854	<0.00140	0.00277 J	<0.101	<0.000733	0.0230 J	<0.000130	<0.00217	0.00343 J B	<0.000941	<0.000693	0.00528 J
HSM240 Lead	05/04/2018	0.279	<0.00161	<0.00109	0.0355	<0.00124	<0.000854	<0.00140	<0.00200	1.53	0.00262 J	0.0571	0.000174 J	<0.00217	0.00257 J B	<0.000941	<0.000693	0.0181 J
HSM240 Peak	05/04/2018	<0.0500	<0.00161	0.00111 J	0.0336	<0.00124	<0.000854	<0.00140	<0.00200	<0.101	0.00158 J	0.0425 J	<0.000130	0.00387 J	0.00129 J	<0.000941	<0.000693	0.0584
HSM240 Trail	05/04/2018	<0.0500	<0.00161	0.00241 J	0.0353	<0.00124	<0.000854	<0.00140	<0.00200	<0.101	<0.000733	<0.0116	<0.000130	<0.00217	0.00138 J	<0.000941	<0.000693	<0.00355
HSM250 Lead	05/04/2018	0.107	<0.00161	0.00111 J	0.0240	<0.00124	<0.000854	<0.00140	<0.00200	0.574	0.00125 J	0.105	0.000148 J	<0.00217	<0.00108	<0.000941	<0.000693	0.00642 J
HSM250 Peak	05/04/2018	<0.0500	<0.00161	0.00121 J	0.0243	<0.00124	<0.000854	<0.00140	<0.00200	<0.101	<0.000733	0.0427 J	<0.000130	<0.00217	<0.00108	<0.000941	<0.000693	0.00452 J
HSM250 Trail	05/04/2018	<0.0500	<0.00161	0.00242 J	0.0342	<0.00124	<0.000854	<0.00140	0.00242 J	<0.101	<0.000733	0.0127 J	<0.000130	<0.00217	<0.00108	<0.000941	<0.000693	0.00465 J B

Location	Date Collected	Aluminum (mg/L)	Antimony (mg/L)	Arsenic (mg/L)	Barium (mg/L)	Beryllium (mg/L)	Cadmium (mg/L)	Chromium (mg/L)	Copper (mg/L)	Iron (mg/L)	Lead (mg/L)	Manganese (mg/L)	Mercury (mg/L)	Nickel (mg/L)	Selenium (mg/L)	Strontium (mg/L)	Thallium (mg/L)	Zinc (mg/L)
HSM260 Lead	05/04/2018	<0.0500	<0.00161	0.00131 J	0.0400	<0.00124	<0.000854	<0.00140	<0.00200	<0.101	<0.000733	<0.0116	<0.000130	<0.00217	<0.00108	<0.000941	<0.000693	<0.00355
HSM260 Peak	05/04/2018	<0.0500	<0.00161	<0.00109	0.0258	<0.00124	<0.000854	<0.00140	<0.00200	<0.101	<0.000733	0.0580	0.000138 J	<0.00217	<0.00108	<0.000941	<0.000693	<0.00355
HSM260 Trail	05/04/2018	<0.0500	<0.00161	0.00232 J	0.0257	<0.00124	<0.000854	<0.00140	0.00278 J	<0.101	<0.000733	0.0160 J	<0.000130	<0.00217	<0.00108	<0.000941	<0.000693	<0.00355
FDHSM260 Trail	05/04/2018	<0.0500	<0.00161	0.00308 J	0.0256	<0.00124	<0.000854	<0.00140	0.00399 J	0.122 J B	<0.000733	0.0184 J	<0.000130	<0.00217	<0.00108	<0.000941	<0.000693	<0.00355
HSM270 Lead	05/04/2018	0.123	<0.00161	0.00253 J	0.0491	<0.00124	<0.000854	0.00505	<0.00200	0.704	<0.000733	0.451	<0.000130	<0.00217	<0.00108	<0.000941	<0.000693	<0.00355
HSM270 Peak	05/04/2018	1.26	<0.00161	0.00210 J	0.0365	<0.00124	<0.000854	0.00218 J	<0.00200	5.24	0.00424 J	0.184	<0.000130	<0.00217	<0.00108	<0.000941	<0.000693	0.0194 J
HSM270 Trail	05/04/2018	0.0802 J	<0.00161	0.00326 J	0.0255	<0.00124	<0.000854	<0.00140	0.00536 J	0.263 B	<0.000733	0.0228 J	<0.000130	<0.00217	<0.00108	<0.000941	<0.000693	0.00429 J B
TCEQ Acute Surface Water Benchmark for Aquatic Life†		0.99	6.6	0.34	96	0.13	0.0044	0.32	0.00739	NE	0.03014	2.37	0.0024	0.26	0.02	0.001	0.54	0.0651
TCEQ Chronic Surface Water Benchmark for Aquatic Life†		0.087	2.2	0.15	16	0.0053	0.00015	0.042	0.00524	1.00	0.00117	1.310	0.0013	0.0289	0.0005	0.0001	0.18	0.0657
Contact Recreation Water PCL‡		403	0.199	0.0285	64.9	0.0943	0.149	126	33.1	NE	NE	40.9	0.00973	11.3	4.13	1.57	0.0661	201

B – Compound was found in the laboratory blank and sample

J – Detection is greater than the method detection limit, but less than the reporting limit

mg/L – milligrams per liter

NE – Not established

PCL – Protective concentration level

TCEQ – Texas Commission on Environmental Quality

† Aquatic Life Surface Water Benchmark Table (TCEQ 2018)

‡ Contact Recreation Water PCL Table (TCEQ 2006)

5.2.2.7 Stormwater – Nitrates

Stormwater samples were analyzed for nitrate-nitrite as nitrogen, in accordance with the EAHCP Work Plan. All samples contained nitrate results below the MCL of 10 mg/L. During the May 2018 event, the range of nitrate results was 0.376 mg/L to 1.22 mg/L, with an average concentration of approximately 0.712 mg/L. None of the detections exceeded the Surface Water Benchmarks for aquatic life or the Contact Recreation Water PCLs. Because the sampling event occurred on a Friday, the samples could not be submitted to a laboratory and analyzed within the 48-hour holding time. Nitrate detections are summarized in Table 23.

Table 23. Stormwater Samples – Nitrate Detections – San Marcos Springs Complex

Location	Date	Concentration (mg/L)
HSM210 Lead 1	5/4/2018	0.376 J H
HSM210 Lead 2	5/4/2018	0.464 J H
HSM210 Lead 3	5/4/2018	0.469 J H
HSM230 Lead 1	5/4/2018	0.470 J H
HSM230 Lead 2	5/4/2018	0.547 H
HSM230 Lead 3	5/4/2018	0.594 H
HSM231 Lead	5/4/2018	0.697 H
HSM240 Lead	5/4/2018	0.684 H
HSM250 Lead	5/4/2018	0.463 J H
HSM260 Lead	5/4/2018	1.22 H
HSM270 Lead	5/4/2018	0.645 H
HSM210 Peak	5/4/2018	0.471 J H
HSM230 Peak	5/4/2018	0.450 J H
HSM231 Peak	5/4/2018	0.988 H
HSM240 Peak	5/4/2018	1.09 H
HSM250 Peak	5/4/2018	0.586 H
HSM260 Peak	5/4/2018	0.747 H
HSM270 Peak	5/4/2018	0.690 H
HSM210 Trail	5/4/2018	0.434 J H
FDHSM210 Trail	5/4/2018	0.435 J H
HSM230 Trail	5/4/2018	0.829 H
FDHSM230 Trail	5/4/2018	0.828 H
HSM231 Trail	5/4/2018	1.09 H
HSM240 Trail	5/4/2018	1.20 H
HSM250 Trail	5/4/2018	1.11 H
HSM260 Trail	5/4/2018	0.761 H
FDHSM260	35/4/2018	0.866 H
HSM270 Trail	5/4/2018	0.743 H

Location	Date	Concentration (mg/L)
TCEQ Acute Surface Water Benchmark for Aquatic Life†		550
TCEQ Chronic Surface Water Benchmark for Aquatic Life†		13
Contact Recreation Water PCL‡		1320

H – Samples were prepped or analyzed beyond the specified holding time
J – Detection is greater than the method detection limit, but less than the reporting limit
mg/L – milligrams per liter
PCL – Protective concentration level
TCEQ – Texas Commission on Environmental Quality
† Aquatic Life Surface Water Benchmark Table (TCEQ 2018)
‡ Contact Recreation Water PCL Table (TCEQ 2006)

5.2.2.8 Stormwater – Caffeine

Stormwater was analyzed for caffeine, which can indicate an anthropogenic source. Caffeine may enter surface water from leaking sewer or septic systems or it may be present in the aquifer from similar sources in the recharge zone (EPA 2012). Potential ecological effects are currently unknown but could include reduced reproductive success in aquatic species (EPA 2012). Caffeine detections in stormwater samples from San Marcos Springs in May 2018 ranged from 48 ng/L to 600 ng/L and was detected in all samples except HSM210 Lead 2, HSM210 Lead 3, HSM260 Lead, HSM210 Trail, FDHSM210 Trail, and HSM2400 Trail. There is no regulatory standard or expected value for comparison. Results are shown in Table 24.

Table 24. Stormwater Samples – Caffeine Detections – San Marcos Springs Complex

Location	Date Collected	Caffeine (ng/L)
HSM210 Lead 1	5/4/2018	55
HSM230 Lead 1	5/4/2018	340
HSM230 Lead 2	5/4/2018	590
HSM230 Lead 3	5/4/2018	400
HSM230 Peak	5/4/2018	380
HSM230 Peak	5/4/2018	270
FDHSM230 Trail	5/4/2018	220
HSM231 Lead	5/4/2018	230
HSM231 Peak	5/4/2018	170
HSM231 Trail	5/4/2018	220
HSM240 Lead	5/4/2018	360
HSM240 Peak	5/4/2018	130
HSM250 Lead	5/4/2018	460
HSM250 Peak	5/4/2018	270
HSM250 Trail	5/4/2018	48
HSM260 Peak	5/4/2018	290
HSM260 Trail	5/4/2018	210
FDHSM260 Trail	5/4/2018	180
HSM270 Lead	5/4/2018	600
HSM270 Peak	5/4/2018	250

	Date	Caffeine
HSM270 Trail	5/4/2018	230

ng/L – nanograms per liter

5.2.3 San Marcos Springs Surface Water Passive Sampling

PDSs were installed in the San Marcos Springs system in February, April, June, August, October, and December 2018. Several samplers were vandalized, and one was lost due to vandalism or was carried downstream by a flood event. Any changes to deployment locations or nonrecovered samplers are discussed in Appendix C.

Rain events occurred during all PDS deployment periods during 2018. Figures 44–49 show conductivity and stream discharge rates for each PDS deployment period.

PDSs were analyzed for a suite of SVOCs, VOCs, and organochlorine pesticides. Tetrachloroethene was detected in every sample analyzed, except for samples from the most upstream location, HSM410. TPH was detected in several samples and 1,2,4-trimethylbenzene, 1,3,5-trimethylbenzene, undecane, o-xylenes, and m-,p-xylenes had few incidents of detection. The concentrations detected were compared with the Surface Water Benchmarks for aquatic life and the Contact Recreation Water PCLs. None of those comparison values were exceeded by the concentrations detected. The TCEQ comparison standards and positive detections are presented in Table 25.

Figure 44. Passive Diffusion Sampling – February 2018 Stream Discharge and Specific Conductivity – San Marcos Springs Complex

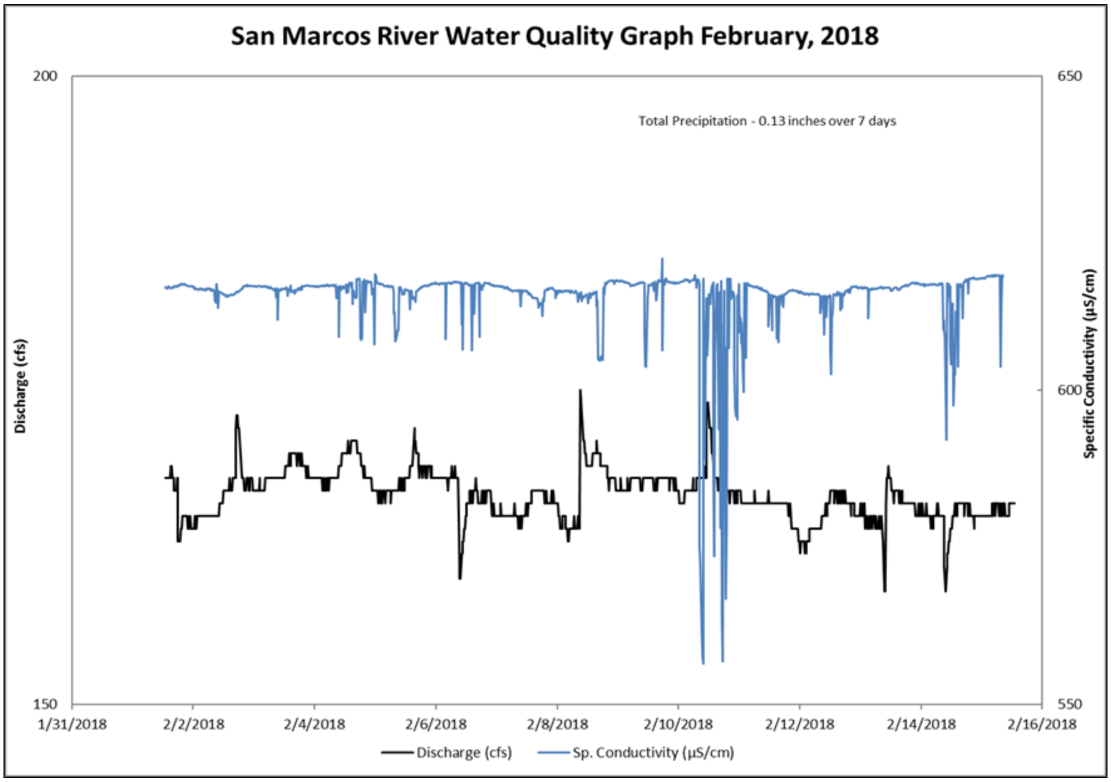


Figure 45. Passive Diffusion Sampling – April 2018 Stream Discharge and Specific Conductivity – San Marcos Springs Complex

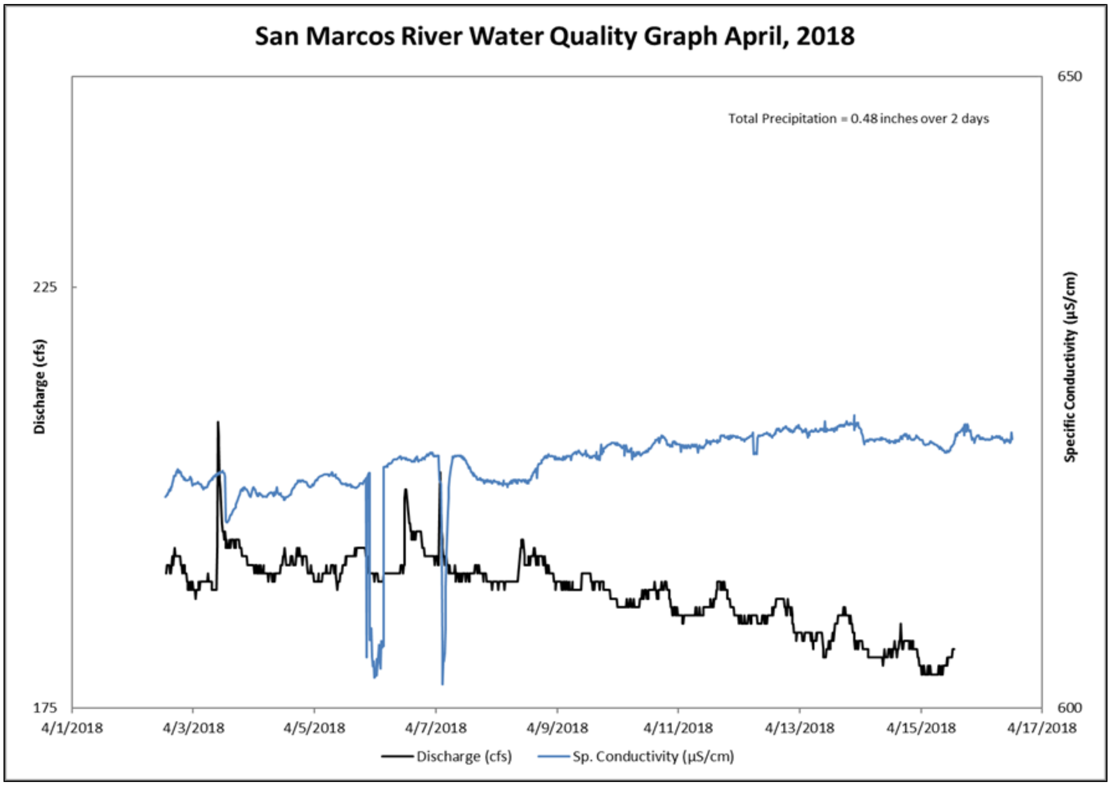


Figure 46. Passive Diffusion Sampling – June 2018 Stream Discharge and Specific Conductivity – San Marcos Springs Complex

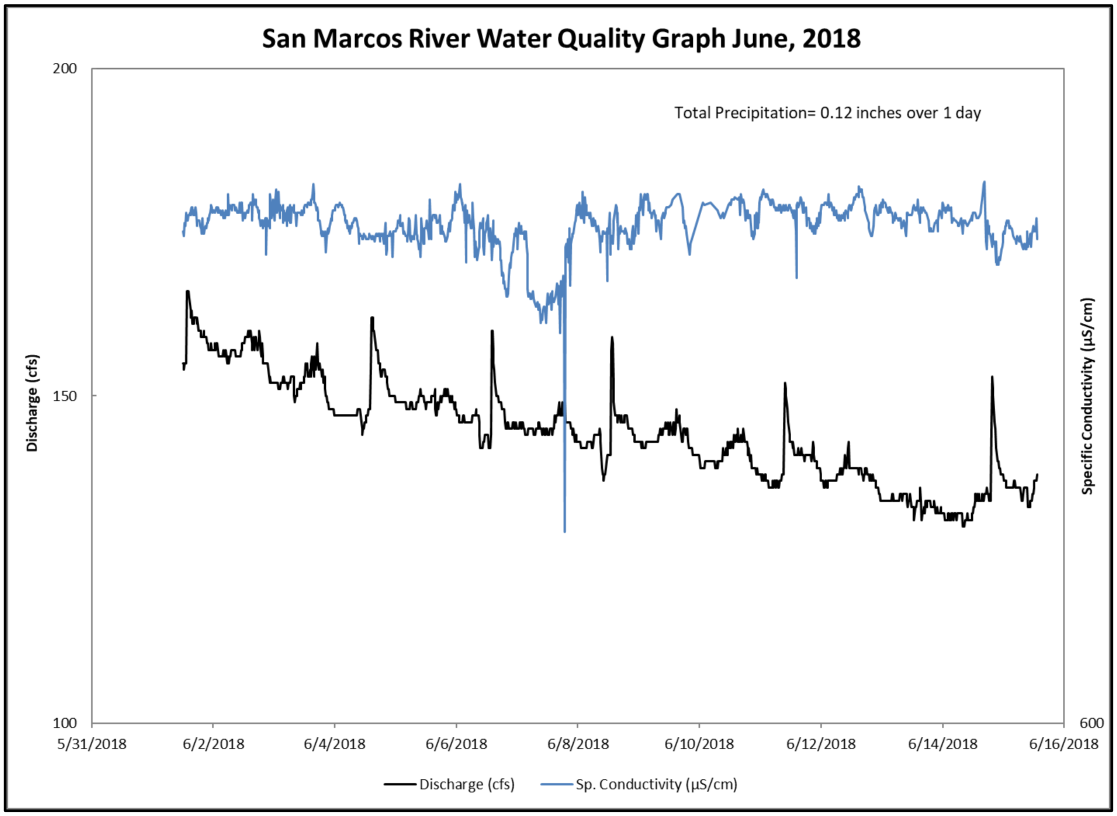


Figure 47. Passive Diffusion Sampling – August 2018 Stream Discharge and Specific Conductivity – San Marcos Springs Complex

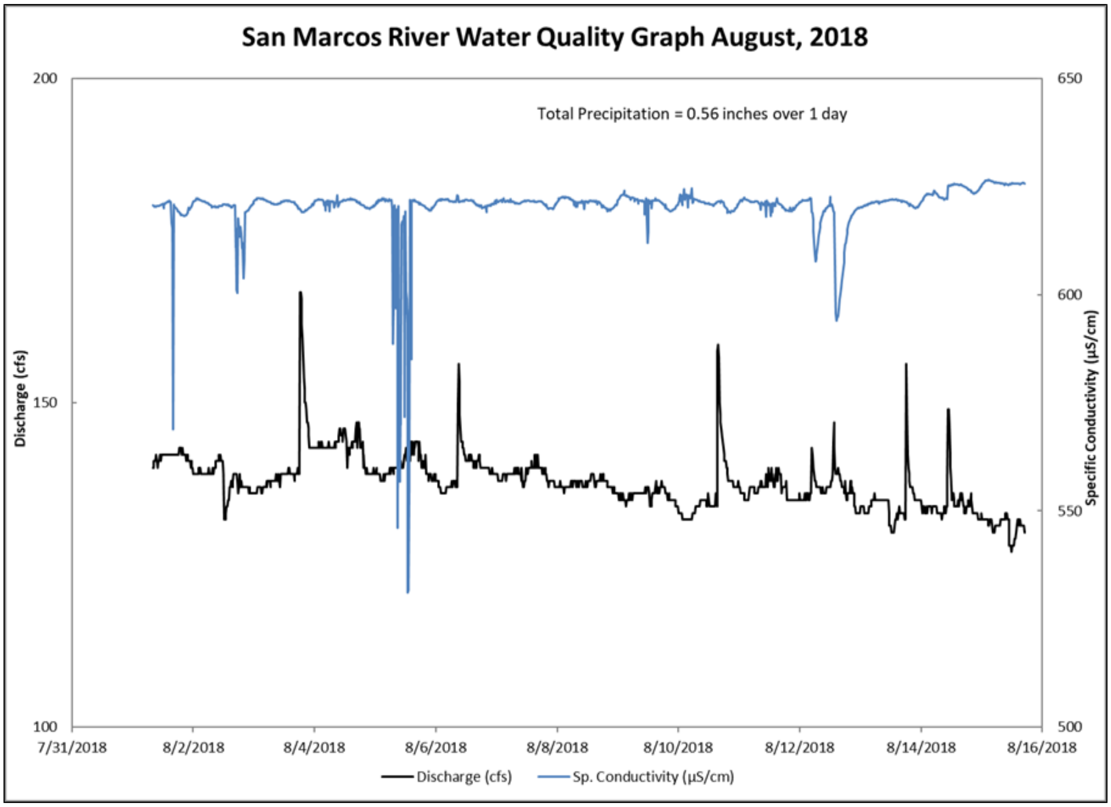


Figure 48. Passive Diffusion Sampling – October 2018 Stream Discharge and Specific Conductivity – San Marcos Springs Complex

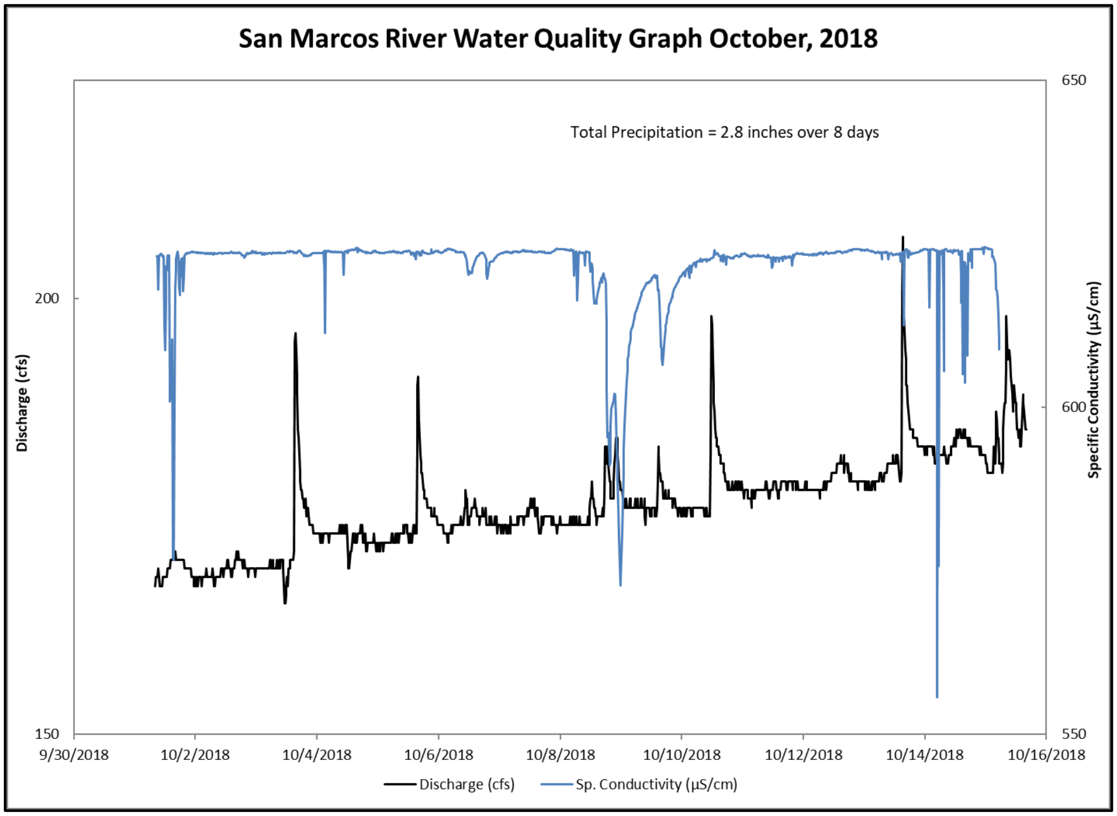


Figure 49. Passive Diffusion Sampling – December 2018 Stream Discharge and Specific Conductivity – San Marcos Springs Complex

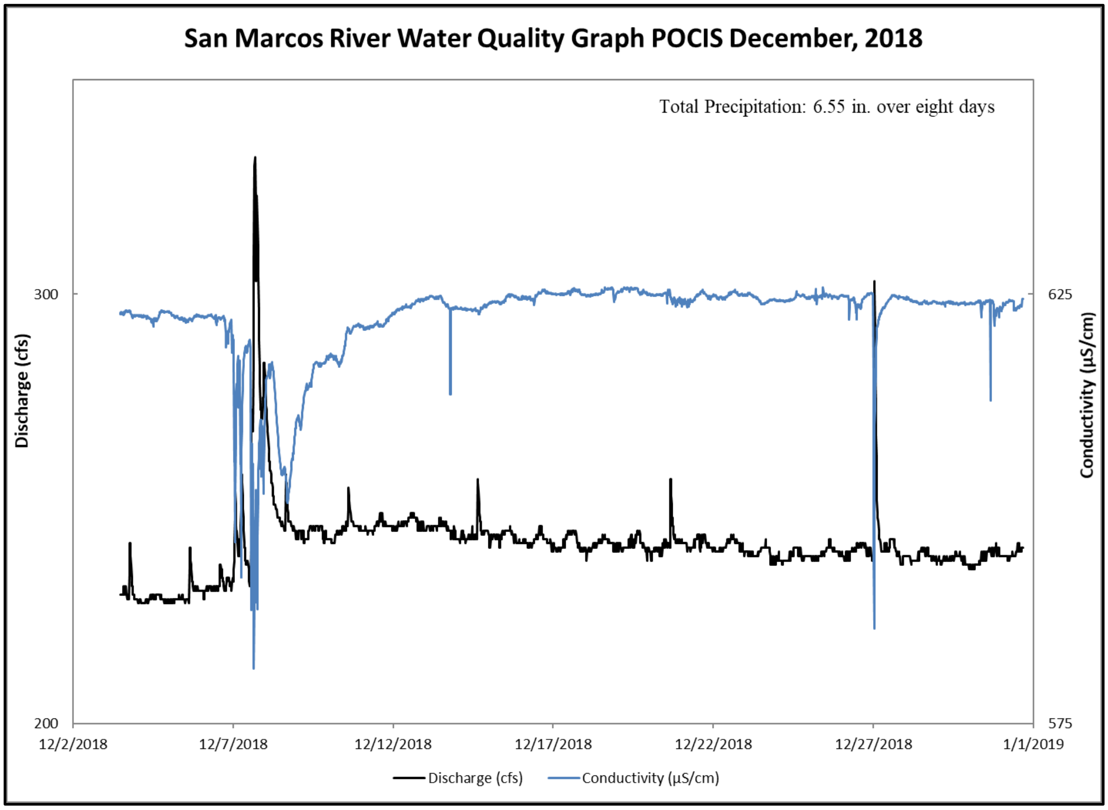


Table 25. Passive Diffusion Sampling –Volatile and Semi-volatile Organic Compound Detections – San Marcos Springs Complex

Location	Month 2018	1,2,4-trimethylbenzene (µg/L)	Tridecane (µg/L)	Benzene (µg/L)	2-Methyl naphthalene (µg/L)	m-,p-xylene (µg/L)	o-xylene (µg/L)	Undecane (µg/L)	1,3,5-Trimethylbenzene (µg/L)	Tetrachloroethene (µg/L)	TPH (µg/L)
HSM410	February	<0.005	<0.021	<0.006	<0.014	<0.006	<0.006	<0.021	<0.005	<0.006	0.066
	April	<0.005	<0.021	<0.006	<0.014	<0.005	<0.006	<0.021	<0.005	<0.006	0.106
	June	<0.005	<0.020	<0.006	<0.014	<0.005	<0.005	<0.020	<0.005	<0.005	0.098
	August	<0.005	<0.019	<0.006	<0.013	<0.005	<0.005	<0.019	<0.004	<0.005	0.062
	October	<0.02	<0.05	<0.02	<0.05	<0.02	<0.02	<0.05	<0.02	<0.02	0.58
	December	<0.02	<0.05	<0.02	<0.05	<0.02	<0.02	<0.05	<0.02	<0.02	<0.50
HSM420	February	<0.005	<0.021	<0.006	<0.014	<0.006	<0.006	<0.021	<0.005	0.045	0.066
	April	<0.005	<0.021	<0.006	<0.014	<0.005	<0.006	<0.021	<0.005	0.054	<0.055
	June	<0.005	<0.020	<0.006	<0.014	<0.005	<0.005	<0.020	<0.005	0.021	0.072
	August	<0.005	<0.019	<0.006	<0.013	<0.005	<0.005	<0.019	<0.004	0.031	0.059
	October	<0.02	<0.05	<0.02	<0.05	<0.02	<0.02	<0.05	<0.02	0.14	1.11
	December	<0.02	<0.05	<0.02	<0.05	<0.02	<0.02	<0.05	<0.02	0.11	<0.50
FDHSM420	February	<0.005	<0.021	<0.006	<0.014	<0.006	<0.006	<0.021	<0.005	0.040	0.062
	April	<0.005	<0.021	<0.006	<0.014	<0.005	<0.006	<0.021	<0.005	0.049	<0.055
	June	<0.005	<0.020	<0.006	<0.014	<0.005	<0.005	<0.020	<0.005	0.023	0.078
	August	<0.005	<0.019	<0.006	<0.013	<0.005	<0.005	<0.019	<0.004	0.031	<0.051
	October	<0.02	<0.05	<0.02	<0.05	<0.02	<0.02	<0.05	<0.02	0.14	1.08
	December	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Location	Month 2018	1,2,4-trimethylbenzene (µg/L)	Tridecane (µg/L)	Benzene (µg/L)	2-Methyl naphthalene (µg/L)	m-,p-xylene (µg/L)	o-xylene (µg/L)	Undecane (µg/L)	1,3,5-Trimethylbenzene (µg/L)	Tetrachloroethene (µg/L)	TPH (µg/L)
HSM430	February	0.58	0.026	<0.006	0.042	0.018	0.011	<0.021	0.016	0.101	0.278
	April	<0.005	<0.021	<0.006	<0.014	<0.005	<0.006	0.026	<0.005	0.140	<0.055
	June	<0.005	<0.020	0.08	<0.014	<0.005	<0.005	<0.020	<0.005	0.091	0.072
	August	<0.005	<0.019	<0.006	<0.013	<0.005	<0.005	<0.019	<0.004	0.076	0.069
	October	<0.02	<0.05	<0.02	<0.05	<0.02	<0.02	<0.05	<0.02	0.54	<0.50
	December	<0.02	<0.05	<0.02	<0.05	<0.02	<0.02	<0.05	<0.02	0.52	<0.50
HSM440	February	<0.005	<0.021	<0.006	<0.014	<0.006	<0.006	<0.021	<0.005	0.042	0.066
	April	<0.005	<0.021	<0.006	<0.014	<0.005	<0.006	<0.021	<0.005	0.038	<0.055
	June	<0.005	<0.020	<0.006	<0.014	<0.005	<0.005	<0.020	<0.005	0.027	0.076
	August	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	October	<0.02	<0.05	<0.02	<0.05	<0.02	<0.02	<0.05	<0.02	0.16	0.75
	December	<0.02	<0.05	<0.02	<0.05	<0.02	<0.02	<0.05	<0.02	0.06	<0.50
HSM450	February	<0.005	<0.021	<0.006	<0.014	<0.006	<0.006	<0.021	<0.005	0.023	0.064
	April	<0.005	<0.021	<0.006	<0.014	<0.005	<0.006	<0.021	<0.005	0.014	<0.055
	June	<0.005	<0.020	<0.006	<0.014	<0.005	<0.005	<0.020	<0.005	0.011	<0.054
	August	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	October	<0.02	<0.05	<0.02	<0.05	<0.02	<0.02	<0.05	<0.02	0.03	1.11
	December	<0.02	<0.05	<0.02	<0.05	<0.02	<0.02	<0.05	<0.02	0.04	<0.50

Location	Month 2018	1,2,4-trimethylbenzene (µg/L)	Tridecane (µg/L)	Benzene (µg/L)	2-Methyl naphthalene (µg/L)	m-,p-xylene (µg/L)	o-xylene (µg/L)	Undecane (µg/L)	1,3,5-Trimethylbenzene (µg/L)	Tetrachloroethene (µg/L)	TPH (µg/L)
FDHSM450	December	<0.02	<0.05	<0.02	<0.05	<0.02	<0.02	<0.05	<0.02	0.03	<0.50
HSM460	February	<0.005	<0.021	<0.006	<0.014	<0.006	<0.006	<0.021	<0.005	0.022	0.071
	April	<0.005	<0.021	<0.006	<0.014	<0.005	<0.006	<0.021	<0.005	0.028	<0.055
	June	<0.005	<0.020	<0.006	<0.014	<0.005	<0.005	<0.020	<0.005	0.017	0.067
	August	<0.005	<0.019	<0.006	<0.013	<0.005	<0.005	<0.019	<0.004	0.018	0.061
	October	<0.02	<0.05	<0.02	<0.05	<0.02	<0.02	<0.05	<0.02	0.07	0.73
	December	<0.02	<0.05	<0.02	<0.05	<0.02	<0.02	<0.05	<0.02	0.05	<0.50
HSM470	February	<0.005	<0.021	<0.006	<0.014	<0.006	<0.006	<0.021	<0.005	0.019	0.062
	April	<0.005	<0.021	<0.006	<0.014	<0.005	<0.006	<0.021	<0.005	0.018	<0.055
	June	<0.005	<0.020	<0.006	<0.014	<0.005	<0.005	<0.020	<0.005	0.013	0.067
	August	<0.005	<0.019	<0.006	<0.013	<0.005	<0.005	<0.019	<0.004	0.011	0.057
	October	<0.02	<0.05	<0.02	<0.05	<0.02	<0.02	<0.05	<0.02	0.08	1.02
	December	<0.02	<0.05	<0.02	<0.05	<0.02	<0.02	<0.05	<0.02	0.06	<0.50
TCEQ Acute Surface Water Benchmark for Aquatic Life†		462	NE	2,300	380	32*	32*	NE	424.5	3,840	NE
TCEQ Chronic Surface Water Benchmark for Aquatic Life†		77	NE	13	63	1.8*	1.8*	NE	71	1,280	NE
Contact Recreation Water PCL‡		650	NE	235	276	208,000	227,000	NE	3,050	148	28,100**

Note: The field duplicate sample location was HSM430 for each sample event except for the April and December 2016 events.

µg/L – micrograms per liter

NA – Not analyzed

NE – Not established

PCL – Protective concentration level

TCEQ – Texas Commission on Environmental Quality

TPH – Total petroleum hydrocarbons

*m-xylene value presented

**Value presented is the PCL for >16-21 C aromatics TPH

† Aquatic Life Surface Water Benchmark Table (TCEQ 2018)

‡ Contact Recreation Water PCL Table (TCEQ 2006)

5.2.4 San Marcos Springs Polar Organic Chemical Integrative Sampling

POCIS were installed in the San Marcos System at the farthest downstream sampling location, HSM470, in February, April, June, August, October, and December 2018. Any changes to deployment locations or nonrecovered samplers are discussed in Appendix C.

Rain events occurred during all POCIS deployment periods during 2018. Figures 50–55 show conductivity and discharge for each POCIS deployment period.

No suitable regulatory standards are available to compare to POCIS results, but the data can be used as a qualitative tool for evaluating the presence of PPCP constituents. Of the 43 PPCP constituents analyzed, 10 were detected at San Marcos. Positive detections are shown in Table 26.

Figure 50. Polar Organic Chemical Integrative Sampling (POCIS) – February 2018 Stream Discharge and Conductivity – San Marcos Springs Complex

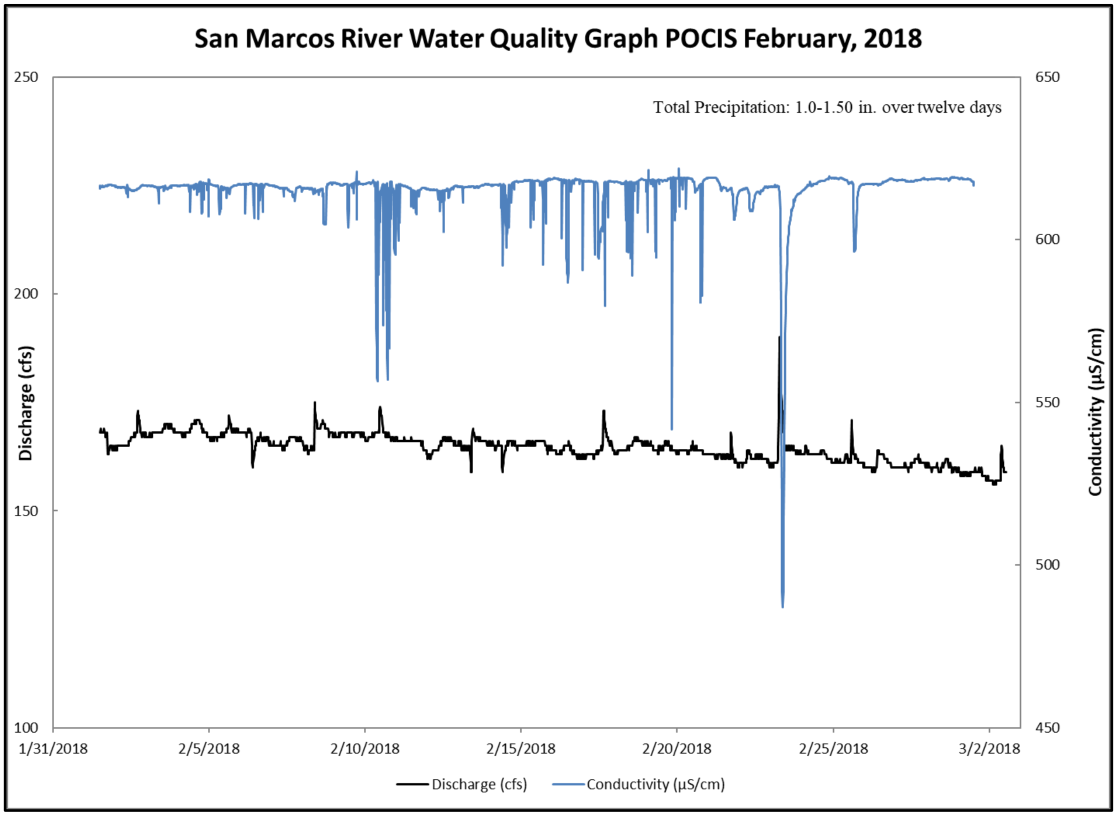


Figure 51. Polar Organic Chemical Integrative Sampling (POCIS) – April 2018 Stream Discharge and Conductivity – San Marcos Springs Complex

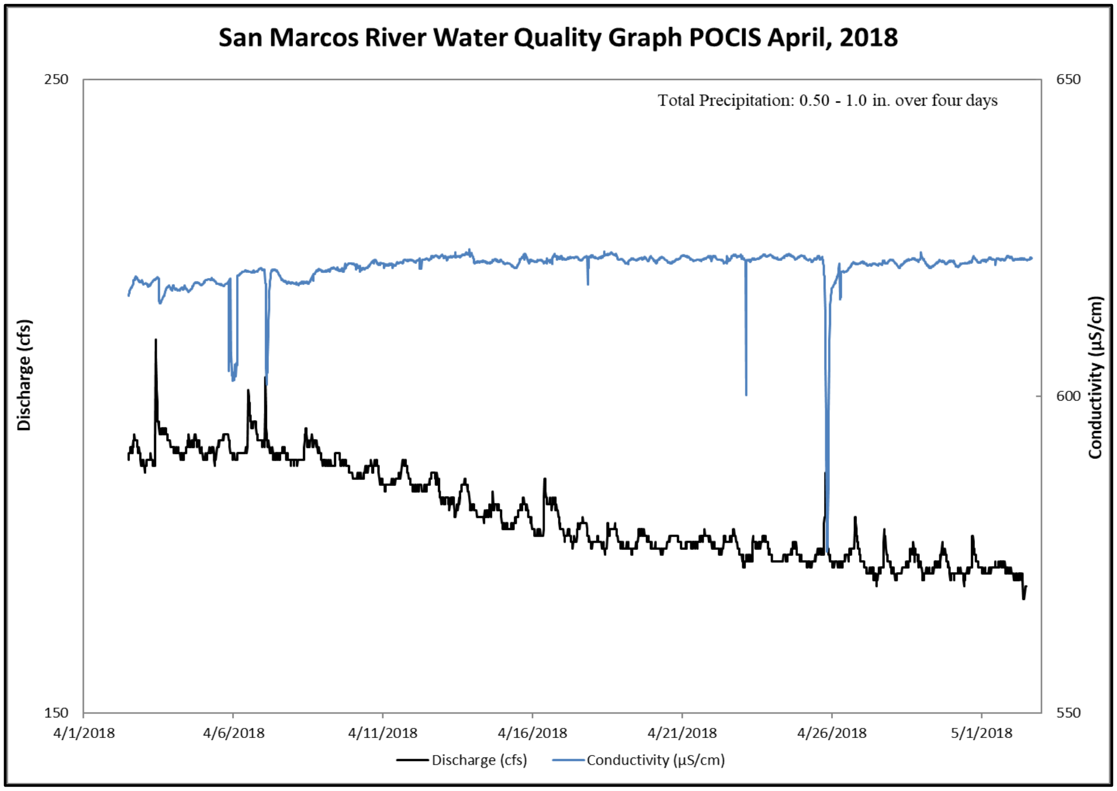


Figure 52. Polar Organic Chemical Integrative Sampling (POCIS) – June 2018 Stream Discharge and Conductivity – San Marcos Springs Complex

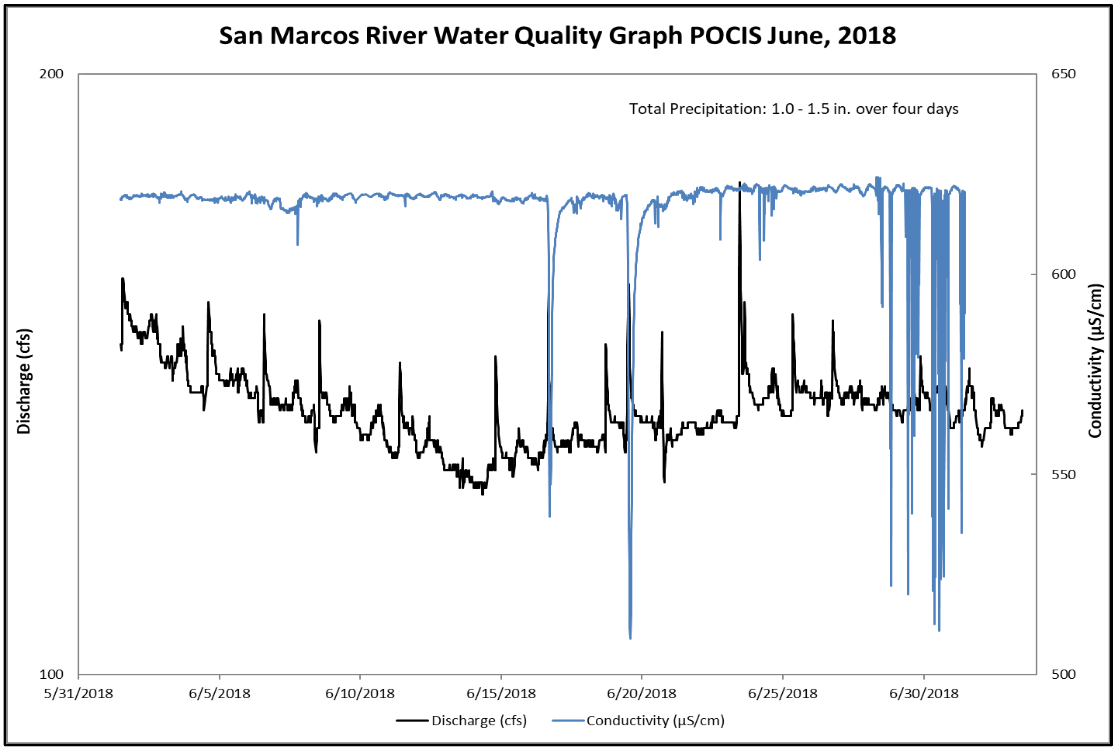


Figure 53. Polar Organic Chemical Integrative Sampling (POCIS) – August 2018 Stream Discharge and Conductivity – San Marcos Springs Complex

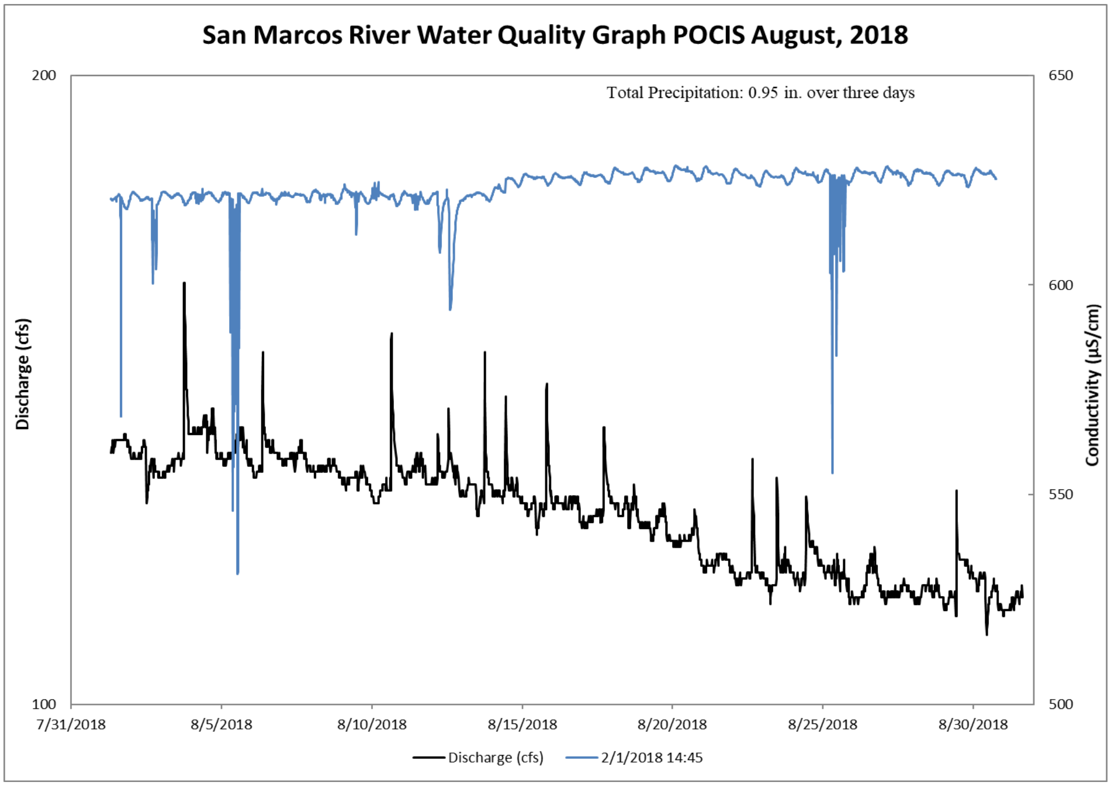


Figure 54. Polar Organic Chemical Integrative Sampling (POCIS) – October 2018 Stream Discharge and Conductivity – San Marcos Springs Complex

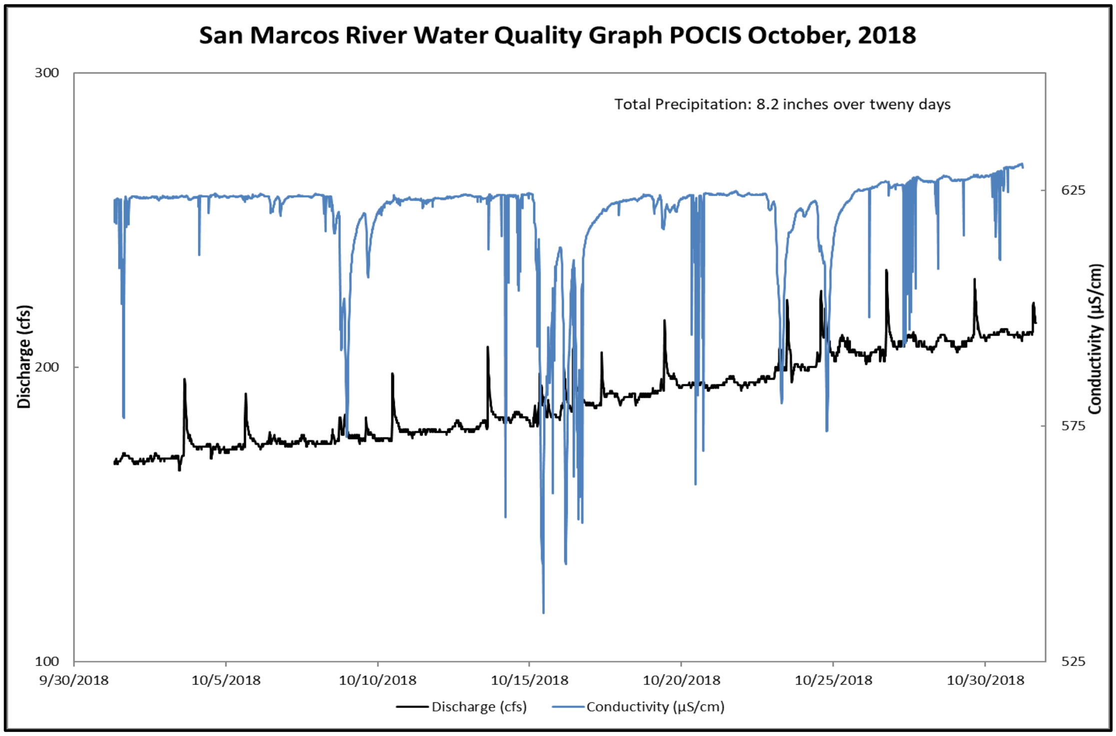


Figure 55. Polar Organic Chemical Integrative Sampling (POCIS) – December 2018 Stream Discharge and Conductivity – San Marcos Springs Complex

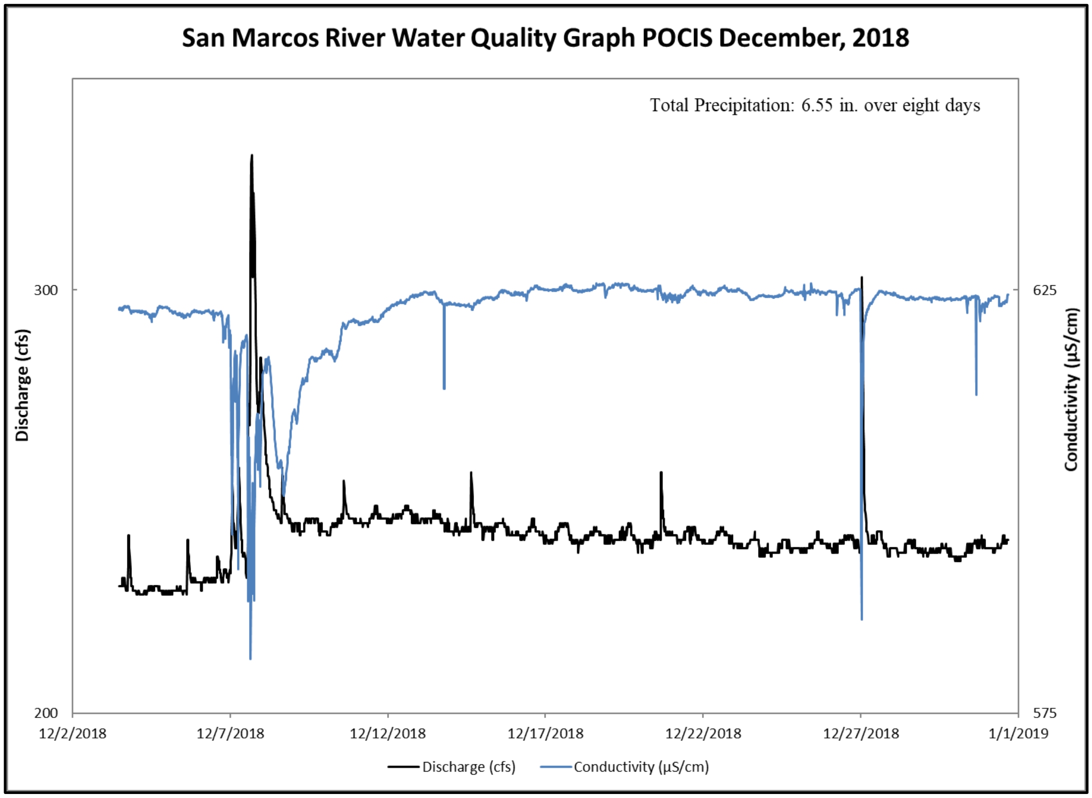


Table 26. Polar Organic Chemical Integrative Sampling – Pharmaceutical and Personal Care Products – San Marcos Springs Complex

Location	Month 2018	Progesteron (ng/L)	Testosterone (ng/L)	Bisphenol A (ng/L)	Gemfibrozil (ng/L)	Ibuprofen (ng/L)	Iopromide (ng/L)	Naproxen (ng/L)	Triclosan (ng/L)	Caffeine (ng/L)	Cotinine (ng/L)	DEET (ng/L)	HHCB (ng/L)	Oxybenzone (ng/L)	Quinoline (ng/L)	Sulfamethoxazole (ng/L)	TCEP (ng/L)	TCPP (ng/L)	TDCPP (ng/L)	Trimethoprim (ng/L)
HSM470	February	ND	ND	1,800	ND	ND	ND	ND	120,000	2,600	ND	4,200	190,000	3,800	ND	ND	6,400	70,000	5,200	ND
	April	ND	ND	3,200	ND	1,300	ND	ND	34,000	1,500	ND	32,000	56,000	1,700	ND	ND	3,000	220,000	7,700	ND
	June	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	August	ND	ND	13,000	ND	16,000	ND	16,000	52,000	6,200	ND	160,000	51,000	9,100	ND	ND	6,400	130,000	170,000	8,800
	October	ND	ND	ND	ND	ND	ND	ND	38,000	ND	ND	1,100	61,000	1,400	ND	ND	ND	45,000	1,300	ND
	December	ND	ND	5,500	ND	ND	ND	ND	42,000	2,300	ND	40,000	130,000	4,000	3,200	ND	11,000	200,000	37,000	ND
Extraction Blank	February	ND	ND	ND	ND	ND	ND	ND	111,000	1,200	ND	ND	120,000	2,700	ND	ND	ND	26,000	1,200	ND
	April	ND	ND	ND	ND	ND	ND	ND	16,000	ND	ND	ND	29,000	ND	ND	ND	ND	48,000	1,900	ND
	June	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	August	ND	ND	ND	ND	ND	ND	ND	10,000	ND	ND	ND	28,000	ND	ND	ND	ND	34,000	2,700	ND
	October	ND	ND	2,600	ND	ND	ND	ND	65,000	9,100	ND	3,400	64,000	3,000	10,000	ND	5,800	110,000	22,000	ND
	December	ND	ND	8,800	ND	1,400	ND	ND	51,000	2,000	ND	43,000	160,000	7,000	2,100	ND	8,400	200,000	58,000	ND

DEET – *N,N*-Diethyl-*meta*-toluamide

HHCB – Glaxolide

TCEP – Tris(2-carboxyethyl)phosphine

TCPP – Tris(2-chloroethyl) phosphate

TDCPP – Tris(1,3-dichloroisopropyl)phosphate

ND – Not detected

ng/L – nanograms per liter

6.0 SUMMARY OF RESULTS

SWCA staff collected sediment, stormwater, passive diffusion samples, and POCIS samples from Comal and San Marcos Springs complexes. The sampling events met the requirements of the EAHCP and provided background data for these two systems. The limited number of detections above comparative standards is indicative of generally high water quality. Specific compounds detected above a Surface Water Benchmark for aquatic life or Contact Recreation Water PCL (for water) or PEC (for sediment) are listed in Table 27.

Table 27. Compounds Detected above Protective Concentration Levels or Probable Effect Concentrations

Sample Location	Sample Type	Date	Analyte	Concentration	PCL or PEC	
HCS210 Lead 2	Stormwater	03/28/2018	Aluminum	3.15 mg/L	0.087 mg/L	SWB Acute
HCS210 Lead 3	Stormwater	03/28/2018	Aluminum	1.67 mg/L	0.087 mg/L	SWB Acute
HCS210 Peak	Stormwater	03/28/2018	Aluminum	0.157 mg/L	0.087 mg/L	SWB Chronic
HCS260 Lead 2	Stormwater	03/28/2018	Aluminum	0.223 mg/L	0.087 mg/L	SWB Chronic
HCS270 Trail	Stormwater	03/28/2018	Aluminum	0.296 mg/L	0.087 mg/L	SWB Chronic
HCS210 Lead 2	Stormwater	03/28/2018	Lead	0.00652 mg/L	0.00117 mg/L	SWB Chronic
HCS210 Lead 3	Stormwater	03/28/2018	Lead	0.00303 J mg/L	0.00117 mg/L	SWB Chronic
HCS210 Lead 2	Stormwater	03/28/2018	Iron	2.73 mg/L	1.00 mg/L	SWB Chronic
HCS210 Lead 3	Stormwater	03/28/2018	Iron	1.65 mg/L	1.00 mg/L	SWB Chronic
HSM230 Lead 1	Stormwater	05/04/2018	Aluminum	0.940 mg/L	0.087 mg/L	SWB Chronic
HSM230 Lead 2	Stormwater	05/04/2018	Aluminum	0.165 mg/L	0.087 mg/L	SWB Chronic
HSM240 Lead	Stormwater	05/04/2018	Aluminum	0.279 mg/L	0.087 mg/L	SWB Chronic
HSM250 Lead	Stormwater	05/04/2018	Aluminum	0.107 mg/L	0.087 mg/L	SWB Chronic
HSM270 Lead	Stormwater	05/04/2018	Aluminum	0.123 mg/L	0.087 mg/L	SWB Chronic
HSM270 Peak	Stormwater	05/04/2018	Aluminum	1.26 mg/L	0.087 mg/L	SWB Acute
HSM270 Trail	Stormwater	05/04/2018	Copper	0.00536 J mg/L	0.00524 mg/L	SWB Chronic
HSM210 Trail	Stormwater	05/04/2018	Lead	0.00227 mg/L	0.0017 mg/L	SWB Chronic
HSM230 Lead 1	Stormwater	05/04/2018	Lead	0.00291 mg/L	0.0017 mg/L	SWB Chronic

Sample Location	Sample Type	Date	Analyte	Concentration	PCL or PEC	
HSM240 Lead	Stormwater	05/04/2018	Lead	0.00262 mg/L	0.0017 mg/L	SWB Chronic
HSM240 Peak	Stormwater	05/04/2018	Lead	0.00158 mg/L	0.0017 mg/L	SWB Chronic
HSM250 Lead	Stormwater	05/04/2018	Lead	0.00125 mg/L	0.0017 mg/L	SWB Chronic
HSM270 Peak	Stormwater	05/04/2018	Lead	0.00424 mg/L	0.0017 mg/L	SWB Chronic
HSM230 Lead 1	Stormwater	05/04/2018	Iron	4.86 mg/L	1.00 mg/L	SWB Chronic
HSM240 Lead	Stormwater	05/04/2018	Iron	1.53 mg/L	1.00 mg/L	SWB Chronic
HSM270 Peak	Stormwater	05/04/2018	Iron	5.24 mg/L	1.00 mg/L	SWB Chronic
HSM320	Sediment	06/28/2018	Benzo(a)anthracene	3.88 J mg/kg	1.05 mg/kg	PEC
HSM320	Sediment	06/28/2018	Benzo(a)pyrene	3.86 J mg/kg	1.45 mg/kg	PEC
HSM320	Sediment	06/28/2018	Chrysene	4.30 J mg/kg	1.29 mg/kg	PEC
HSM320	Sediment	06/28/2018	Fluoranthene	6.81 J mg/kg	2.23 mg/kg	PEC
HSM320	Sediment	06/28/2018	Pyrene	5.50 mg/kg	1.52 mg/kg	PEC
HSM320	Sediment	06/28/2018	Total PAH	39.71 mg/kg	22.8 mg/kg	PEC

PAH – Polycyclic aromatic hydrocarbon
PCL – Protective concentration levels
PEC – Probable effect concentrations
SWB Acute – Acute Surface Water Benchmark for aquatic life
SWB Chronic – Chronic Surface Water Benchmark for aquatic life

Metals in Stormwater

In stormwater samples, no analytes exceeded the Texas Commission on Environmental Quality (TCEQ) surface water standards for contact recreation and ecological health for VOCs, SVOCs, pesticides, herbicides, or PCBs (2018). Aluminum was detected in three samples at concentrations above the TCEQ acute ecological health freshwater benchmark. Aluminum concentrations exceeded chronic ecological health benchmarks in eight samples. Copper was detected in one sample at a concentration above the TCEQ chronic ecological health benchmark. Lead concentrations exceeded chronic ecological health benchmarks in eight samples. Iron concentrations exceeded chronic ecological health benchmarks in five samples. Metals are naturally occurring in soil, sediment, groundwater, and surface water. The water samples for metals analyses were filtered to reduce the potential for sediment impacting the laboratory results; however, the turbidity of the stormwater samples may have contributed to the concentrations of metals detected.

Polycyclic Aromatic Hydrocarbons in Sediment

PAHs are a group of SVOCs common in urban runoff (Mahler et al. 2005) that can have adverse effects on aquatic life, including plants, invertebrates, and fish. The effects of exposure vary but can include organ damage, reproductive harm, or immune system weakening (Mahler et al. 2005). Coal-tar parking lot sealants have been identified as a significant source of PAHs in urban waterways and were banned from use in areas surrounding the recharge zone of the Edwards Aquifer within Comal and Hays Counties by the EAA in 2012. In each sample year thus far, levels of total PAH in sediment samples have exceeded TECs and PECs at location HSM320 in the San Marcos Springs complex.

Bis(2-Ethylehexyl)Phthalate in Sediment

DEHP was detected in the majority of sediment samples from the Comal and San Marcos Springs complexes in 2013. However, DEHP results were noted in the laboratory blank samples for October 2013 surface water (base flow) sampling event and were considered likely post collection contaminants or false positive detections. In general, DEHP is quite problematic in that it is common in plastics and other materials. Therefore, the EAA considered DEHP as a likely laboratory or sampling equipment artifact. DEHP was not detected in water quality samples from both spring complexes in 2014 and 2015. In 2016, DEHP was detected in multiple surface water (base flow) and stormwater samples collected from both spring complexes. However, DEHP detections were "J" flagged, indicating that the detections were greater than the method detection limit but less than the reporting limit. In 2018, DEHP was detected in three stormwater samples in the San Marcos Springs complex and three stormwater samples in the Comal Springs complex. None of the concentrations detected exceeded Surface Water Benchmarks for aquatic life or Contact Recreation Water PCLs. DEHP was not detected in any sediment samples from either the Comal Springs or San Marcos Springs complexes.

Lead in Sediment

Lead has been detected at concentrations of 56.0 mg/kg, 235 mg/kg, 63.5 mg/kg, and 260 mg/kg in years 2013, 2014, 2015, and 2016, respectively, at sample location HSM340. The TEC and PEC for lead are 35.8 and 128 mg/kg, respectively. In 2018, lead exceeded the TEC at HSM360. Although the detection level of 127 kg/mg did not exceed the PEC at HSM360, the detection was relatively close to the PEC level of 128 mg/kg.

PDS testing conducted in both spring systems detected tetrachloroethene in the majority of samples analyzed. TPH was detected in approximately half of the samples analyzed. A few other constituents were detected only sporadically. None of the concentrations detected exceeded TCEQ Surface Water Benchmarks for aquatic life or Contact Recreation PCLs.

POCIS testing was conducted six times during the year at HCS460 and HSM470. Of the 43 PPCP constituents analyzed, 13 were detected in the Comal Springs complex and 13 were detected in the San Marcos Springs complex. No suitable regulatory standards are available to compare to POCIS results, but the data can be used as are a qualitative tool for evaluating the presence of trace concentrations of PPCP constituents.

An overview Scope of Work for the 2018 is shown in Table 28.

Table 28. Overview of Scope of Work 2018

Sample Type	Frequency
Sediment	Biennially in even years
Stormwater	• One sampling event per year in each spring complex • Test only for Integrated Pest Management Plan chemicals in odd years • Test full suite in even years as currently done • Add two samples to the rising limb of the hydrograph for a total of five samples per location when possible ○ Priority given to locations at tributary outflows
Passive Diffusion Samplers	• Currently conducted • Add pharmaceutical and personal care product membrane only at the bottom of the channel in both systems

7.0 DATA QUALITY OBJECTIVES

SWCA evaluated each sampling event to determine whether procedures should be modified to improve data collection to ensure data quality objectives are met. Appendix C discusses problems encountered, deviations to the Work Plan, and resolutions to these circumstances. The only ongoing challenge recognized is the inability to consistently deliver *E. coli* samples to a laboratory within hold times during stormwater sampling events. This inability is inherent to stormwater sampling events due to the occurrence of storms during nonworking hours. SWCA uses special runners to deliver samples to the laboratory as early as possible to minimize hold-time exceedances.

Given the procedures implemented to correct or improve data collection methods and the relatively low significance of the deviations, the circumstances described in Appendix C do not compromise the integrity of the study or this report.

8.0 DEFINITIONS

Alkalinity	The capacity of water to neutralize acids, a property imparted by the water’s content of carbonate, bicarbonate, hydroxide, and on occasion borate, silicate, and phosphate. It is expressed in milligrams per liter of equivalent calcium carbonate (mg/L $CaCO_3$).
Aquifer	Underground geological formation or group of formations containing water; source of groundwater for wells and springs.
ASTM	Abbreviation for American Society for Testing and Materials. A nonprofit organization that develops and publishes approximately 12,000 technical standards, covering the procedures for testing and classification of materials of every sort.
Bacteria	Microscopic living organisms that can aid in pollution control by metabolizing organic matter in sewage, oil spills, or other pollutants. However, certain bacteria in soil, water, or air can also cause human, animal, and plant health problems.
Basin	Any area draining to a point of interest.
Baseline data	Initial data generated by consistent monitoring of the same sites over time.
Caffeine	A stimulant drug found naturally in coffee, tea, and chocolate, and also within soft drinks and other foods. If detected, it might indicate an anthropogenic source of water impacts.
Channel	A long, narrow excavation or surface feature that conveys surface water and is open to the air.
Deionized water	Water with all ions removed.
Detection limit	The lowest concentration of a given pollutant that an analytical method or equipment can detect and still report as greater than zero. Generally, as readings approach the detection limit, they become less and less reliable quantitatively.
Dissolved solids	The total amount of dissolved material, organic, and inorganic, contained in water or wastewater. Measurements are expressed as ppm or mg/L.
DO	Abbreviation for dissolved oxygen. Oxygen molecules that are dissolved in water and available for living organisms to use for respiration. Usually expressed in milligrams per liter or percent of saturation. The concentration of DO is an important environmental parameter contributing to water quality.
DOC	Abbreviation for dissolved organic carbon, a broad classification of organic molecules of varied origin and composition within aquatic systems. Organic

	carbon compounds are a result of decomposition processes from dead organic matter, such as plants.
DQO	Abbreviation for data quality objectives, a process used to develop performance and acceptance criteria or data quality objectives that clarify study objectives, define the appropriate type of data, and specify tolerable levels of data needed to support decisions.
Drainage	The collection, conveyance, containment, and/or discharge of surface and stormwater runoff.
EARIPHCP	Abbreviation for Edwards Aquifer Recovery Implementation Program Habitat Conservation Plan.
Endpoint	That state in titration at which an effect, such as a color change, occurs, indicating that a desired point in the titration has been reached.
Equipment blank	Sample used to assess the effectiveness of the decontamination process on sampling equipment. The equipment blank is prepared by pouring reagent-grade water over/through sampling equipment and analyzing for parameters of concern (to match the sampling routine applicable to the site).
Field duplicate	Second sample collected simultaneously from the same source as the parent sample, but which is submitted and analyzed as a separate sample. This sample should generally be identified such that the laboratory is unaware that it is a field duplicate.
Filtration	The process of separating solids from a liquid by means of a porous substance (filter) through which only the liquid can pass.
Groundwater	Water found beneath Earth's surface that fills pores between materials, such as sand, soil, or gravel.
Habitat	The specific area of environment in which a particular type of plant or animal lives and grows.
HCP	Abbreviation for Habitat Conservation Plan. A planning document that is required by the United States Fish and Wildlife Service as part of their enforcement of the Endangered Species Act.
LCS/LCSD	Abbreviation for Laboratory control samples and laboratory control sample duplicate. LCS/LCSD are evaluated to assess overall method performance and are the primary indicators of laboratory performance. In general, laboratory control samples are similar in composition as the environmental samples, contain known concentrations of all the analytes of interest, and undergo the same preparatory and determinative procedures as the environmental samples. An LCS/LCSD may be analyzed to provide information on the precision of the analytical method.

MS/MSD	Abbreviation for matrix spike/matrix spike duplicate. MS/MSD results are examined to evaluate the impact of matrix effects on overall analytical performance and potential usability of the data. A matrix spike is a representative environmental sample that is spiked with target analytes of interest prior to being taken through the entire analytical process in order to evaluate analytical bias for an actual matrix. A matrix duplicate is a collected (e.g., a VOC soil sample) or a homogenized sample that is processed through the entire analytical procedure in order to evaluate overall precision for an actual matrix.
MDL	Abbreviation for method detection limit, minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero, as determined from analysis of a sample containing the analyte in a given matrix.
MPN	Abbreviation for most probable number. An analytical method used to detect the presence of coliforms in a water sample and estimate their numbers.
PCBs	Abbreviation for polychlorinated biphenyls. Group of more than 200 chlorinated toxic hydrocarbon compounds that can be biomagnified.
PCL	Abbreviation for protective concentration levels, which is established to protect human health.
Peak	Maximum instantaneous flow at a specific location resulting from a given storm condition.
pH	A measure of the alkalinity or acidity of a substance. Also defined as the negative logarithm of the hydrogen ion concentration ($-\log10[H^+]$) where H^+ is the hydrogen ion concentration in moles per liter. The pH of a substance is neutral at 7.0, acidic below 7.0, and alkaline above 7.0.
PQL	Abbreviation for practical quantitation limit, which is the smallest concentration of the analyte that can be reported with a specific degree of confidence.
Precipitation	The discharge of water, in liquid or solid state, out of the atmosphere, generally upon a land or water surface. Precipitation includes rainfall, snow, hail, and sleet.
Precision	The ability of a measurement to be consistently reproduced.
QA/QC	Abbreviation for quality assurance/quality control. The total integrated program for assuring reliability of monitoring and measurement data.
Recession	End of runoff event, which is defined as the point in time when the recession limb of the hydrograph is < 2% of the peak or is within 10% of the prestorm base flow, whichever is greater.

RPD	Abbreviation for relative percent difference. The RPD provide a measure of precision.
Representative	Said of samples collected that are similar to those of groundwater in its in situ condition.
RL	Abbreviation for reporting limit, the smallest concentration of an analyte reported by the laboratory to a customer. The RL is never less than the PQL and is generally twice the MDL.
Runoff	Precipitation, snowmelt, or irrigation water that runs off the land into surface water. Runoff can carry pollutants from the air and land into the receiving waters.
Sediment	Fragmental material that originates from weathering of rocks and is transported by, suspended in, or deposited by water or air.
Shelby Sampler	A thin-walled tube with a cutting edge at the toe. A sampler head attaches the tube to the drill rod and pressure vents. Generally used in cohesive soils. Soil or sediment sampled from this sampler is considered undisturbed.
Spring	Water coming naturally out of the ground.
Stormwater	Stormwater is the water that runs off surfaces such as rooftops, paved streets, highways, and parking lots. It can also come from hard, grassy surfaces such as lawns, play fields, graveled roads, and parking lots.
Surface water	Water that forms and remains above ground, such as lakes, ponds, rivers, streams, bays, and oceans.
SVOC	Abbreviation for semi-volatile organic compounds, which is a group of chemicals composed primarily of carbon and hydrogen that have a relatively low tendency to evaporate (volatilize) into the air from water or soil. Some of the compounds that make up asphalt are examples of SVOCs.
TDS	Abbreviation for total dissolved solids, or the total amount of all inorganic and organic substances, including minerals, salts, metal, cations, or anions that are dispersed within a volume of water.
Temporal	Over a period of time.
TKN	Abbreviation for total Kjeldahl nitrogen, which is the total concentration of organic and ammonia nitrogen in wastewater.
TOC	Abbreviation for total organic carbon, which is the gross amount of organic matter found in natural water. Suspended-particulate, colloidal, and dissolved organic matter are part of the TOC measurement. Settable solids consisting of inorganic

	sediments and some organic particulate are not transferred from the sample by the lab analyst and are not part of the TOC measurement.
TSBC	Texas-specific Background Concentrations as established by the Texas Commission on Environmental Quality.
Turbidimeter	An instrument for measuring turbidity in which a standard suspension is used for reference.
Turbidity	A measure of how clear the water is; how much the suspended material in water results in the scattering and absorption of light rays. An analytical quantity is usually reported in turbidity units and determined by measurements of light diffraction. Material that can increase turbidity (reduce clarity of water) are suspended clay, silt, sand, algae, plankton, microbes, and other substances.
Trip blank	Sample known to be free of contamination (for target analytes) that is prepared in the laboratory and treated as an environmental sample after receipt by the sampler. Trip blank samples are applicable to VOC analysis only.
TSS	Abbreviation for total suspended solids, which are the nonfilterable residue retained on a glass-fiber disk filter mesh measuring 1.2 micrometers after filtration of a sample of water or wastewater.
USGS	Abbreviation for Unites States Geological Services. USGS is a federal research organization that provides impartial information on health of ecosystems and environment, natural hazards that may threaten us, natural resources, impacts of climate and land use change, and core science systems which provide timely, relevant, and useable information.
VOC	Abbreviation for volatile organic compounds, which are often used as solvents in industrial processes and are either known or suspected carcinogens or mutagens. The five most toxic are vinyl chloride, tetrachloroethene, trichloroethene, 1,2-dichloroethane, and carbon tetrachloride.
Whirl-Pak®	Sterilized, clear polyethylene bag used to collect water samples for analysis.
WQAL	Abbreviation for a list of parameters defined as the following: pH, conductivity, temperature, dissolved oxygen, turbidity, and alkalinity in the field. Other parameters submitted for laboratory analysis include cations, anions, nutrients, metals, VOCs, SVOCs, herbicides and pesticides, bacteria, TOC, PCBs, and phosphorous.

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APPENDIX A

EDWARDS AQUIFER HABITAT CONSERVATION PLAN (EAHCP) REPORT OF THE 2016 EXPANDED WATER QUALITY MONITORING PROGRAM WORK GROUP AND REPORT OF THE 2016 BIOLOGICAL MONITORING PROGRAM WORK GROUP

Edwards Aquifer Habitat Conservation Plan

Report of the 2016 Expanded Water Quality Monitoring Program Work Group

and

Report of the 2016 Biological Monitoring Program Work Group

June 23, 2016

The 2016 EAHCP Biological Monitoring Program Work Group (BioMWG) and the 2016 EAHCP Expanded Water Quality Monitoring Program Work Group (WQWG) were formed to produce final reports for review by the EAHCP Implementing Committee. The Work Groups were comprised of representatives from throughout the Edwards Aquifer Region and the charge of both Work Groups was to carry out a holistic review of the current programs and to evaluate possible changes based on the recommendations of National Academy of Sciences (NAS), the NAS Work Group, the input of the Science Committee, the Permittees, and subject matter experts.

The Implementing Committee appointed members to each of the Work Groups. Meetings took place from March through May 2016. At these meetings, each Work Group engaged in focused discussions about possible modifications to its respective monitoring program. Each meeting was facilitated by EAHCP staff and Design Workshop (a facilitation contractor) and was open for public participation. All related meeting materials, including agendas, meeting minutes, presentations, and draft reports were posted to the EACHP website (www.eahcp.org).

The WQWG initially reviewed two alternate Scopes of Work (SOW) which resulted in the development of a third SOW alternative that combined elements of Alternatives 1 and 2. The WQWG approved Alternative 3 with modifications, which included the following: (1) removing surface water (base flow) monitoring from the program; (2) reducing sediment monitoring to once per year, only in even years; (3) adding one real-time monitoring station per spring system; (4) reducing stormwater monitoring to one sampling event per year with Integrated Pest Management Plan (IPMP) chemicals plus atrazine in odd years, and the full suite of chemicals in even years; (5) continuing PDS sampling, but adding a PPCP membrane to the furthest downstream PDS site in each system; (6) removing groundwater monitoring from the program; and (7) adding biotic tissue (e.g., fish tissue) sampling in odd-numbered years (**Table W7**).

The WQWG's final recommendations also included recommendations on the methodology for determining historic water quality conditions in the spring systems, (**Table W8**), recommendations on the criteria for analytical limits for EAHCP water quality data, (**Table W9**), and recommendations related to the NAS *Report 1* (**Table W10**).

The background of the Biological Monitoring Program (BioMP) was reviewed by the BioMWG, and it was determined that due to the maturity of the program, minimal changes to the SOW were required. The final recommendations (**Table B3**) by the BioMWG included for (1) macroinvertebrate food source monitoring to be substituted with rapid bioassessments (RBAs); and (2) to remove flow partitioning within Landa Lake, because it will be monitored through EAA.

Throughout their meetings, the WQWG and the BioMWG discussed the importance of integrating the two programs in order to improve overall effectiveness of EAHCP monitoring efforts. At their final meeting, the WQWG and the BioMWG jointly made recommendations for synergistic activities between the programs that, if implemented, will be beneficial to the implementation of the EAHCP. These synergies (**Tables W11 and B5**) included:

1. Using RBAs to help identify water quality impairments and measure ecosystem health;
2. Using water quality data from the BioMP to measure nutrient impairments, such as Soluble Reactive Phosphorus (SRP);
3. Analyzing data from WQMP, BioMP, EAA Well Sampling Program, and Clean Rivers Program (CRP), collectively;
4. Collecting more real-time water quality data, because it is more biologically-relevant; and
5. Requiring monitoring of riparian conditions as a part of the City of New Braunfels, City of San Marcos, and Texas State University Work Plans.

The Work Groups also explored the feasibility of coordinating sampling at the same locations. It was determined that adjusting the monitoring locations would not be appropriate.

The final draft of *Report of the 2016 EAHCP Expanded Water Quality Monitoring Program Work Group* and *Report of the 2016 EAHCP Biological Monitoring Program Work Group* was presented under one cover page, along with this joint executive summary and the following joint table of contents and index of tables, to the Implementing Committee for approval at their June 23, 2016 meeting.

Joint Table of Contents

Report of the 2016 Expanded Water Quality Monitoring Program Work Group

Report of the 2016 Biological Monitoring Program Work Group

Appendices

Index of Tables

Report of the 2016 Expanded Water Quality Monitoring Program Work Group

Introduction: Report of the 2016 Expanded Water Quality Monitoring Program Work Group

The Edwards Aquifer Habitat Conservation Plan (2012) (EAHCP) outlined the Expanded Water Quality Monitoring Program (WQMP) to:

(1) provide early detection of water quality impairments associated with the San Marcos and Comal Spring and River systems that may negatively impact the Covered Species, and
(2) identify the point and nonpoint sources of those impairments, supporting Covered Species protection by allowing for investigation and adoption of any necessary measures through the Adaptive Management Process (AMP) to address the source(s) of the concerning indicators (*EAHCP, §5.7.2*).

As WQMP components, the EAHCP outlines stormwater, surface, and groundwater sampling (*EAHCP, §5.7.2*). Since the start of the program, the EAHCP Science and Implementing Committees supported the addition of sediment and passive diffusion sampling (PDS) to the WQMP. The EAHCP allows for flexibility in the determination of frequency, sampling time, location, and parameters.

In 2015, the EAHCP received the *National Academy of Sciences (NAS) Report 1* (2015), containing recommendations for EAHCP's Monitoring, Modeling and Applied Research programs, including the WQMP. From *Report 1*, a list of water quality monitoring recommendations was presented to the NAS Recommendation Review Work Group (NAS Work Group). Based on the NAS Work Group assessment, at its February 18, 2016 meeting, the Implementing Committee convened the 2016 EAHCP Expanded Water Quality Monitoring Program Work Group (WQWG) to carry out a holistic review of the WQMP, taking into account the recommendations of NAS, the NAS Work Group, the input of the Science Committee, the Permittees, and subject matter experts. The purpose of the Work Group is to produce a final report for review by the Implementing Committee, developed through a consensus-based decision making process.

The Implementing Committee assigned the following members to the WQWG and approved its charge: Kenneth Diehl (San Antonio Water System), Melani Howard (City of San Marcos/Texas State University), Charles Kreitler (EAHCP Science Committee), Steven Raabe (EAHCP Stakeholder Committee/San Antonio River Authority), Benjamin Schwartz (Texas State University), and Michael Urrutia (Guadalupe-Blanco River Authority). The WQWG held meetings from March to May 2016. Steven Raabe was appointed as joint Chair of both the WQWG and the Biological Monitoring Work Group (BioMWG). Meetings were held as open forums where attendees actively participated in the discussion and provided valuable input. Abbreviations, acronyms and a glossary of terms are in Appendices A and B. The charge, agendas and minutes from each meeting are included in Appendices C and E.

Operational Guidelines

In its first meeting, the WQWG identified basic operational principles and guidelines to ensure a holistic review and focused discussion about possible modifications to the SOW for the existing EAHCP WQMP (Appendix F). The WQWG unanimously approved four guidelines at its March 29, 2016 meeting, which are listed below, along with a short description:

1. Consensus-approved
   Formulating recommendations through group discussion and consensus, to ensure that everyone has a voice in the process.
2. Conserves dollars (no increase in budget)
   Prioritizing modifications to the SOW that may have impacts on the allocation of finite program resources. Some WQWG members maintained that this consideration, while important, should not compromise science-based decision-making. This advice was heeded over the course of both the WQWG's and BioMWG's processes.
3. Species-driven
   Confirming sampling methods are reliable, valid measures of conditions that have a potential impact on the health of the species.
4. Supports Habitat Conservation Plan Biological Goals and Objectives
   Ensuring recommendations relate to the habitat conservation, consistent with Biological Objectives and Goals.

Six additional points to consider were agreed upon as important, but not required, as the group performed its duties. These points are:

- Does the modification eliminate duplication?
- Does the modification enable an evaluation of long-term trends?
- Does the modification integrate data collected by the EAHCP WQMP, EAHCP BioMP, and other monitoring programs?
- Does the modification contribute to an understanding of the effectiveness of conservation measures?
- Does the modification consider point and non-point sources?
- Does the modification demonstrate an awareness of strategies employed by others?

The WQWG followed a thoughtful, deliberative process when considering possible modifications to the existing EAHCP WQMP. Each meeting featured a great deal of productive discussion by Work Group members. Work Group meetings were facilitated by EAHCP staff as well as by Design Workshop, a facilitation contractor retained to assist with the meetings.

The WQWG process began with presentations of potential revised Scopes of Work (SOW) for the EAHCP WQMP. These revised SOW were designed to incorporate different blends of the recommendations that have been made by NAS, the EAHCP Science Committee, and various other entities. EAHCP developed the initial SOW based on the input of a wide variety of stakeholders, including the EAA's Aquifer Science Department, Work Group members, the Science Committee, and the US Fish & Wildlife Service. The revised SOW are "Alternatives 1 and 2" presented in **Table W1**.

At the work session meeting on March 29, 2016, Alternatives 1 and 2 were discussed. The need for additional information was identified. The WQWG requested EAHCP staff to provide additional information concerning results to date of sampling proposed to be suspended (e.g., surface water), and to provide comparisons between the EAHCP water quality program and other programs, such as the CRP, that would provide surrogate information in the event the WQWG decided to recommend discontinuing certain current sampling methods within the EAHCP WQMP.

The WQWG also emphasized that any changes should, to the extent practicable and appropriate, build on existing data sets. This would ensure that investment in the existing baseline would be added to over coming years, providing a potentially useful data set for the evaluation of trends in water quality, changes in water quality, or any other applied analyses appropriate and consistent with the EAHCP. The WQWG also considered potential contamination related to the golf courses, as well as potential non-point source contamination associated with urbanization of the springs system watersheds. The WQWG recommends that any changes to the monitoring programs account for these potential sources of potential water quality impairments.

Also at the March 29 work session, the WQWG discussed the benefits of adding tissue sampling, such as fish tissue, into the EAHCP monitoring program during the odd-numbered years. At this meeting, the WQWG did not make specific recommendations as to the type of tissue sampling. They recommended consulting with subject matter experts to determine the specific species to be sampled and parameters to be analyzed for this sampling method.

For the April 27, 2016 meeting, the EAHCP Program Manager developed a third revised SOW, "Alternative 3," in response to issues identified by the WQWG with Alternatives 1 and 2. Alternative 3, also presented in **Table W1**, combined certain elements of Alternatives 1 and 2 that the WQWG agreed to, and introduced new elements that were not previously presented. At the April 27, 2016 meeting, the WQWG approved Alternative 3, with the incorporation of the following modifications:

- The addition of two stormwater samples at each existing stormwater sampling location to the initial rise of the hydrograph, while keeping the same 3 original samples as identified (onset, peak, and tail) in the original SOW, for a total of 5 samples per location.
- It is understood that due to timing and logistics, 5 samples at each location may not be feasible. Therefore, the 5 samples, rather than just 3, should be prioritized for locations near tributary outflows, with Sessom and Purgatory creeks having priority.

Table W1 Proposed SOW Modifications.

At the March 29, 2016 and April 27, 2016 meetings of the WQWG, the EAHCP Program Manager presented a matrix outlining options for modifying the EAHCP WQMP SOW based upon input received as described in the WQWG charge.

	Alternative 1	Alternative 2	Alternative 3
Current WQMP Sampling Method	Proposed Modification and Rationale		
Surface water (base flow)	Remove from program • Sampled by CRP • No significant detects • EAA BioMP collects field and nutrients water quality at low and high flow	Remove from program • Sampled by CRP • No significant detects • EAA BioMP collects field and nutrients water quality at low and high flow	Remove from program • Sampled by CRP • No significant detects • EAA BioMP collects field and nutrients water quality at low and high flow
Sediment	Reduce to biennial • Also covered through PDS • Biological monitoring data do not suggest impact to Covered Species	Remove from program • Replace with PDS and tissue sampling • Biological monitoring data do not suggest impact to Covered Species	Remove in odd years, reduce to once per year • Data will change little throughout the year • Biological monitoring data do not suggest impact to Covered Species • Provides information on water quality trends in toxic parameters

	Alternative 1	Alternative 2	Alternative 3
Current WQMP Sampling Method	Proposed Modification and Rationale		
Real-time monitoring	Add one sampling station per system • Valuable source of continuous information that is ecologically relevant • Field parameters collected every 15 minutes: DO, conductivity, turbidity, temperature, pH	Add one sampling station per system • Valuable source of continuous information that is ecologically relevant • Field parameters collected every 15 minutes: DO, conductivity, turbidity, temperature, pH	Add one sampling station per system • Valuable source of continuous information that is ecologically relevant • Field parameters collected every 15 minutes: DO, conductivity, turbidity, temperature, pH
Stormwater	Reduce to one sampling event per year, test only for IPMP chemicals • Turnover rate, dilution • Lack of significant detects	Remove from program • Turnover rate; dilution • Lack of significant detects	Reduce to one sampling event each year; test for herbicide and pesticide compounds included in the City of San Marcos and New Braunfels IPMPs associated with golf courses, including atrazine in odd years, full suite in even years as currently done, add two samples to the rising limb of the hydrograph for a total of 5 samples/location; priority given to locations at tributary outflows • Turnover rate, dilution • Lack of significant detects
PDS	Add PPCP membrane • PDS provides a sensitive index for contamination in the spring systems	Add PPCP membrane • PDS provides a sensitive index for contamination in the spring systems	Add PPCP membrane only at furthest downstream site • PDS provides a sensitive index for contamination in the spring systems
Groundwater (well)	Remove from program • Purpose is to detect movement of bad water line	Remove from program • Purpose is to detect movement of bad water line	Remove from program • Purpose is to detect movement of bad water line

	Alternative 1	Alternative 2	Alternative 3
Current WQMP Sampling Method	Proposed Modification and Rationale		
	• Already sampled by EAA	• Already sampled by EAA	• Already sampled by EAA
Tissue sampling	Not included as component	Add to program • Represents direct link to Covered Species • Parameters to be established (work with experts) • Provides new information and data • Largemouth Bass, Asian Clams, Fountain Darter to be sampled	Add to program, one sample in odd years • Represents direct link to Covered Species • Parameters and species to be established (work with experts) • Provides new information and data • Species to be sampled will be determined in consultation with experts

Table W2, summarizes the EAHCP surface WQMP parameters suspended as part of Alternative 3. The WQWG carefully evaluated the implications of dropping each of the surface parameters. The list features only those elements which, once dropped from the EAHCP WQMP, would no longer be monitored within either of the spring systems by either the EAHCP BioMP, which includes some water quality elements, or the CRP as conducted by the Guadalupe-Blanco River Authority (GBRA) or the Texas Commission on Environmental Quality (TCEQ).

As shown in the “Justification” column of **Table W2**, some dropped parameters would continue to be monitored through other sampling methodologies (e.g., stormwater), or were drinking water quality oriented. It should be noted that surface water monitoring data will not be dropped entirely from the EAHCP WQMP, as EAHCP will use CRP surface water quality data instead (see also *Review and Analysis of EAHCP Water Quality Data*, p. 12).

Table W2 Suspended Water Quality Parameters.

Suspended Water Quality Parameters		
Surface (Base Flow) Parameters		Justification
Chem	"General chemistry" (TDS, Br, Fl, Ca, Mg, Na, K, Si, Sr, CO3)	Will be monitored through: stormwater, sediment, EAA spring sampling
Toxics/PCPP/Pathogens	VOCs & SVOCs	Will be monitored through: stormwater, sediment, PDS, EAA spring sampling
	Organochlorine Pesticides	
	Polychlorinated Biphenyls (PCBs)	
	Organophosphorus Pesticides	
	Herbicides	
	Metals (Al, Sb, As, Ba, Be, Cd, Cr (total), Cu, Fe, Pb, Mn,Hg, Ni, Se, Ag, Tl, and Zn)	
	Caffeine	
Nutrients	Total Organic Carbon (TOC)	Drinking water quality concern; will be monitored through EAA spring sampling
	Dissolved Organic Carbon (DOC)	Drinking water quality concern

The EAHCP sets Key Management Objectives for the Covered Species that water quality conditions should remain within 10 percent deviation (daily average) of the long-term historical average (*EAHCP, §4.1.1*). The EAHCP indicates that the data set from which long-term historical averages are to be calculated is the EAA Variable Flow Study. However, the 15 locations originally monitored within that study were dropped after two years of highly consistent data (2000-2002).

Nevertheless, since the beginning of the Variable Flow Study in 2000, water quality parameters have been collected through other components of the Variable Flow Study. This issue was revisited by the WQWG in order to obtain their recommendation on what datasets would be appropriate to use to calculate long-term historical averages (2000-2012). Daily average water quality conditions would be compared in accordance with the EAHCP Key Management Objectives (see also *Review and Analysis of EAHCP Water Quality Data*, p. 12).

At the March 29, 2016 meeting, the WQWG agreed by consensus to recommend the following datasets, presented in **Table W3**, to calculate the historic water quality conditions (long-term averages of field parameters: DO, pH, temperature, conductivity) in the Comal River and San Marcos River ecosystems.

Table W3 Historic Water Quality Conditions.

Species Type	Data Source	Comal River Ecosystem	San Marcos River Ecosystem	Justification
Fountain Darter	*Variable Flow study Fountain Darter Drop-net Sampling, 2000-2012 (biannual)*	• Upper Spring Run • Landa Lake • Old Channel Reach • New Channel Reach	• IH-35 • City Park • Spring Lake Dam; initiated in 2013	• Long-term • Consistent with EAHCP • Measurements taken at multiple water column levels, including sediment-interface, which is to be used for Fountain Darter analysis.
Comal Springs Riffle Beetle, Comal	*EAA monitoring data of Comal spring openings*	• Spring Run 1 • Spring Run 3 • Spring Run 7		• Long-term

Springs Dryopid Beetle, Peck’s Cave Amphipod				
Texas Blind Salamander	*EAA monitoring data of Spring Lake spring openings*		• Deep Spring • Hotel Spring	• Long-term

Since its inception, the EAHCP WQMP has been implemented using Drinking Water Quality Standards (*30 TAC Chapter 290*) as the criteria for comparison of whether water quality results were below, at, or in exceedance of regulatory limits. Due to the fact that the WQMP is intended for protection of the Covered Species and their habitat, however, the WQWG determined that drinking water quality standards were not well-suited.

For this reason, at the March 29, 2016 meeting, the WQWG agreed by consensus on the following recommendations (**Table W4**) for changes to analytical limits for the EAHCP WQMP data. In instances where a parameter on the Aquatic Life Protection (ALP) criteria is not currently included within the standard EAHCP parameters, it will be added. Conversely, current EAHCP parameters not included within ALP criteria will be maintained. Parameters not listed on the Aquatic Life Protection will be compared against drinking water quality standards consistent with current practice (*30 TAC Chapter 307*).

The WQWG suggested it be noted that interpreting stormwater results in comparison with ALP criteria should take into account dilution and flow-through; stormwater results largely represent ephemeral water quality conditions, and duration of exceedance of criteria should be taken into account. In instance where ALP minimum criteria are less than current criteria, current criteria will not be lowered to conform with ALP criteria, in order to maintain comparability in the dataset over time.

Table W4 Analytical Limits.

Sampling Method	Current	WQWG Approved Limits
Surface (base flow)	Drinking water quality standards *30 TAC Chapter 290*	Aquatic life protection *30 TAC Ch. 307 Rule Section 307.6*
Stormwater	Drinking water quality standards *30 TAC Chapter 290*	Aquatic life protection *30 TAC Ch. 307 Rule Section 307.6*
Real-time monitoring	Historical long-term averages	Historical long-term averages
Sediment	*MacDonald, Ingersoll, and Berger (2000) & Texas Commission on Environmental Quality (2014)*	*MacDonald, Ingersoll, and Berger (2000) & Texas Commission on Environmental Quality (2014)*
PDS	None	Create baseline
Tissue sampling	None	Create baseline

Throughout its meetings, the WQWG recommended that the regular review and analysis of all water quality data be proceduralized, including data incorporated under the EAHCP WQMP and other programs, such as the EAHCP BioMP and the CRP, in cases where data from those other programs has been identified as appropriate to be included (such as surface water (base flow) sampling).

The WQWG recommends collaboration with other programs conducting water quality monitoring within the spring systems, namely, the CRP, currently conducted by GBRA and TCEQ in the Comal and San Marcos rivers, respectively, as well as the BioMP, which is a component of the EAHCP (see also, *Synergies between the Monitoring Work Groups*, p. 16), and the EAA Aquifer Science Department, which conducts groundwater and spring orifice sampling programs. Results from these complementary programs will be obtained by EAHCP staff once they are available; review and analysis of results will be conducted as contemplated by the plan developed to proceduralize the regular review and analysis of EAHCP water quality data.

As part of the review and analysis procedure, the Work Group also recommended that, in the event of changes to land-use within either of the spring system watersheds, a contingent re-evaluation of whether stormwater sampling methodologies should be modified should be conducted (e.g., if the Texas State University Golf Course or Landa Park Golf Course were converted to some other use).

Further, the WQWG recommended that the regular review and analysis of data should include results from past years, so that trends associated with any impairments to the systems can be identified. Through the analysis of stormwater data in particular, this exercise would help develop a better understanding of flood events, and their impact on the two systems. In 2016, the EAHCP will be developing a comprehensive database to store and secure all data collected through the EAHCP and the Edwards Aquifer Recovery Implementation Program (EARIP). This database will integrate water quality monitoring data with biological monitoring data to make this regular review and analysis of all data a routine component of the EAHCP monitoring programs.

Overall, the purpose for recommending a more systematic, regular procedure for the review and analysis of the water quality data was to ensure that monitoring results are duly taken under consideration to inform the ongoing management of the EAHCP, in accordance with the purpose of the WQMP as it is described in the EAHCP.

NAS Report 1 and NAS Work Group Recommendations

In 2015, the EAHCP received the National Academy of Sciences (NAS) *Report 1* (2015), containing recommendations for the WQMP. From *Report 1*, a list of water quality monitoring-related recommendations was presented to the NAS Work Group. The NAS Work Group deferred certain NAS recommendations associated with water quality monitoring for consideration by the WQWG. At its March 29, 2016 meeting, the WQWG considered recommendations from the NAS' *Review of the Edwards Aquifer Habitat Conservation Plan: Report 1*, and the *Final Report* of the NAS Work Group. The WQWG's final recommendations are presented below in **Table W5**:

Table W5 NAS Recommendations.

NAS Report 1	NAS Work Group	WQWG Recommendation
Sampling not randomized; cannot extrapolate. Expand reaches to system-wide sampling.	If a reason to scale results to the entire spring system is identified, then consider through by work group.	No. Continue to utilize Long Term Biological Goal (LTBG); extrapolation unnecessary.
Consider household chemicals, personal care products, & residential herbicides.	Determining whether enhanced sampling for nutrients and household/personal care products is needed.	Agreed. Alternative #3 – Golf course IPMP sampling Alternatives #3– PCPP PDS sampling
Reduce frequency/locations if no significant concentrations of given contaminant are observed.	None	Agreed. Alternative #3 – Surface water quality, nutrients, others (see **Table W2**)
Increased coordination/integration of the monitoring activities is needed.	None	Agreed. To be accomplished through WQWG and BioMWG

NAS Report 1	NAS Work Group	WQWG Recommendation
Nutrients detection limits should be reduced to enhance detection of possible water quality impairments.	Nutrients play an important role in the systems; re-evaluate.	Drop nutrient sampling from the EAHCP WQMP; Recommend nitrate, ammonia, and soluble reactive phosphorus as the primary nutrients of concern within the spring systems; Lower soluble reactive phosphorus detection limits employed by the EAHCP BioMP to at least 5 micrograms/liter to enhance detection of possible impairments associated with this nutrient; and continue use of 100 micrograms/liter for ammonia as used by CRP.
None	WQMP should focus on parameters and limits used for Covered Species protection and for watersheds, rather than mimicking standard WQMPs.	Agreed. Operational Guidelines
None	PDS might be a more cost-effective alternative to comprehensive grab sampling.	Agreed. Alternative #3 - PDS

With regards to NAS' recommendation concerning nutrients, the WQWG requested additional information concerning current sampling, detection limits, and the relationship between various nutrients and ecosystem functioning be presented at their April 27, 2016 meeting.

This exercise resulted in **Table W6**, which compares nutrient parameters monitored between each of the three programs operating in the springs systems, along with detection limits used for each parameter.

Table W6 Monitored Nutrient Parameters.

Analytes	Results	EAHCP WQ	EAHCP BioMP	CRP
	Detection level comments	*Method Detection Limit*	*Method Detection Limit*	*Ambient Water Reporting Limit*
Nitrate	Minimum 110/180 µg/L Comal,/San Marcos, respectively	25 µg/L	50 µg/L	50 µg/L
Ammonia	Ammonia detection limits meet TCEQ approval	Not tested	Not tested	100 µg/L
SRP	~95% non-detects	Not tested	50 µg/L	Not tested

Additionally, staff analyzed existing water quality data to compare against recommended detection limits. Among primary nutrients of concern, it was found that:

- The vast majority of the time, nitrate levels were well above NAS-recommended limits; and
- Soluble reactive phosphorus analysis resulted in 95% non-detects at the current detection limits.

Based on this presentation, and additional research presented to the WQWG at the May 11, 2016 meeting, the WQWG recommended:

- Discontinue nutrient sampling from within the EAHCP WQMP;
- Acknowledge nitrate, ammonia, and soluble reactive phosphorus as the primary nutrients of concern within the spring systems;
- Decrease the SRP detection limits employed by the EAHCP BioMP to 3-5 micrograms/liter to enhance detection of this nutrient; and
- Obtaining information on ammonia levels from the CRP.

Synergies between the Monitoring Work Groups

While NAS *Report 1* recognized that the EAHCP monitoring programs have provided a wealth of information on the physical, chemical, and biological characteristics of the springs ecosystems, NAS recommended an increase in the coordination between the monitoring programs to more fully assess the systems' environmental conditions.

Throughout their meetings, the WQWG and the BioMWG discussed the importance of integrating the two programs in order to improve overall effectiveness of the EAHCP monitoring efforts. They also discussed how monitoring data can assist in implementing some habitat restoration measures.

At their final meeting on May 20, 2016, the WQWG and the BioMWG jointly considered synergistic activities between the programs that, if implemented, will be beneficial to the implementation of the EAHCP. These synergies are:

1. Using RBAs to help identify water quality impairments and measure ecosystem health;

2. Using water quality data from the BioMP to measure nutrient impairments, such as Soluble Reactive Phosphorus (SRP);

3. Analyzing data from WQMP, BioMP, EAA Well Sampling Program, and Clean Rivers Program (CRP), collectively;

4. Collecting more real-time water quality data, because it is more biologically-relevant; and

5. Requiring monitoring of riparian conditions as a part of the City of New Braunfels, City of San Marcos, and Texas State University Work Plans.

The Work Groups also explored the feasibility of coordinating sampling at the same locations. It was determined that adjusting the monitoring locations would not be appropriate.

WQWG Conclusion

At their final meeting on May 20, 2016, the WQWG unanimously approved this draft report, along with the tables which summarize the following:

- Final recommendations of changes to the SOW for EAHCP WQMP (**Table W7**);
- Final recommendations on the methodology to be used in determining historic water quality conditions in the spring systems (**Table W8**);
- Final recommendations on the criteria for analytical limits for EAHCP water quality data (**Table W9**);
- Final recommendations related to the WQMP recommendations from the NAS *Report 1* and the NAS Recommendations Review Work Group (**Table W10**); and
- WQMP synergies with the BioMP (**Table W11**).

Table W7 Final SOW Recommendations.

Sampling Method	Final Recommendations	Justification
Surface water (base flow)	Remove from program	• Sampled by CRP • No significant detects • EAA BioMP collects field and nutrients water quality at low and high flow
Sediment	Biennially in even years	• Data will change little throughout the year • Biological monitoring data do not suggest impact to Covered Species • Provides information on water quality trends in toxic parameters
Real-time monitoring	Add one monitoring station per system	• Valuable source of continuous information that is ecologically relevant • Field parameters collected every 15 minutes: DO, conductivity, turbidity, temperature, pH

Sampling Method	Final Recommendations	Justification
Stormwater	Reduce to one sampling event each year; Test only for IPMP chemicals in odd years, test full suite in even years as currently done, add two samples to the rising limb of the hydrograph for a total of 5 samples/location; priority given to locations at tributary outflows	• Turnover rate, dilution • Lack of significant detects
PDS	Add PPCP membrane only at bottom of channel	• PDS provides a sensitive index for contamination in the spring systems
Groundwater (well)	Remove from program	• Purpose is to detect movement of bad water line • Already sampled by EAA
Tissue sampling	Add to program, one sample in odd years	• Represents direct link to Covered Species • Parameters and species to be established (work with experts) • Provides new information and data • Species to be sampled will be determined in consultation with experts

Table W8 Final Recommendations for Determining Historic Water Quality Conditions.

Species Type	Data Source	Comal River Ecosystem	San Marcos River Ecosystem	Justification
Fountain Darter	*Variable Flow study Fountain Darter Drop-net Sampling, 2000-2012 (biannual)*	• Upper Spring Run • Landa Lake • Old Channel Reach • New Channel Reach	• IH-35 • City Park • Spring Lake Dam initiated in 2013	• Long-term • Consistent with EAHCP • Measurements taken at multiple water column levels, including sediment-interface, which is to be used for Fountain Darter analysis.
Comal Springs Riffle Beetle, Comal Springs Dryopid Beetle, Peck's Cave Amphipod	*EAA monitoring data of Comal spring openings*	• Spring Run 1 • Spring Run 3 • Spring Run 7		Long-term
Texas Blind Salamander	*EAA monitoring data of Spring Lake spring openings*		• Deep Spring • Hotel Spring	• Long-term

Table W9 Final Recommendations for Analytical Limits.

Sampling Method	WQWG Approved Limits
Surface (base flow)	Aquatic Life Protection *30 TAC Ch. 307 Rule Section 307.6*
Stormwater	Aquatic Life Protection *30 TAC Ch. 307 Rule Section 307.6*
Real-time monitoring	Historical long-term averages
Sediment	*MacDonald, Ingersoll, and Berger (2000) & Texas Commission on Environmental Quality (2014)*
PDS	Create baseline
Tissue sampling	Create baseline

Table W10 NAS Recommendations.

Recommendations from NAS Report 1	Final Recommendations
Sampling not randomized; cannot extrapolate. Expand reaches to system-wide sampling.	Continue to use LTBG
Consider household chemicals, personal care products, & residential herbicides.	Include Golf course IPMP sampling in stormwater sampling and include PPCP in PDS sampling
Reduce frequency/locations if no significant concentrations of given contaminant are observed.	Surface water quality, nutrients, others (see **Table W2**)
Nutrients detection limits should be reduced to enhance detection of possible water quality impairments.	Discontinue nutrient sampling from the EAHCP WQMP; Recommend nitrate, ammonia, and soluble reactive phosphorus as the primary nutrients of potential concern within the spring systems; Lower soluble reactive phosphorus detection limits employed by the EAHCP BioMP to at least 5 micrograms/liter to enhance detection of nutrient; and continue use of 100 micrograms/liter for ammonia as used by CRP

WQMP should focus on parameters and limits used for Covered Species protection and for watersheds, rather than mimicking standard WQMPs.	Operational Guidelines of Work Group includes the focus on the Covered Species
PDS might be a more cost-effective alternative to comprehensive grab sampling.	Continue PDS monitoring
Increased coordination and integration of the monitoring activities is needed.	Synergies between monitoring programs are summarized in **Table W11**

Table W11 Synergies.

Synergies with the BioMP	
Synergy	Comments
Using RBAs (EAHCP BioMP) to help identify toxic water quality impairments.	RBAs will be included in the BioMP as a first screening of water quality impairments in the springs' systems.
Using water quality data from BioMP to measure nutrient impairments, such as SRP	Modify method detection limit (MDL) for SRP from 50 ug/L to at least 5 ug/L.
Analyzing data from WQMP, BioMP, EAA Well Sampling & CRP, collectively.	No comments.
Collecting more real-time water quality data because it is more biologically-relevant.	One additional data sonde will be installed in each springs system.
Requiring monitoring of riparian conditions as a part of Permittees' Work Plans.	Require monitoring before and after riparian conditions as part of the Permittees' Riparian Work Plans, such as light penetration and potentially other measures - depending on the project footprint and design.
Explore the feasibility of coordinating sampling at the same locations and/or times.	No changes will be made to existing sampling locations or times as it is unlikely to provide any additional information.

With these summaries, the WQWG recommends this report to the Implementing Committee, as its final deliverable for approval and adoption.

Suggested Citation:
Edwards Aquifer Habitat Conservation Plan (2016). *Report of the 2016 Expanded Water Quality Monitoring Work Group*. San Antonio, TX: Edwards Aquifer Habitat Conservation Plan.

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Report of the 2016 Biological Monitoring Program Work Group

Introduction: Report of the 2016 Biological Monitoring Program Work Group

The Edwards Aquifer Habitat Conservation Plan (2012) (EAHCP) outlined the Biological Monitoring Program (BioMP) to fill important gaps in knowledge about, and to refine estimates of, the ecological condition of the Comal and San Marcos springs and river ecosystems through an ongoing program of collection of baseline and critical period biological monitoring data (*EAHCP, §6.3.1*). This program provides a means of monitoring changes to habitat availability and population abundance of the Covered Species that may result from Covered Activities (*EAHCP, §6.3.1*).

In 2015, the EAHCP received the National Academy of Sciences (NAS) *Report 1* (2015), containing recommendations for all EAHCP programs, including the BioMP. From *Report 1*, a list of biological monitoring-related recommendations was presented to the NAS Recommendation Review Work Group (NAS Work Group). Based on the NAS Work Group assessment (2015), at its February 18, 2016 meeting, the Implementing Committee approved the creation of the 2016 EAHCP BioMP Work Group (BioMWG) whose charge is to carry out a holistic review of the BioMP, taking into account the recommendations of NAS and the NAS Work Group, and the input of the Science Committee, the Permittees, and subject matter experts. The purpose of the Work Group is the production of this final report for review by the Implementing Committee, developed through a consensus-based decision-making process.

On February 18, 2016, the Implementing Committee assigned the following members to the BioMWG and approved its charge: Tyson Broad (Texas Tech University), Jacquelyn Duke (EAHCP Science Committee/Baylor University), Mark Enders (City of New Braunfels), Rick Illgner (EAA), and Doyle Mosier (EAHCP Science Committee). The Work Group held meetings from March to May 2016. To help coordinate and lead efforts, Steven Raabe was appointed as joint Chair of both the WQWG and BioMWG. Meetings were held as open forums where attendees actively participated in the discussion and provided valuable input. Abbreviations, acronyms, and a glossary of terms are provided in Appendices A and B. The charge, agendas, and minutes from each meeting are included in Appendices D and E.

Operational Guidelines

In its first meeting, the BioMWG identified basic operating principles and guidelines to ensure a holistic review and focused discussion about possible modifications to the SOW for the existing EAHCP BioMP (Appendix G). The BioMWG approved the following guidelines at its March 29 meeting; with the condition that budget should not affect scientific recommendations for the BioMP:

1. Consensus-approved
   Formulating recommendations, through group discussion and consensus.
2. Conserves dollars
   Prioritizing modifications to the BioMP that may have impacts on the allocation of finite available program resources. Some BioMWG members maintained that this consideration, while important, should not compromise science-based decision-making; this advice was heeded over the course of both the WQWG and BioMWG deliberations.
3. Species-driven
   Confirming sampling methods are reliable, valid measures of conditions that have a potential impact on the Covered Species.
4. Supports Habitat Conservation Plan Biological Goals and Objectives
   Ensuring recommendations are consistent with Biological Objectives and Goals.

Six additional points to consider were agreed upon as important, but not required, as the group performed its duties. These points are:

- Does the modification eliminate duplication?
- Does the modification enable an evaluation of long-term trends?
- Does the modification integrate data collected by the EAHCP WQMP, EAHCP BioMP, and other monitoring programs?
- Does the modification contribute to an understanding of the effectiveness of conservation measures?
- Does the modification consider point and non-point sources?
- Does the modification demonstrate an awareness of strategies employed by others?

The BioMWG followed a thoughtful, deliberative process when considering possible modifications to the existing EAHCP BioMP. Each meeting featured a great deal of productive discussion by Work Group members. Work Group meetings were facilitated by EAHCP staff, as well as by Design Workshop, a facilitation firm retained by staff to assist with the meetings.

The BioMWG process began with a presentation of an overview of the background of the BioMP. The BioMP is considered to be a mature program, requiring minimal changes. As such, minimal modifications to the SOW for the EAHCP BioMP were proposed by staff. These modifications considered recommendations made by the NAS, the EAHCP Science Committee, and various other entities and stakeholders since the EAHCP's inception, as well as lessons learned from subject matter experts and data collected over 15 years.

At the work session meeting on March 29, 2016, the BioMWG considered these proposed modifications. The BioMWG first discussed the proposed modification to substitute macroinvertebrate food source sampling with RBAs. Members discussed the cost effectiveness of two different options of RBAs. While both options would follow TCEQ/TPWD Rapid Bioassessment Protocols for macroinvertebrate community health, each option had distinct protocols. The table below summarizes each option.

Option 1	Option 2
• TCEQ/TPWD Rapid Bioassessment Protocol for macroinvertebrate community health. • Samples the five (5) Reaches in Comal system; four (4) reaches in San Marcos system. One (1) composite sample per reach. Thus, total of nine (9) samples for both systems per Comprehensive and Critical Period Event. • To be conducted at the same time as fixed drop-net sampling for Fountain Darters. • Collect and identify (to lowest practical taxonomic level) first one hundred (100) macroinvertebrates.	• TCEQ/TPWD Rapid Bioassessment Protocol for trending macroinvertebrate community composition w/ variables (e.g., depth, velocity, substrate, aquatic vegetation type, temperature, dissolved oxygen, etc.). • Stratified random sampling of the five (5) Reaches in Comal system; four (4) reaches in San Marcos system per environmental variables selected. • Results in multiple samples per given reach depending on the number of environmental variables selected for evaluation. • Collect and identify (to lowest practical taxonomic level) first one hundred (100) macroinvertebrates.

At the work session meeting on April 27, 2016, the BioMWG approved the removal of flow-partitioning within Landa Lake, because EAA will be able to conduct this monitoring.

The BioMWG also approved the staff's recommendation for the Option 1 RBA sampling method, primarily because it is more pragmatic and is effective for a long-term monitoring program.

Table B1 lists the proposed modifications to the SOW with the rationales that were discussed by the Work Group.

Table B1 Proposed Modifications.

Current BioMP Sampling Method	Proposed Modification and Rationale
Fixed station photography	No modification • Valuable historical baseline
Aquatic vegetation mapping, including TWR	No modification • Valuable baseline, trend and compliance information
Fountain Darter sampling	No modification • Valuable index to fish population health
Fish community sampling	No modification • Provides macro information pertinent to Covered Species
Invertebrate sampling – Covered Species	No modification • Provides macro information pertinent to Covered Species
Macroinvertebrate food source monitoring	Modify • Substitute RBA – <u>Option 1</u> o Purpose: TCEQ/TPWD RBA Protocol for macroinvertebrate community health without variables. o Frequency and locations: Samples the five (5) Reaches in Comal system; four (4) reaches in San Marcos system. One (1) composite sample per reach. Thus, nine (9) samples for both systems per Comprehensive and Critical Period Event. o Sampling details: The result is only one sample per reach. o Logistics: To be conducted at the same time as fixed drop-net sampling for Fountain Darters. o Procedural details: Collect and identify (to lowest practical taxonomic level) first one hundred (100) macroinvertebrates. o Cost: More economical option.
Salamander visual observations	No modification • Necessary to monitor population health

Current BioMP Sampling Method	Proposed Modification and Rationale
Comal Springs discharge measurement	No modification • Important environmental measure
Flow partitioning within Landa Lake	Remove from Program • Will be done through EAA
WQ grab sampling	No modification • Continue—important accompaniment to biological information
Critical period (high and low-flow events)	No modification • Important index during critical periods
ITP (Take, 10% Disturbance)	No modification • Required for permit

NAS *Report 1* and NAS Work Group Recommendations

In 2015, the EAHCP received the National Academy of Sciences (NAS) *Report 1* (2015), containing recommendations for all EAHCP programs, including the BioMP. From *Report 1*, a list of biological monitoring-related recommendations was presented to the NAS Recommendation Review Work Group (NAS Work Group). The NAS Work Group deferred certain NAS recommendations associated with biological monitoring for consideration by this Work Group. At the March 29, 2016 meeting, the BioMWG considered recommendations from the NAS' *Review of the Edwards Aquifer Habitat Conservation Plan: Report 1*, and the the *Final Report* of the NAS Work Group (2015). **Table B2** summarizes the Work Group's rationale and recommendations for each recommendation from the NAS.

Table B2 NAS Recommendations.

NAS Report 1	NAS Work Group	BioMWG Recommendations
Sampling not randomized; cannot extrapolate. Expand reaches to system-wide sampling.	If a reason to scale results to the entire spring system is identified, then consider through by work group.	Extrapolation unnecessary. Continue to use Intensive Study Reaches.
Cotton-lure approach for riffle beetle sampling needs to be improved.	Supportive of optimizing the sampling methods for the Comal Springs Riffle Beetle.	Addressed by Comal Springs Riffle Beetle Cotton-lure SOP Work Group.
Increased coordination and integration of the monitoring activities is needed.	None	WQWG and BioMWG addressed the coordination and integration which is summarized in the next section.
None	Determining if the Covered Species are impacted by anthropogenic parameters.	WQWG to address if the Covered Species are impacted.

Synergies between the Monitoring Work Groups

While NAS *Report 1* recognized that the EAHCP monitoring programs have provided a wealth of information on the physical, chemical, and biological characteristics of the springs ecosystems, NAS recommended an increase in the coordination between the monitoring programs to more fully assess the systems' environmental conditions.

Throughout their meetings, the WQWG and the BioMWG discussed the importance of integrating the two programs in order to improve overall effectiveness of the EAHCP monitoring efforts. They also discussed how monitoring data can assist in implementing some habitat restoration measures.

At their final meeting on May 20, 2016, the WQWG and the BioMWG jointly considered synergistic activities between the programs that, if implemented, will be beneficial to the implementation of the EAHCP. These synergies are:

1. Using RBAs to help identify water quality impairments and measure ecosystem health;

2. Using water quality data from the BioMP to measure nutrient impairments, such as Soluble Reactive Phosphorus (SRP);

3. Analyzing data from WQMP, BioMP, EAA Well Sampling Program, and Clean Rivers Program (CRP), collectively;

4. Collecting more real-time water quality data, because it is more biologically-relevant; and

5. Requiring monitoring of riparian conditions as a part of the City of New Braunfels, City of San Marcos, and Texas State University Work Plans.

The Work Groups also explored the feasibility of coordinating sampling at the same locations. It was determined that adjusting the monitoring locations would not be appropriate.

At their final meeting on May 20, 2016, the BioMWG unanimously approved this draft report, along with tables which summarize their final recommendations to the SOW for EAHCP BioMP (**Table B3**), their final recommendations related to the BioMP recommendations from the NAS *Report 1* (**Table B4**) and the BioMP synergies with the WQMP (**Table B5**).

Table B3 Final Recommendations.

SOW Sampling Methods	Final Recommendations	Justification
Fixed station photography	No modification	• Valuable historical baseline
Aquatic vegetation mapping, including TWR	No modification	• Valuable baseline, trend and compliance information
Fountain Darter sampling	No modification	• Valuable indices to fish population health
Fish community sampling	No modification	• Provides macro information pertinent to Covered Species
Invertebrate sampling – Covered Species	No modification	• Provides macro information pertinent to Covered Species
Macroinvertebrate food source monitoring	• Substitute RBAs o Use TCEQ/TPWD RBA Option 1 Protocol for macroinvertebrate community health without variables. o Frequency and locations: Samples the five (5) Reaches in Comal system; four (4) reaches in San Marcos system. One (1) composite sample per reach. Thus, total of nine (9) samples for both systems per Comprehensive and Critical Period Event. o Sampling details: The result is only one sample per reach. o Logistics: To be conducted at the same time as fixed drop-net sampling for Fountain Darters.	• Cost: More economical option • Programmatic: More consistent with requirements of EAHCP biological monitoring program.

	- Procedural details: Collect and identify (to lowest practical taxonomic level) first one hundred (100) macroinvertebrates.	
Salamander visual observations	No modification	• Necessary to monitor population health
Comal Springs discharge measurement	No modification	• Important environmental measure
Flow partitioning within Landa Lake	Remove from Program	• To be done through EAA
WQ grab sampling	Continue to collect but modify method detection limit (MDL) for SRP from 50 ug/L to at least 5 ug/L	• Continue—important accompaniment to biological information
Critical period (high and low-flow events)	No modification	• Important index during critical periods

Table B4 NAS Recommendations.

Recommendations from NAS Report 1	Final Recommendations
Sampling not randomized; cannot extrapolate. Expand reaches to system-wide sampling.	Continue to use Intensive Study Reaches.
Cotton-lure approach for riffle beetle sampling needs to be improved.	Addressed by Comal Springs Riffle Beetle Cotton-lure SOP Work Group.
Increased coordination and integration of the monitoring activities is needed.	Synergies between monitoring programs are summarized in **Table B5**.

Table B5 Synergies.

Synergies with the Expanded WQMP	
Synergy	Comments
Using RBAs (EAHCP BioMP) to help identify toxic WQ impairments.	RBAs will be included in the BioMP as a first screening of WQ impairments in the springs' systems.
Using WQ data from BioMP to measure nutrient impairments, such as SRP	Modify method detection limit (MDL) for SRP from 50 ug/L to at least 5 ug/L.
Analyzing data from WQMP, BioMP, EAA Well Sampling & CRP, collectively.	No comment.

Collecting more real-time WQ data because it is more biologically-relevant.	One additional data sonde will be installed in each springs system.
Requiring monitoring of riparian conditions as a part of Permittees' Work Plans.	Require monitoring before and after riparian conditions as part of the Permittees' Riparian Work Plans, such as light penetration and potentially other measures - depending on the project footprint and design.
Explore the feasibility of coordinating sampling at the same locations and/or times.	No changes will be made to existing sampling locations or times as it is unlikely to provide any additional information.

With these summaries, the BioMWG recommends this report to the Implementing Committee as its final deliverable for approval and adoption.

Suggested Citation:
Edwards Aquifer Habitat Conservation Plan (2016). *Report of the 2016 Biological Monitoring Work Group*. San Antonio, TX: Edwards Aquifer Habitat Conservation Plan.

Edwards Aquifer Habitat Conservation Plan. “Review of the Edwards Aquifer Habitat Conservation Plan: Report 1 Implementation Plan.” August 2015. http://www.eahcp.org/files/admin-records/NEPA-and-HCP/Final_Report.pdf.

Edwards Aquifer Recovery Implementation Program. “Habitat Conservation Plan.” *Edwards Aquifer Recovery Implementation Program Habitat Conservation Plan*. 2012. http://www.eahcp.org/files/uploads/Final%20HCP%20November%202012.pdf.

National Academy of Sciences. “Review of the Edwards Aquifer Habitat Conservation Plan: Report 1.” March 2015. http://www.eahcp.org/files/uploads/21699.pdf.

Appendix A: Abbreviations & Acronyms

Adaptive Management Process	AMP
Aquatic Life Protection	ALP
Biological Monitoring Program Work Group	BioMWG
Biological Monitoring Program	BioMP
Clean Rivers Program	CRP
Dissolved Oxygen	DO
Edwards Aquifer Authority	EAA
Edwards Aquifer Habitat Conservation Plan	EAHCP
Expanded Water Quality Monitoring Program Work Group	WQWG
Expanded Water Quality Monitoring Program	WQMP
Guadalupe-Blanco River Authority	GBRA
Hydrogen Potential	pH
Integrated Pest Management Plan	IPMP
Long Term Biological Goals	LTBG
National Academy of Sciences	NAS
Passive Diffusion Sampling	PDS
Pharmaceutical and Personal Care Products	PPCP
Scope(s) of Work	SOW
Soluble Reactive Phosphorus	SRP
Standard Operating Procedures	SOP
Texas Commission on Environmental Quality	TCEQ
Texas Parks and Wildlife Department	TPWD
Texas Wild-rice	TWR
Water Quality	WQ

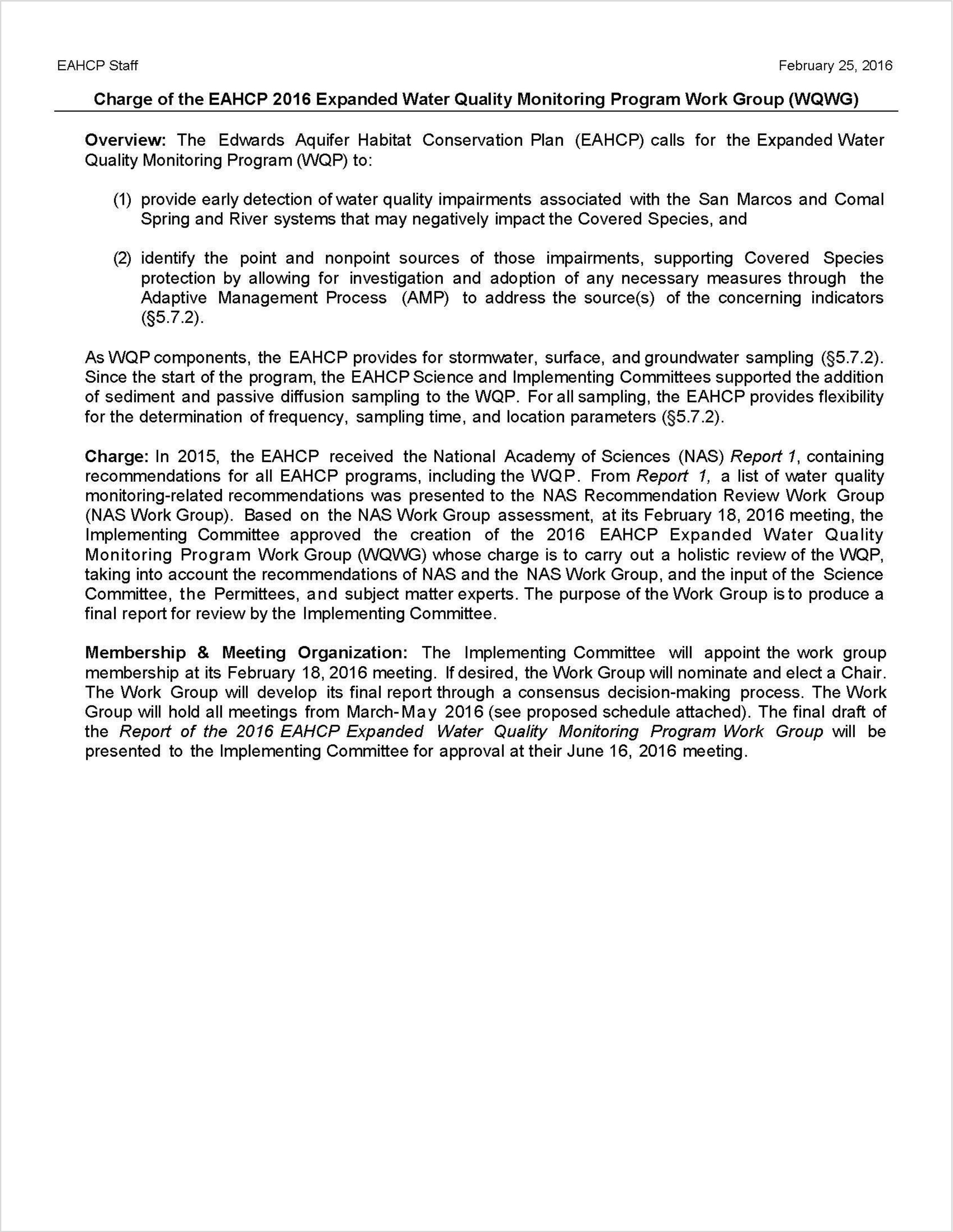
Adaptive Management Process (AMP)	The designated process contemplated in the EAHCP that informs the Program Manager and the Implementing Committee to make strategic decisions for implementation that may or may not alter the current plan by using best available science and/or experience from previous years' work.
Analytical Limits	The lowest level at which an analyte can be accurately measured for a specific laboratory method.
Aquatic Life Protection (ALP)	Numeric or narrative levels of a pollutant or other measurable parameter that allows for protection of aquatic life. Most use EPA established ALPs.
Aquatic vegetation mapping	Periodic mapping of the San Marcos and Comal system that is used to determine increased fountain darter habitat.
Baseline	The background, or established level of a parameter that has been measured over time, used to evaluate change in a system.
Biological Goals and Objectives	The quantitative measurement of protection for a given species (specifically Texas wild-rice and fountain darter habitat).
Clean Rivers Program (CRP)	Texas Commission on Environmental Quality (TCEQ) program utilizing regional water authorities, local entities and volunteers to provide consistent, reliable water quality data to the TCEQ database for analysis and decision-making.
Comal Springs Discharge Measurement	A measurement of cubic-feet per second (CFS) of cumulative spring flow out of the Comal Springs system.
Comprehensive and Critical Period Events	Comprehensive events are routine biological monitoring events. Critical period events are those triggered by an established range of either high, or low flows.
Covered Activities	Activities in our region including recreation and pumping that are covered under the ITP.
Covered Species	The species the EAHCP and the Incidental Take Permit (ITP) are assigned to protect.
Critical Period (high and low events)	High flow and low flow specific sampling to evaluate disturbance and recovery, as well as declining or improving conditions linked to flow. High flow (after a flood) sampling must be approved by EAA staff working with the Contractor. Low flow sampling is linked to a series of flow triggers.
Detect Limits	The lowest level at which an analyte is detected (not accurately measured) for a specific laboratory method.
Detects	The presence of an analyte in a sample that cannot be reliably measured for a specific laboratory procedure.
EAA Variable Flow Study	Predecessor of the current Biological Monitoring program.

EAA Well Sampling program	Each year the EAA monitors the quality of water in the Aquifer by sampling approximately 80 wells, eight surface water sites, and major spring groups across the region. Tests for the wells included measurements of temperature, pH, conductivity, alkalinity, major ions, minor elements (including heavy metals), total dissolved solids, nutrients, pesticides, herbicides, VOCs, and other parameters.
Expanded Water Quality program	Defined in the EAHCP as a comprehensive water quality monitoring program to provide early detection of water quality impairments that may negatively impact the Covered Species and to identify the point and nonpoint sources of those impairments.
Field Parameters	Conditions and water quality measured on-site, during field operations and sampling.
Fish Community Sampling	All members of the fish community sampled, collected or observed by seining, drop net, dip net, or visual observation.
Fixed dip-net sampling	Dip-net sampling that occurs at fixed (as opposed to random) locations in a study reach.
Fixed Station Photography	Annual imagery taken of various locations throughout the San Marcos and Comal systems to determine visual changes in system health.
Flow Partitioning within Landa Lake	The measurement of spring (including upwellings) flow contributions by section to the total flow of water through Landa Lake.
Flow-Partitioning	The measurement of spring (including upwellings) flow contributions by section to the total flow of water through Landa Lake.
Fountain Darter Sampling	Fountain Darter sampling, collection or observation conducted by drop net, dip net, or visual observation.
household/personal care products	Medicine, cleaning products, makeup, food preservatives, caffeine, etc.
Hydrograph	Graph of flow through a defined period of time.
Implementing Committee	The decision making body of the EAHCP made up of representation from all 5 permittees, including a non-voting member - the Guadalupe-Blanco River Authority.
Incidental Take Permit (ITP)	The Incidental Take Permit (ITP) is a permit issued under Section 10 of the US Endangered Species Act that because of the EAHCP was awarded to the Implementing Committee to allow covered activities in the Edwards Aquifer region.
Intensive Study Reaches	Sections of the systems where monitoring takes place to provide consistent areas for evaluation as indications of the overall condition of the systems.
Invertebrate Sampling	Macroinvertebrate community sampling in the study reaches of above and below ground vegetation types, roots and

	sediment to determine species composition, relative number, and vegetation associations.
IPMP Chemicals	IPMP = Integrated Pest Management Plan. Chemicals listed in such a plan would be specific to the use of the plan (golf course, green space, etc.). Generally, these are fertilizers, herbicides and pesticides.
Key Management Objectives	General term to include the quantitative goals associated with determining success in protecting the covered species (see "biological goals and objectives").
Long-term historical average	The observed and recorded average throughout the history of collection (can cover a variety of different collected data).
Macroinvertebrate Food Source Monitoring	Macroinvertebrate community sampling in the study reaches of above and below ground vegetation types, roots and sediment to determine species composition, relative number, and vegetation associations.
Macroinvertebrate Food Source Sampling	Macroinvertebrate community sampling in the study reaches of above and below ground vegetation types, roots and sediment to determine species composition, relative number, and vegetation associations.
Onset, peak, and tail	"Onset" is the start of a flow event, "peak" is the apogee of the flow event, and the "tail" is the decline of the flow event.
Passive diffusion sampler (PDS)	Sampling device that absorbs the chemicals it samples, no additional energy required for sampling.
PCPP	Pharmaceutical and Personal Care Products.
Permittees	The 5 organizations/communities that make up the participants of the EAHCP and covered under the ITP (Edwards Aquifer Authority, San Antonio Water System, City of New Braunfels, City of San Marcos, and Texas State University).
Permittees' Riparian Work Plans	The specific Work Plan associated with the City of New Braunfels' and/or the City of San Marcos and Texas State University's riparian improvement conservation measure.
Permittees' Work Plans	The annual documentation of planned activities for each conservation measure for the next year.
PPCP membrane	PPCP = Pharmaceutical and Personal Care Products. A PPCP membrane is a passive sampler component that specifically targets PPCPs.
Rapid bioassessments (RBAs)	RBAs are an integrated assessment of the physical aspects of a habitat with water quality and biological measures, providing an empirical relationship between habitat quality and biological conditions, so that impacts can be objectively discriminated.
Salamander Visual Observations	Timed, diver sampling specific areas involving documenting substrate overturning rocks, counting individuals, estimating size and condition, then returning the rock to original position to cover the salamander as quickly as practical.

Science Committee	A collection of scientists selected to advise the Program Manager and the Implementing Committee on scientific components of the EAHCP implementation.
Scope of Work	The portion of a given contract that dictates the specific requirements a given contractor has been tasked with.
Soluble Reactive Phosphorous (SRP)	Soluble reactive phosphorous, may also be referred to as dissolved phosphorous. It is the phosphorous form that is actively available as a plant nutrient.
Sonde	An on-site water quality parameter measuring device. Usually measures temperature, pH, dissolved oxygen, and specific conductance.
Spring system	General term to include the ecosystem surrounding, or dependent on, the San Marcos or Comal springs.
Surface water quality parameters	Water temperature, pH, conductivity, dissolved oxygen, water depth, flow and direction (Suite I) and nitrate nitrogen, total nitrogen, ammonium, soluble reactive phosphorous, total phosphorous, alkalinity, and total suspended solids (Suite II) are sampled during Biological Monitoring and Critical Period Monitoring.
Taxonomic level	The scientific naming of organisms based on the biological classification of living and fossil organisms, ordered from most common traits (Kingdom) to fewest common traits (species).
Tissue sampling	Analysis of biological tissues for specific parameters (metals, pesticides, etc.).
Toxic Parameters	Components of a water sample known to produce harmful effects on desired organisms.
Water Column Levels	Generally, the depth of the water column where a sample was collected. May also be used to denote water depth.
Water Quality Grab Sampling	Water temperature, pH, conductivity, dissolved oxygen, water depth, flow and direction (Suite I) and nitrate nitrogen, total nitrogen, ammonium, soluble reactive phosphorous, total phosphorous, alkalinity, and total suspended solids (Suite II) are sampled during Biological Monitoring and Critical Period Monitoring.
Work Plans	The annual documentation of planned activities for each conservation measure for the next year.

Appendix C: WQWG Charge



EAHCP Staff February 25, 2016

Charge of the EAHCP 2016 Expanded Water Quality Monitoring Program Work Group (WQWG)

Overview: The Edwards Aquifer Habitat Conservation Plan (EAHCP) calls for the Expanded Water Quality Monitoring Program (WQP) to:

(1) provide early detection of water quality impairments associated with the San Marcos and Comal Spring and River systems that may negatively impact the Covered Species, and

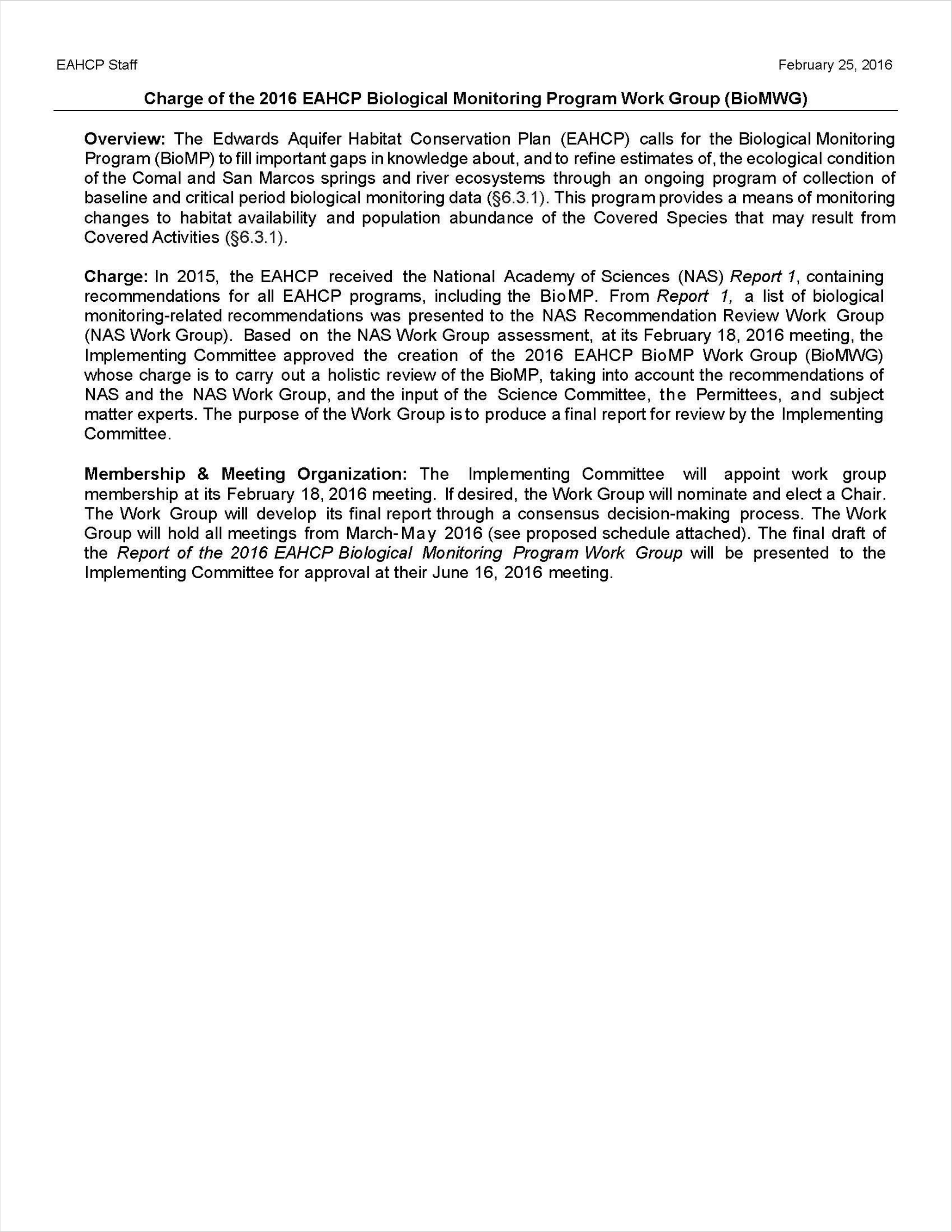
(2) identify the point and nonpoint sources of those impairments, supporting Covered Species protection by allowing for investigation and adoption of any necessary measures through the Adaptive Management Process (AMP) to address the source(s) of the concerning indicators (§5.7.2).

As WQP components, the EAHCP provides for stormwater, surface, and groundwater sampling (§5.7.2). Since the start of the program, the EAHCP Science and Implementing Committees supported the addition of sediment and passive diffusion sampling to the WQP. For all sampling, the EAHCP provides flexibility for the determination of frequency, sampling time, and location parameters (§5.7.2).

Charge: In 2015, the EAHCP received the National Academy of Sciences (NAS) *Report 1*, containing recommendations for all EAHCP programs, including the WQP. From *Report 1,* a list of water quality monitoring-related recommendations was presented to the NAS Recommendation Review Work Group (NAS Work Group). Based on the NAS Work Group assessment, at its February 18, 2016 meeting, the Implementing Committee approved the creation of the 2016 EAHCP Expanded Water Quality Monitoring Program Work Group (WQWG) whose charge is to carry out a holistic review of the WQP, taking into account the recommendations of NAS and the NAS Work Group, and the input of the Science Committee, the Permittees, and subject matter experts. The purpose of the Work Group is to produce a final report for review by the Implementing Committee.

Membership & Meeting Organization: The Implementing Committee will appoint the work group membership at its February 18, 2016 meeting. If desired, the Work Group will nominate and elect a Chair. The Work Group will develop its final report through a consensus decision-making process. The Work Group will hold all meetings from March-May 2016 (see proposed schedule attached). The final draft of the *Report of the 2016 EAHCP Expanded Water Quality Monitoring Program Work Group* will be presented to the Implementing Committee for approval at their June 16, 2016 meeting.

Appendix D: BioMWG Charge



EAHCP Staff February 25, 2016

Charge of the 2016 EAHCP Biological Monitoring Program Work Group (BioMWG)

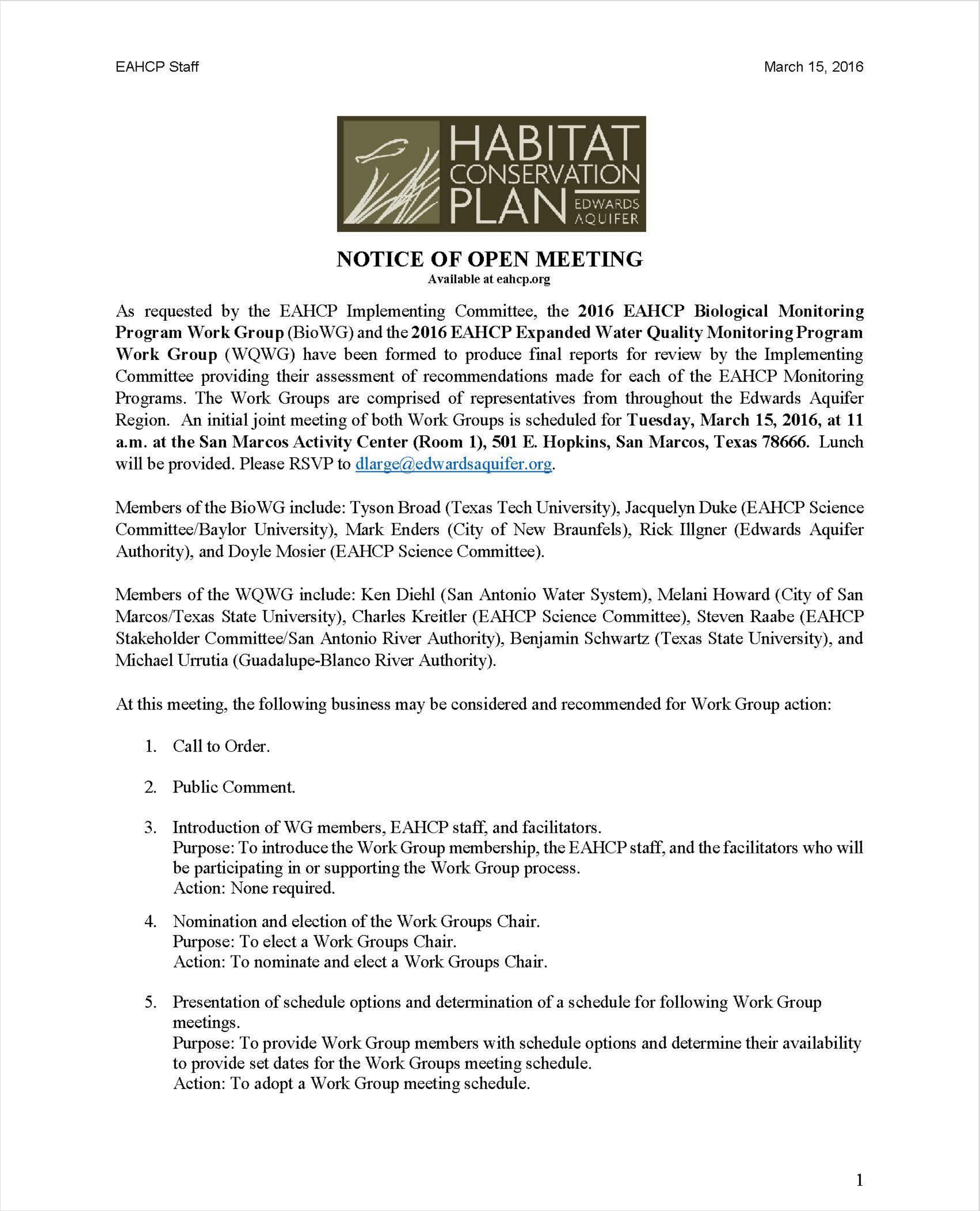
Overview: The Edwards Aquifer Habitat Conservation Plan (EAHCP) calls for the Biological Monitoring Program (BioMP) to fill important gaps in knowledge about, and to refine estimates of, the ecological condition of the Comal and San Marcos springs and river ecosystems through an ongoing program of collection of baseline and critical period biological monitoring data (§6.3.1). This program provides a means of monitoring changes to habitat availability and population abundance of the Covered Species that may result from Covered Activities (§6.3.1).

Charge: In 2015, the EAHCP received the National Academy of Sciences (NAS) *Report 1*, containing recommendations for all EAHCP programs, including the BioMP. From *Report 1,* a list of biological monitoring-related recommendations was presented to the NAS Recommendation Review Work Group (NAS Work Group). Based on the NAS Work Group assessment, at its February 18, 2016 meeting, the Implementing Committee approved the creation of the 2016 EAHCP BioMP Work Group (BioMWG) whose charge is to carry out a holistic review of the BioMP, taking into account the recommendations of NAS and the NAS Work Group, and the input of the Science Committee, the Permittees, and subject matter experts. The purpose of the Work Group is to produce a final report for review by the Implementing Committee.

Membership & Meeting Organization: The Implementing Committee will appoint work group membership at its February 18, 2016 meeting. If desired, the Work Group will nominate and elect a Chair. The Work Group will develop its final report through a consensus decision-making process. The Work Group will hold all meetings from March-May 2016 (see proposed schedule attached). The final draft of the *Report of the 2016 EAHCP Biological Monitoring Program Work Group* will be presented to the Implementing Committee for approval at their June 16, 2016 meeting.

Appendix E: Agendas and Meeting Minutes of the Work Groups

Agendas



HABITAT CONSERVATION PLAN EDWARDS AQUIFER

NOTICE OF OPEN MEETING

Available at eahcp.org

As requested by the EAHCP Implementing Committee, the **2016 EAHCP Biological Monitoring Program Work Group** (BioWG) and the **2016 EAHCP Expanded Water Quality Monitoring Program Work Group** (WQWG) have been formed to produce final reports for review by the Implementing Committee providing their assessment of recommendations made for each of the EAHCP Monitoring Programs. The Work Groups are comprised of representatives from throughout the Edwards Aquifer Region. An initial joint meeting of both Work Groups is scheduled for **Tuesday, March 15, 2016, at 11 a.m. at the San Marcos Activity Center (Room 1), 501 E. Hopkins, San Marcos, Texas 78666.** Lunch will be provided. Please RSVP to dlarge@edwardsaquifer.org.

Members of the BioWG include: Tyson Broad (Texas Tech University), Jacquelyn Duke (EAHCP Science Committee/Baylor University), Mark Enders (City of New Braunfels), Rick Illgner (Edwards Aquifer Authority), and Doyle Mosier (EAHCP Science Committee).

Members of the WQWG include: Ken Diehl (San Antonio Water System), Melani Howard (City of San Marcos/Texas State University), Charles Kreitler (EAHCP Science Committee), Steven Raabe (EAHCP Stakeholder Committee/San Antonio River Authority), Benjamin Schwartz (Texas State University), and Michael Urrutia (Guadalupe-Blanco River Authority).

At this meeting, the following business may be considered and recommended for Work Group action:

1. Call to Order.

2. Public Comment.

3. Introduction of WG members, EAHCP staff, and facilitators.
   Purpose: To introduce the Work Group membership, the EAHCP staff, and the facilitators who will be participating in or supporting the Work Group process.
   Action: None required.

4. Nomination and election of the Work Groups Chair.
   Purpose: To elect a Work Groups Chair.
   Action: To nominate and elect a Work Groups Chair.

5. Presentation of schedule options and determination of a schedule for following Work Group meetings.
   Purpose: To provide Work Group members with schedule options and determine their availability to provide set dates for the Work Groups meeting schedule.
   Action: To adopt a Work Group meeting schedule.

6. Discussion of the Work Group Charges, general information about the Work Groups, and overview of the Monitoring Programs and their background (Attachments 1 & 2).
   Purpose: To inform the Work Groups about their Charges, about the Work Groups more generally, and about the Monitoring Programs.
   Action: None required.

7. Discussion of and possible endorsement of the basic operational guidelines and principles which will direct the Work Groups in carrying out their charges.
   Purpose: To inform the Work Groups about the proposed basic operational guidelines and principles which are intended to direct the Work Groups' deliberations in carrying out their charges.
   Action: To possibly endorse the basic operational guidelines and principles which will direct the Work Groups in carrying out their charges.

8. Presentation of current EAHCP Expanded Water Quality Monitoring Program (WQP) (SWCA, Phil Pearce)
   Purpose: To inform the Work Groups concerning the monitoring findings identified to date through the WQP.
   Action: To obtain feedback on the WQP findings and answer any questions that Work Group members may have.

9. Presentation of current EAHCP Biological Monitoring Program (BioMP) (BIO-WEST, Ed Oborny)
   Purpose: To inform the Work Groups concerning the monitoring findings identified to date through the BioMP.
   Action: To obtain feedback on the BioMP findings and answer any questions that Work Group members may have.

10. Presentation of Budget Info related to the WQP and BioMP.
    Purpose: To inform the Work Groups concerning budgetary considerations associated with the Monitoring Programs.
    Action: To obtain feedback from the Work Groups concerning budgetary considerations and answer any questions that Work Group members may have.

11. Next Steps – timeline and associated list of goals.
    Purpose: To inform the Work Groups concerning budgetary considerations associated with the Monitoring Programs.
    Action: To obtain feedback from the Work Groups concerning budgetary considerations and answer any questions that Work Group members may have.

12. Consider future meetings, dates, locations, and agendas.

13. Questions and comments from the public.

14. Adjourn.

NOTICE OF OPEN MEETING

Available at eahcp.org

As requested by the Edwards Aquifer Habitat Conservation Plan (EAHCP) Implementing Committee, the 2016 EAHCP Biological Monitoring Program Work Group (BioWG) and the 2016 EAHCP Expanded Water Quality Monitoring Program Work Group (WQWG) have been formed to produce final reports for review by the Implementing Committee providing their assessment of recommendations made for each of the EAHCP Monitoring Programs. The Work Groups are comprised of representatives from throughout the Edwards Aquifer Region.

The second meeting for the **Expanded Water Quality Monitoring Work Group** is scheduled for **Tuesday, March 29, 2016, at 9 a.m. at the San Marcos Activity Center (Room 1), 501 E. Hopkins, San Marcos, Texas 78666.** Please RSVP to dlarge@edwardsaquifer.org.

Members of the WQWG include: Ken Diehl (San Antonio Water System), Melani Howard (City of San Marcos/Texas State University), Charles Kreitler (EAHCP Science Committee), Steven Raabe (EAHCP Stakeholder Committee/San Antonio River Authority), Benjamin Schwartz (Texas State University), and Michael Urrutia (Guadalupe-Blanco River Authority).

At this meeting, the following business may be considered and recommended for Work Group action:

1. Call to Order.
2. Public Comment.
3. Recap of Work Group Meeting #1.
   Purpose: To provide an overview of activities and outcomes from the previous meeting.
   Action: None required.
4. Review and achieve consensus on revised basic operational principles and guidelines.
   Purpose: To confirm how basic operational principles and guidelines were revised based on Meeting #1 discussions.
   Action: Achieve consensus on basic operational principles and guidelines, which will direct the work groups in carrying out their charges.
5. Presentation and discussion of draft modifications to the Scope of Work for the EAHCP Water Quality Monitoring Program.
   Purpose: To discuss staff-generated proposal modifying the Scope of Work for the EAHCP Water Quality Monitoring Program.
   Action: None required.
6. Presentation and possible recommendation of the methodology to calculate the historically-recorded water quality conditions (long-term averages) in the Comal River and San Marcos River ecosystems.

Purpose: To discuss and possibly recommend a methodology to calculate the historically-recorded water quality conditions (long-term averages) that will be used to determine the 10 percent deviation in the Comal River and San Marcos River ecosystems.
Action: To possibly recommend the methodology to calculate the historically-recorded water quality conditions (long-term averages) that will be used to determine the 10 percent deviation in the Comal River and San Marcos River ecosystems.

7. Presentation of and possible recommendation of analytical limits for water quality data that is used for the EAHCP.
   Purpose: To identify and possibly recommend appropriate analytical limits for water quality data used for protection of the Covered Species in the EAHCP.
   Action: To possibly recommend analytical limits for EAHCP water quality data.

8. Presentation and discussion of National Academy of Sciences (NAS) recommendations.
   Purpose: To discuss recommendations from the NAS *Report 1* for the EAHCP Water Quality Monitoring Program.
   Action: None required.

9. Presentation and discussion of the Draft Report.
   Purpose: To present and discuss a draft of the Work Group's final report.
   Action: None required.

10. Consider future meetings, dates, locations, and agendas.

11. Questions and comments from the public.

12. Adjourn.

NOTICE OF OPEN MEETING

Available at eahcp.org

As requested by the Edwards Aquifer Habitat Conservation Plan (EAHCP) Implementing Committee, the 2016 EAHCP Biological Monitoring Program Work Group (BioWG) and the 2016 EAHCP Expanded Water Quality Monitoring Program Work Group (WQWG) have been formed to produce final reports for review by the Implementing Committee providing their assessment of recommendations made for each of the EAHCP Monitoring Programs. The Work Groups are comprised of representatives from throughout the Edwards Aquifer Region.

The second meeting for the **Biological Monitoring Work Group** is scheduled for **Tuesday, March 29, 2016, at 1 p.m. at the San Marcos Activity Center (Room 1), 501 E. Hopkins, San Marcos, Texas 78666.** Please RSVP to dlarge@edwardsaquifer.org.

Members of the BioWG include: Tyson Broad (Texas Tech University), Jacquelyn Duke (EAHCP Science Committee/Baylor University), Mark Enders (City of New Braunfels), Rick Illgner (Edwards Aquifer Authority), and Doyle Mosier (EAHCP Science Committee).

At this meeting, the following business may be considered and recommended for Work Group action:

1. Call to Order.

2. Public Comment.

3. Recap of Work Group Meeting #1.
   Purpose: To provide an overview of activities and outcomes from the previous meeting.
   Action: None required.

4. Review and achieve consensus on revised basic operational principles and guidelines.
   Purpose: To confirm how basic operational principles and guidelines were revised based on Meeting #1 discussions.
   Action: Achieve consensus on basic operational principles and guidelines, which will direct the work groups in carrying out their charges.

5. Presentation and discussion of draft modifications to the Scope of Work for the EAHCP Biological Monitoring Program.
   Purpose: To discuss staff-generated proposal modifying the Scope of Work for the EAHCP Biological Monitoring Program.
   Action: None required.

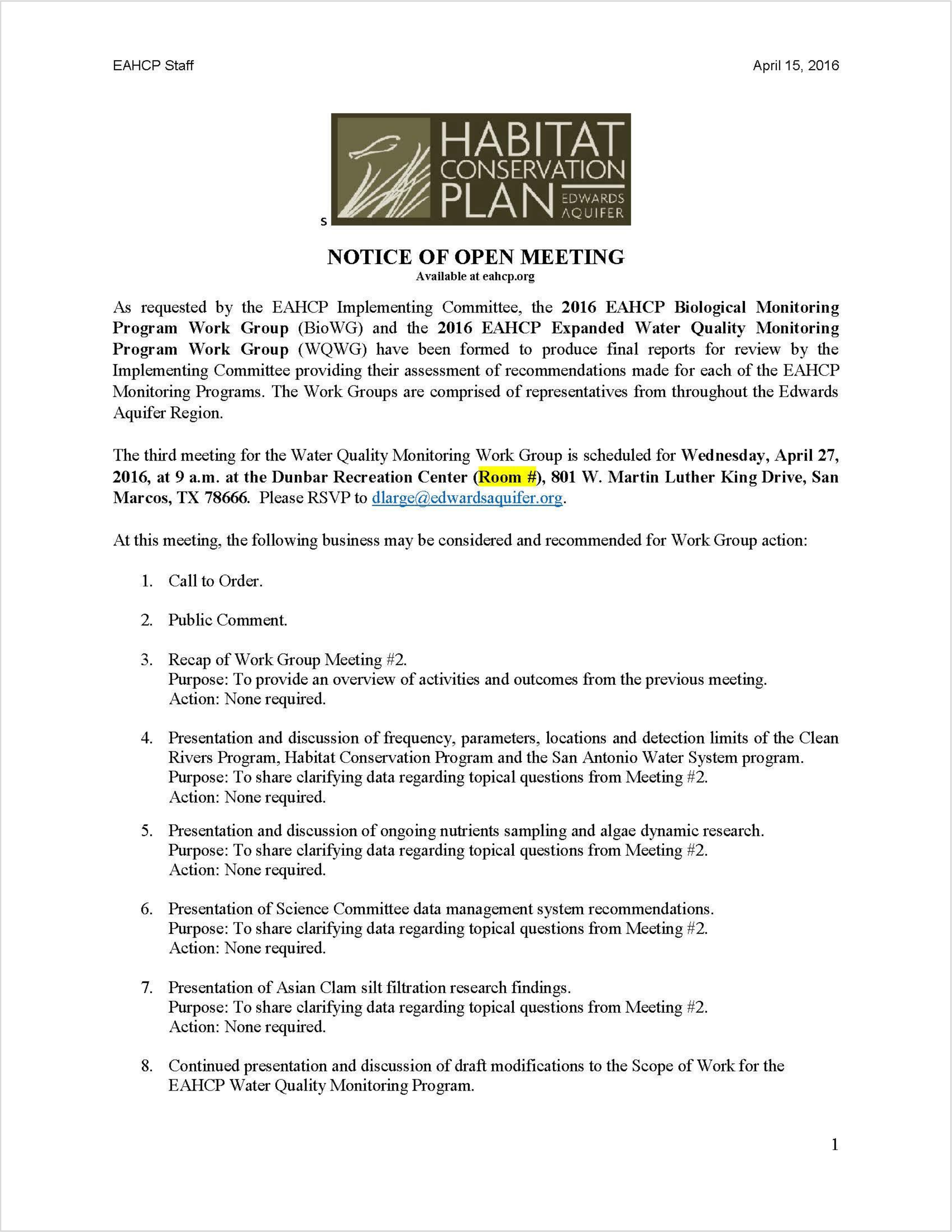
6. Presentation and discussion of National Academy of Sciences (NAS) recommendations.
   Purpose: To discuss recommendations from the NAS *Report 1* for the EAHCP Biological Monitoring Program.
   Action: None required.

7. Presentation and discussion of the Draft Report.
   Purpose: To present and discuss a draft of the Work Group's final report.
   Action: None required.

8. Consider future meetings, dates, locations, and agendas.

9. Questions and comments from the public.

10. Adjourn.



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NOTICE OF OPEN MEETING

Available at eahcp.org

As requested by the EAHCP Implementing Committee, the **2016 EAHCP Biological Monitoring Program Work Group** (BioWG) and the **2016 EAHCP Expanded Water Quality Monitoring Program Work Group** (WQWG) have been formed to produce final reports for review by the Implementing Committee providing their assessment of recommendations made for each of the EAHCP Monitoring Programs. The Work Groups are comprised of representatives from throughout the Edwards Aquifer Region.

The third meeting for the Water Quality Monitoring Work Group is scheduled for **Wednesday, April 27, 2016, at 9 a.m. at the Dunbar Recreation Center (Room #), 801 W. Martin Luther King Drive, San Marcos, TX 78666**. Please RSVP to dlarge@edwardsaquifer.org.

At this meeting, the following business may be considered and recommended for Work Group action:

1. Call to Order.
2. Public Comment.
3. Recap of Work Group Meeting #2.
   Purpose: To provide an overview of activities and outcomes from the previous meeting.
   Action: None required.
4. Presentation and discussion of frequency, parameters, locations and detection limits of the Clean Rivers Program, Habitat Conservation Program and the San Antonio Water System program.
   Purpose: To share clarifying data regarding topical questions from Meeting #2.
   Action: None required.
5. Presentation and discussion of ongoing nutrients sampling and algae dynamic research.
   Purpose: To share clarifying data regarding topical questions from Meeting #2.
   Action: None required.
6. Presentation of Science Committee data management system recommendations.
   Purpose: To share clarifying data regarding topical questions from Meeting #2.
   Action: None required.
7. Presentation of Asian Clam silt filtration research findings.
   Purpose: To share clarifying data regarding topical questions from Meeting #2.
   Action: None required.
8. Continued presentation and discussion of draft modifications to the Scope of Work for the EAHCP Water Quality Monitoring Program.

Purpose: To discuss staff-generated proposal modifying the Scope of Work for the EAHCP Water Quality Monitoring Program.
Action: To consider and possibly recommend Scope of Work modifications for the program.

9. Presentation and discussion of the Draft Report.
Purpose: To present and discuss a draft of the Work Group's final report.
Action: None required.

10. Consider future meetings, dates, locations, and agendas.

11. Questions and comments from the public.

12. Adjourn.

EAHCP Staff April 20, 2016

NOTICE OF OPEN MEETING

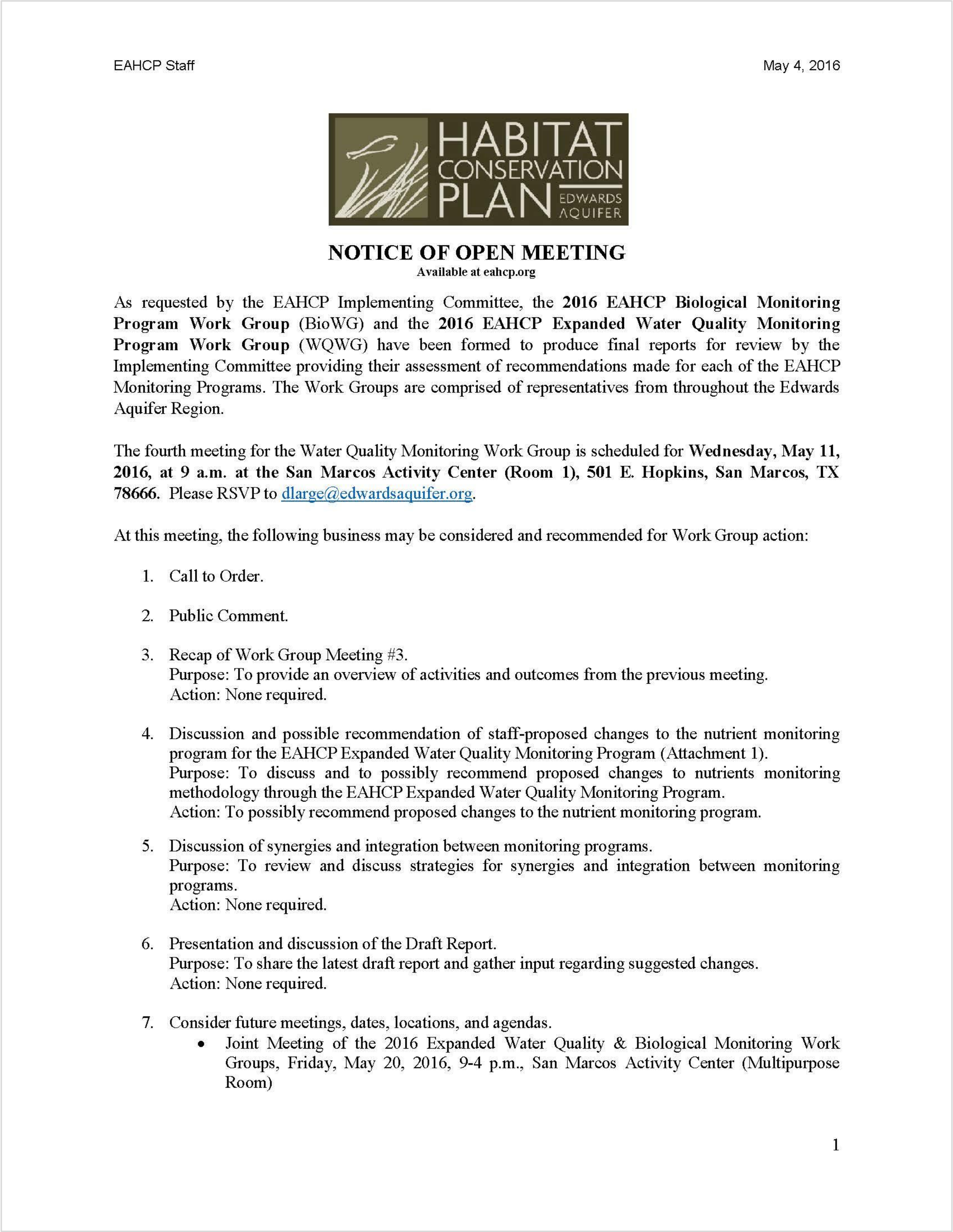
Available at eahcp.org

As requested by the EAHCP Implementing Committee, the **2016 EAHCP Biological Monitoring Program Work Group** (BioWG) and the **2016 EAHCP Expanded Water Quality Monitoring Program Work Group** (WQWG) have been formed to produce final reports for review by the Implementing Committee providing their assessment of recommendations made for each of the EAHCP Monitoring Programs. The Work Groups are comprised of representatives from throughout the Edwards Aquifer Region.

The third meeting for the Biological Monitoring Work Group is scheduled for **Wednesday, April 27, 2016, at 12 p.m. at the Dunbar Recreation Center, 801 W. Martin Luther King Drive, San Marcos, TX 78666.** Please RSVP to dlarge@edwardsaquifer.org. Lunch will be provided.

At this meeting, the following business may be considered and recommended for Work Group action:

1. Call to Order.
2. Public Comment.
3. Recap of Work Group Meeting #2.
   Purpose: To provide an overview of activities and outcomes from the previous meeting.
   Action: None required.
4. Presentation, discussion and possible recommendation of Scope of Work for the EAHCP Biological Monitoring Program.
   Purpose: To discuss staff-generated proposal modifying the Scope of Work for the EAHCP Biological Monitoring Program.
   Action: To consider and possibly recommend Scope of Work modifications for the program.
5. Presentation and discussion of the Draft Report.
   Purpose: To present and discuss a draft of the Work Group's final report.
   Action: None required.
6. Consider future meetings, dates, locations, and agendas.
7. Questions and comments from the public.
8. Adjourn.



NOTICE OF OPEN MEETING

Available at eahcp.org

As requested by the EAHCP Implementing Committee, the **2016 EAHCP Biological Monitoring Program Work Group** (BioWG) and the **2016 EAHCP Expanded Water Quality Monitoring Program Work Group** (WQWG) have been formed to produce final reports for review by the Implementing Committee providing their assessment of recommendations made for each of the EAHCP Monitoring Programs. The Work Groups are comprised of representatives from throughout the Edwards Aquifer Region.

The fourth meeting for the Water Quality Monitoring Work Group is scheduled for **Wednesday, May 11, 2016, at 9 a.m. at the San Marcos Activity Center (Room 1), 501 E. Hopkins, San Marcos, TX 78666.** Please RSVP to dlarge@edwardsaquifer.org.

At this meeting, the following business may be considered and recommended for Work Group action:

1. Call to Order.

2. Public Comment.

3. Recap of Work Group Meeting #3.
   Purpose: To provide an overview of activities and outcomes from the previous meeting.
   Action: None required.

4. Discussion and possible recommendation of staff-proposed changes to the nutrient monitoring program for the EAHCP Expanded Water Quality Monitoring Program (Attachment 1).
   Purpose: To discuss and to possibly recommend proposed changes to nutrients monitoring methodology through the EAHCP Expanded Water Quality Monitoring Program.
   Action: To possibly recommend proposed changes to the nutrient monitoring program.

5. Discussion of synergies and integration between monitoring programs.
   Purpose: To review and discuss strategies for synergies and integration between monitoring programs.
   Action: None required.

6. Presentation and discussion of the Draft Report.
   Purpose: To share the latest draft report and gather input regarding suggested changes.
   Action: None required.

7. Consider future meetings, dates, locations, and agendas.
   - Joint Meeting of the 2016 Expanded Water Quality & Biological Monitoring Work Groups, Friday, May 20, 2016, 9-4 p.m., San Marcos Activity Center (Multipurpose Room)

8. Questions and comments from the public.

9. Adjourn.

NOTICE OF OPEN MEETING

Available at eahcp.org

As requested by the EAHCP Implementing Committee, the **2016 EAHCP Biological Monitoring Program Work Group** (BioWG) and the **2016 EAHCP Expanded Water Quality Monitoring Program Work Group** (WQWG) have been formed to produce final reports for review by the Implementing Committee providing their assessment of recommendations made for each of the EAHCP Monitoring Programs. The Work Groups are comprised of representatives from throughout the Edwards Aquifer Region.

A final joint meeting of both Work Groups is scheduled for **Friday, May 20, 2016, at 9 a.m. at the San Marcos Activity Center (Multipurpose Room), 501 E. Hopkins, San Marcos, Texas 78666.** Please RSVP to dlarge@edwardsaquifer.org.

At this meeting, the following business may be considered and recommended for Work Group action:

1. Call to Order.

2. Public Comment.

3. Recap of Work Group Meetings #3 (Bio) and #4 (Water Quality).
   Purpose: To provide an overview of activities and outcomes from the previous meetings.
   Action: None required.

4. Discussion and possible recommendation of staff-proposed changes to the nutrient monitoring program for the EAHCP Expanded Water Quality Monitoring Program.
   Purpose: For the Water Quality Work Group to discuss and to possibly recommend proposed changes to nutrients monitoring methodology through the EAHCP Expanded Water Quality Monitoring Program.
   Action: For the Water Quality Work Group to possibly recommend proposed changes to the nutrient monitoring program.

5. Discussion and possible recommendation of synergies and integration between monitoring programs.
   Purpose: For both Work Groups to review, discuss, and possibly recommend strategies for synergies and integration between monitoring programs.
   Action: To possibly recommend strategies for synergies and integration between monitoring programs.

6. Presentation, discussion, and possible approval of the draft *Report of the 2016 Expanded Water Quality Monitoring Program Work Group.*
   Purpose: To review the latest draft report, gather input regarding suggested changes, and possibly approve the draft report, as-written, with suggested changes.

Action: To possibly approve the draft report for approval and adoption by the Implementing Committee.

7. Presentation, discussion, and possible approval of the draft *Report of the 2016 Biological Monitoring Program Work Group.*
Purpose: To review the latest draft report, gather input regarding suggested changes, and possibly approve the draft report, as-written, with suggested changes.
Action: To possibly approve the draft report for approval and adoption by the Implementing Committee.

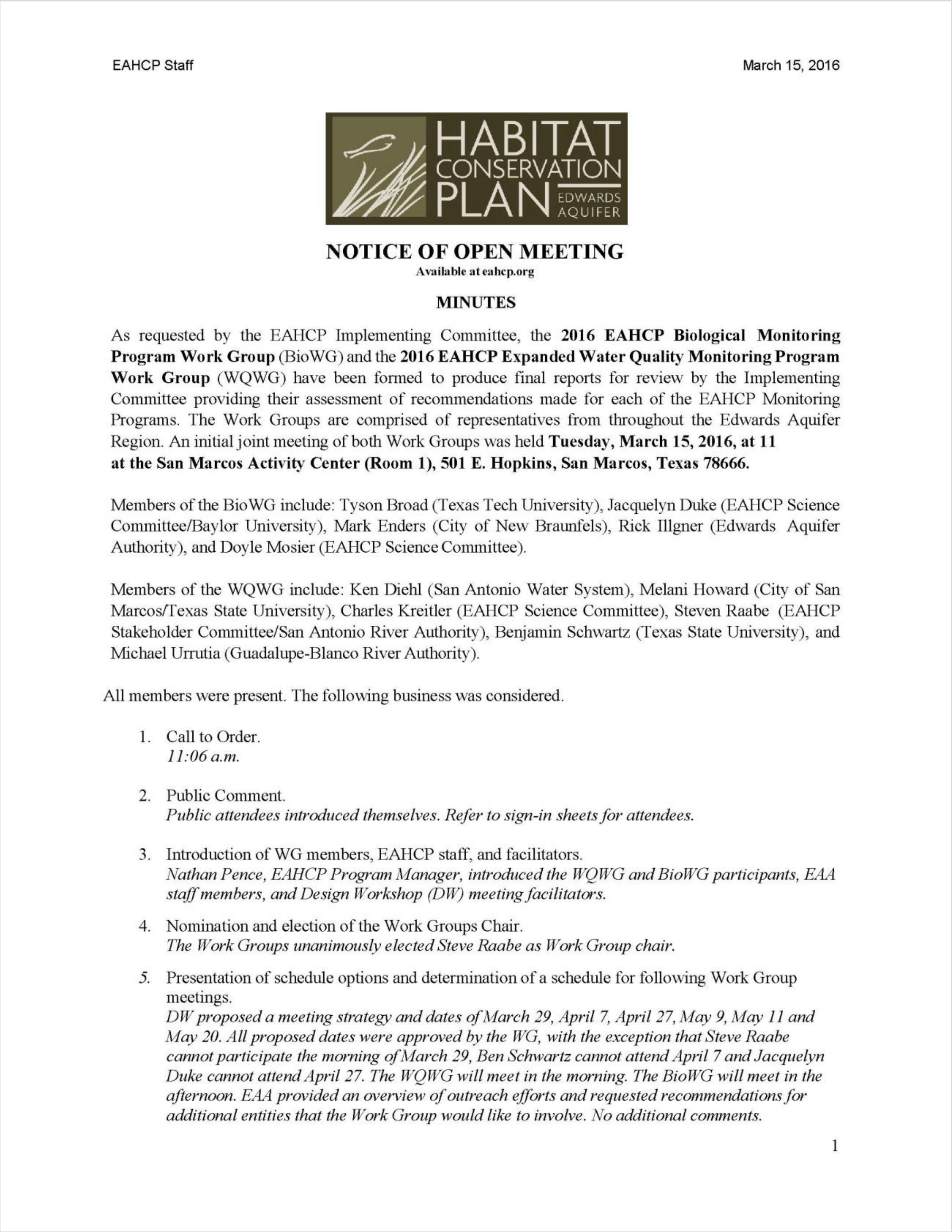
8. Consider next steps for final review of the draft Reports of the Work Groups.

    - May 27, 2016 - Revised final report incorporating discussion and recommendations from the May 20 meeting will be sent to Work Group members via e-mail.

    - June 10, 2016 - Deadline for final comments on revised final report (May 27 version) to be e-mailed for incorporation into the final draft.

9. Questions and comments from the public.

10. Adjourn.



HABITAT CONSERVATION PLAN EDWARDS AQUIFER

NOTICE OF OPEN MEETING

Available at eahcp.org

MINUTES

As requested by the EAHCP Implementing Committee, the **2016 EAHCP Biological Monitoring Program Work Group** (BioWG) and the **2016 EAHCP Expanded Water Quality Monitoring Program Work Group** (WQWG) have been formed to produce final reports for review by the Implementing Committee providing their assessment of recommendations made for each of the EAHCP Monitoring Programs. The Work Groups are comprised of representatives from throughout the Edwards Aquifer Region. An initial joint meeting of both Work Groups was held **Tuesday, March 15, 2016, at 11 at the San Marcos Activity Center (Room 1), 501 E. Hopkins, San Marcos, Texas 78666.**

Members of the BioWG include: Tyson Broad (Texas Tech University), Jacquelyn Duke (EAHCP Science Committee/Baylor University), Mark Enders (City of New Braunfels), Rick Illgner (Edwards Aquifer Authority), and Doyle Mosier (EAHCP Science Committee).

Members of the WQWG include: Ken Diehl (San Antonio Water System), Melani Howard (City of San Marcos/Texas State University), Charles Kreitler (EAHCP Science Committee), Steven Raabe (EAHCP Stakeholder Committee/San Antonio River Authority), Benjamin Schwartz (Texas State University), and Michael Urrutia (Guadalupe-Blanco River Authority).

All members were present. The following business was considered.

1. Call to Order.
   11:06 a.m.

2. Public Comment.
   Public attendees introduced themselves. Refer to sign-in sheets for attendees.

3. Introduction of WG members, EAHCP staff, and facilitators.
   Nathan Pence, EAHCP Program Manager, introduced the WQWG and BioWG participants, EAA staff members, and Design Workshop (DW) meeting facilitators.

4. Nomination and election of the Work Groups Chair.
   The Work Groups unanimously elected Steve Raabe as Work Group chair.

5. Presentation of schedule options and determination of a schedule for following Work Group meetings.
   DW proposed a meeting strategy and dates of March 29, April 7, April 27, May 9, May 11 and May 20. All proposed dates were approved by the WG, with the exception that Steve Raabe cannot participate the morning of March 29, Ben Schwartz cannot attend April 7 and Jacquelyn Duke cannot attend April 27. The WQWG will meet in the morning. The BioWG will meet in the afternoon. EAA provided an overview of outreach efforts and requested recommendations for additional entities that the Work Group would like to involve. No additional comments.

6. Discussion of the Work Group Charges, general information about the Work Groups, and overview of the Monitoring Programs and their background (Attachments 1 & 2).
   Nathan Pence presented the charges of each group. The charge is to carry out a holistic review, take into account the recommendations of the National Academy of Sciences, and produce a final report for review by the Implementing Committee.

7. Discussion of and possible endorsement of the basic operational guidelines and principles which will direct the Work Groups in carrying out their charges.
   Tyson Broad stated that the group needs to define "holistic" and "species-driven". Charlie Kreitler stated that caffeine detections may affect the species. Ken Diehl inquired if there will be an effort to look at compatibility and long-term trends. Nathan Pence confirmed that fifteen years of data will be shared. There is not yet adequate trend data to determine the long-term effects of caffeine on the species. Doyle Mosier stated that enabling long-term monitoring is an important outcome. Some measures will fluctuate, and others will not. Melani Howard stated that the Work Group should consider ways to minimize duplicative efforts. Nathan Pence states that this means focusing on meeting the goals and objectives of HCP. Ken Diehl states that turbidity, sedimentation and construction impacts on waterways should be considered. Melani Howard states that it would be beneficial for the Work Groups to be aware of watershed protection efforts. Ken Diehl recommends that the Work Group consider MS4 permits. It would be advantageous to eliminate duplicative sampling in certain areas. The Work Groups agree to add "integrate data collection" as an operational guideline. The Work Groups agree to add "support biological goals and objectives of the HCP". Steve Raabe, the Work Group chair, requests that DW simplifies the guidelines. He also requests that they are categorized into "guidelines" versus "strategies". Ken Diehl asks if the Work Group has alternates. Nathan Pence confirms that the Implementing Committee did not approve alternates, but they will note this for future work group efforts.

8. Presentation of current EAHCP Expanded Water Quality Monitoring Program (WQP) (SWCA, Phil Pearce)
   Phil Pearce provides a summary of annual water quality sampling efforts (for surface water, stormwater, sediment, passive diffusion and groundwater sampling). Tyson Broad asks if groundwater samples are taken at the same locations. Phil Pearce states that samples require close proximity to the springs. If spring flow drops below 30 cfs, additional parameters apply. Ken Diehl asks whether an analysis of sheet flow from the golf course, and entrance into the tributary, maximizes the location of sampling value to constituents. EAA states that sampling locations above Hinman Island Drive are beyond the flow going into the channel. Sampling depths of 18 inches are not arbitrary and were approved by the Science Committee. Phil Pearce states that sampling occurs multiple times during each storm event and in real time. Ben Schwartz states that many samples for DEET organochloride have been gathered. Is that something that the PHB program is analyzing or do HCP samplings need to include? The Work Groups agree that this is a parking lot topic. EAA is to provide DEET sampling protocols and compare to EAA's. EAA is collecting for rivers, and SWCA is collecting for springs. Ben Schwartz asks if there are data points that minimize manmade impacts. EAA states that this human-related topic is the jurisdiction of TCEQ. This effort should focus on species-related data points. The HCP presents data at TCEQ meetings, but it is not formerly reported. Charlie Kreitler inquires if more sampling points are needed. Ed Oborny states that they have gathered 15 years of data.

9. Presentation of current EAHCP Biological Monitoring Program (BioMP) (BIO-WEST, Ed Oborny)
   Ed Oborny provides an overview of fifteen years of biological monitoring data. In areas where storms and recreation did not disturb native vegetation, species growth occurred. Aquatic vegetation took a hit during the 2013-2014 droughts, followed by invasive plant growth. With Seasonal HCP restorations, reproduction of the Fountain Darter is occurring. Parking lot: EAA to provide comparisons for how these data points compare to other years. Ed Oborny states that measurements are taken twice a year. This year, due to storm events, Bio-West completed two additional trips in June and November. Bio-West monitors for changes in biological conditions. If there's not enough data or no changes ecologically, they are unable to draw correlations. For invertebrates, immediate changes correlate with spring flow. For vertebrates, changes correlate to vegetation and silt. The addition of real time monitoring stations that pick up turbidity and flows would be beneficial. Nathan Pence states that today EAA operates a total of six stations (three in both systems). EAA has learned from all monitoring consultants that stations produce the most useful data for both programs by far. Ed Oborny states that using the macroinvertabrate rapid bioassessment approach could save budget that could then be reallocated to riparian restoration efforts.

10. Presentation of Budget Info related to the WQP and BioMP.
    Nathan Pence provided an overview of the EAHCP program historically budget. Prior to 2013, EAHCP staff performed all sampling and tasks. In 2014, EAHCP staff hired sampling teams, and the budget increase reflects this. Springs communities are currently formulating a 2017 annual work plan that will be implemented starting in January.

11. Next Steps – timeline and associated list of goals.
    Future agenda items will include discussing draft modifications to the Scope of Work for the EAHCP Water Quality Monitoring and Biological Monitoring programs.

12. Consider future meetings, dates, locations, and agendas.
    Upcoming Work Group meetings will be held on March 29. Location to be determined. DW is to provide each Work Group member with calendar reminders for upcoming meetings.

13. Questions and comments from the public.
    None.

14. Adjourn.
    3:25 p.m.

MARCH 29, 2016 MEETING MINUTES

Available at eahcp.org

As requested by the Edwards Aquifer Habitat Conservation Plan (EAHCP) Implementing Committee, the 2016 EAHCP Biological Monitoring Program Work Group (BioWG) and the 2016 EAHCP Expanded Water Quality Monitoring Program Work Group (WQWG) have been formed to produce final reports for review by the Implementing Committee providing their assessment of recommendations made for each of the EAHCP Monitoring Programs. The Work Groups are comprised of representatives from throughout the Edwards Aquifer Region. The second meeting for the **Expanded Water Quality Monitoring Work Group** was held **Tuesday, March 29, 2016, at 9 a.m. at the San Marcos Activity Center (Room 1), 501 E. Hopkins, San Marcos, Texas 78666.** Members of the WQWG present at the meeting included: Ken Diehl (San Antonio Water System), Melani Howard (City of San Marcos/Texas State University), Steven Raabe (EAHCP Stakeholder Committee/San Antonio River Authority), and Michael Urrutia (Guadalupe-Blanco River Authority). Charles Kreitler (EAHCP Science Committee) and Benjamin Schwartz (Texas State University) were not in attendance.

At this meeting, the following business was considered by the Work Group.

1. Call to Order.
   9:10 a.m.

2. Public Comment.
   Pat Hartigan asked if source tracing is being conducted. Nathan Pence stated that the EAA does not perform source tracing. It does perform dye tracing and flow path research.

3. Recap of Work Group Meeting #1.
   Rebecca Leonard provided an overview of activities and outcomes from Meeting #1.

4. Review and achieve consensus on revised basic operational principles and guidelines.
   Rebecca Leonard presented how the basic operational principles and guidelines were revised, based on Meeting #1 discussions. The Work Group discussed whether scientific recommendations should be constrained by budget. The Work Group reached unanimous approval of operational principles and guidelines.

5. Presentation and discussion of draft modifications to the Scope of Work for the EAHCP Water Quality Monitoring Program.
   Nathan Pence presented two alternatives for modifying the Scope of Work for the EAHCP Water Quality Monitoring Program. The following are comments from the discussion regarding Alternative 1. Key changes to the Scope of Work, as proposed in Alternative 1, are: remove of surface (base-flow) sampling parameters, suspend sediment sampling, add real-time sampling, suspend stormwater sampling, enhance passive diffusion sampling (PDS), and suspend low-flow well sampling. ***HCP staff is to provide additional information regarding the proposed suspensions of sampling methods as referenced in Alternative 1. Each Work Group member is to review and be prepared to discuss at next meeting.*** *Ken Diehl requested the parameters, frequencies, detection limits, locations under the HCP, and locations under the Clean Rivers Program.* ***EAA is to coordinate with GRBA to provide the Work***

Group with a list of Clean Rivers Program efforts. *Suspending stormwater sampling during 2017-2018 was discussed (excluding sampling for detects of concern near golf courses). Then, after 2018, a full suite of detects could be sampled for so that efforts to gather a baseline data trend continue. Steve Raabe was in favor of this approach. Ken Diehl requested to see sampling locations so that the Work Group can determine if it is appropriate (is data adequately capturing the first flush of stormwater that enters the Comal system?). Nathan Pence stated that there has been past discussion regarding the use of automatic sampling devices, but there has yet to be consensus on the topic. Ken Diehl cited vandalism and damage as challenges to the validity of data captured by automatic sampling devices. Bob Hall stated that stormwater enters and leaves the system so quickly that eutrophication has not been an issue. Ken Diehl stated that the National Academy of Sciences (NAS) has identified nutrients as a concern, however, these are in designated areas. Ken Diehl stated that there may be a middle ground between the NAS recommendations and testing for a full suite of contaminants every time. Nathan Pence stated that enhanced PDS sampling entails adding a membrane that detects the presence/absence of pharmaceutical/personal care products (this membrane would not report concentration nor frequency). Parking lot topic: SAWS has ongoing monitoring efforts that detect the movement of bad water lines.* ***HCP should explore coordination opportunities with this effort.*** *San Antonio River Authority had USGS sample for emerging constituents of concern. A report has been published.* ***HCP staff will review report.***

The following are comments from the discussion regarding Alternative 2. Key changes to the Scope of Work, as proposed in Alternative 2, are: remove surface water (base flow) sampling, suspend sediment sampling, add real-time monitoring, suspend stormwater sampling, enhance PDS sampling, suspend low-flow well sampling, and add fish tissue sampling (largemouth bass, Asian clam, fountain darter). The rationale for this recommendation was that fish tissue sampling is a species-driven sampling approach. Mike Urrutia posed the question: "Does the Asian clam filter the water or sediment?" Bob Hall clarified that the Asian clam filters fine silt. Nathan Pence clarified that the Asian clam tissue sampling would serve in lieu of sediment sampling. It would let us know if there is a contaminant of concern in the sediment that is affecting the species. By doing tissue sampling, the program can focus on detects that have an acute effect on the species. Ken Diehl stated that we need a constituents list from experts, then we can tissue sample. Steve Raabe supported tissue sampling stating "It directly answers questions relating to the species. However, it does not answer everything we need to know about sediment." We must devise a program with an appropriate interval of sampling for the correct things (that the original database included). Then, in coming years, the program can tackle additional parameters. ***HCP staff shall consider input from this discussion, and draft an Alternative 3, that marries the benefits of both.*** *Steve Raabe, Chair of the Work Group, approved the creation of an Alternative 3 that addresses concerns regarding long-term trends and adjusted frequencies.*

Each Work Group member shared concluding thoughts regarding each alternative. Mike Urrutia stated that he likes Alternative 1 because it's familiar. He is in agreement with the importance of fish-tissue sampling. GBRA does not do this and it may provide valuable data, particularly related to mercury. Plum Creek samplers are automatic, and operating them is challenging. Stave Raabe liked the species direct testing and is in favor of the ability to have long-term data sets (that build upon variable flow studies and three-year data already gathered by the HCP). Steve Raabe stated that there may be need for shorter term sampling efforts (for personal care products, for example) that can be plugged into the long-term model. Ken Diehl stated that the overall challenge is a lot of data has been collected with little detection. He would like to see all the information in one place before he makes a decision. Ken wants to ensure that we are sampling constituents documented to have an impact on the species. He also noted that a person to review the data is needed. Has the Science Subcommittee made recommendations regarding how to proceed? Nathan Pence clarified that data is being collected, placed into one format, and presented to the Science and Implementing Committee. It will likely be 2018 when statistical analysis will be conducted. ***HCP is to provide information all in one place, so that Ken may make a decision regarding what to add or potentially remove from the Scope of Work.***

6. Presentation and possible recommendation of the methodology to calculate the historically-recorded water quality conditions (long-term averages) in the Comal River and San Marcos River ecosystems.
   Nathan Pence provided an overview of a methodology to calculate the historically recorded water quality conditions (long-term averages to determine the 10 percent deviation in the Comal River and San Marcos River ecosystems). Staff proposed using the data from the Variable Flow Study Fountain Darter Drop-net Sampling (2000-2012), which is biannual. U.S. Fish and Wildlife mandates the ten percent requirement. Steve Raabe asked if the Clean Rivers Program has additional data from the last ten years that could be used? Mike Urrutia stated that GBRA does not. Daniel Large stated that the proposed approach incorporates three measurements at different heights of the water column – mid-level, surface-level and high-level, making it more ecologically relevant for the Fountain Darter. The group considered the action. No objections. ***The Work Group unanimously agreed on qualified approval of the proposed data methodology for historical analysis. Meeting facilitators are to note this in the report, and HCP staff is to provide data regarding historical limits.***

7. Presentation of, and possible recommendation of analytical limits for water quality data that is used for the EAHCP.
   Alicia Reinmund-Martinez presented an appropriate analytical limit for water quality data used for protection of the Covered Species in the EAHCP. Steve Raabe stated that we are not discussing changing our detection limits. Nathan Pence stated that this is correct, the Work Group is simply considering the limits for reporting. The group considered an action to endorse this limit to water quality data. No objections. ***The Work Group unanimously approved the proposed recommendation of analytical limits for water quality data of the protection of the covered species.***

8. Presentation and discussion of National Academy of Sciences (NAS) recommendations.
   Nathan Pence provided a summary of recommendations from the NAS Report 1 for the EAHCP Water Quality Monitoring Program. HCP staff recommended that no changes be made to the reach approach for the HCP. Steve Raabe asked if there is a need for system-wide extrapolation? Nathan Pence stated that only data needed for compliance reporting falls within the current reach. ***Meeting facilitators to add to agenda for the next meeting the topic of nutrients. The HCP is to gather data to present at next meeting.***

9. Presentation and discussion of the Draft Report.
   Rebecca Leonard presented a draft of the Work Group's final report. No additional comments.

10. Consider future meetings, dates, locations, and agendas.
    HCP staff is to contact those not in attendance to share Alternative 1 and 2. *The Work Group's next meeting will be held April 27th at the Dunbar Recreation Center, 801 W. MLK, San Marcos, TX 78666.*

11. Questions and comments from the public.
    No questions or comments.

12. Adjourn.
    11:38 a.m. Steve Raabe concludes the meeting.

MARCH 29, 2016 MEETING MINUTES

Available at eahcp.org

As requested by the Edwards Aquifer Habitat Conservation Plan (EAHCP) Implementing Committee, the 2016 EAHCP Biological Monitoring Program Work Group (BioWG) and the 2016 EAHCP Expanded Water Quality Monitoring Program Work Group (WQWG) have been formed to produce final reports for review by the Implementing Committee providing their assessment of recommendations made for each of the EAHCP Monitoring Programs. The Work Groups are comprised of representatives from throughout the Edwards Aquifer Region. The second meeting for the **Biological Monitoring Work Group** was held **Tuesday, March 29, 2016, at 1 p.m. at the San Marcos Activity Center (Room 1), 501 E. Hopkins, San Marcos, Texas 78666.** The following members of the BioWG were present: Tyson Broad (Texas Tech University), Mark Enders (City of New Braunfels), Rick Illgner (Edwards Aquifer Authority), and Doyle Mosier (EAHCP Science Committee). Jacquelyn Duke (EAHCP Science Committee/Baylor University) was not in attendance.

At this meeting, the following business was considered by the Work Group.

1. Call to Order.
   1:10 p.m.
2. Public Comment.
   No comment or questions.
3. Recap of Work Group Meeting #1.
   Rebecca Leonard provided an overview of activities and outcomes from Meeting #1.
4. Review and achieve consensus on revised basic operational principles and guidelines.
   Rebecca Leonard presented how the basic operational principles and guidelines were revised based on Meeting #1 discussions. Rick Illgner requested that "Does it enable long term trends?" be revised to: "Does it enable long term trend analysis?" ***Meeting facilitators are to revise basic operational principles and guidelines to address this request.*** *Tyson Broad asked if being "budget neutral" is required by the group's charge. Nathan Pence clarified that it is not a required charge. Doyle Mosier stated that there is a limited source of money. Steve Raabe stated that the budget is a reality that will have to be considered. Tyson Broad stated that he would not like budget to be a limiting factor. He fears that important recommendations could be removed because funding is yet unavailable. Nathan Pence clarified that HCP staff is recording all of the Work Group recommendations; even those prioritized out due to budget constraints or other considerations. The Work Group unanimously approved the operational guidelines.*

5. Presentation and discussion of draft modifications to the Scope of Work for the EAHCP Biological Monitoring Program.
   Nathan Pence provided an overview of the background and work to date in creating the Biological Monitoring Program. It is a mature program. As such, HCP staff members are proposing minimal changes to the Biological Monitoring Scope of Work. The first change is modifying macroinvertebrate food source monitoring. HCP staff recommended substituting rapid bio assessment. Tyson Broad asked what is being done now. Ed Oborny (BIO-WEST) stated that vegetation-specific sampling is being conducted for seven species in the Comal system and six species in the San Marcos system (triplicate samples per system on each vegetation type). This is quite expensive. Doyle Mosier stated that the benefit of rapid bioassessment is that it allows you to sample a large area and provides an example of how these samples work in the field. Rapid bioassessment is effective, and TPWD has spent years developing it. Bob Hall stated that Option 2 will be more expensive than Option 1. Rick Illgner asked why Option 2 is being discussed, if Option 1 is more economical. Nathan Pence stated that HCP staff wanted to provide multiple options for the Work Group's discussion. Both options also represent potential cost savings from current practices, although Option 1 is more of a cost savings than Option 2. The Work Group requested that the second bullet point on the "Proposed Changes to Bio Monitoring Rapid Bioassessment" slide be changed to ***include the verbiage "most economical methods." Also, include "clarify and simplify the number of reaches." Meeting facilitators are to reformat the slide, so that the group can come to consensus on the wording at the next meeting.*** *Nathan Pence asked the group if there is any additional information that they need to consider the Scope of Work modifications. Tyson Broad stated that the Work Group's charge is also to consider the National Academy of Sciences (NAS) recommendations. The Work Group agreed to hold discussion until they have received the NAS recommendations presentation.*

6. Presentation and discussion of National Academy of Sciences (NAS) recommendations.
   Nathan Pence provided an overview of recommendations from the NAS Report 1 for the EAHCP Biological Monitoring Program. HCP staff recommended continuing to utilize Intensive Study Reaches. In reviewing the NAS Report, HCP staff did not find reason to scale results to the entire spring system. Tyson Broad stated that the Work Group's focus is on compliance with the take permit, however, down the road, answering system-wide questions may prove beneficial. Rick Illgner shared a different perspective. He feels the use of adaptive management strategies should be to fix a specific problem identified through data, not just to do things differently. Doyle Mosier stated that rapid bioassessment is great for sampling vegetation, but it's less useful for sampling riffle beetles. They require specialized sampling. HCP agreed with NAS recommendations regarding the Cotton-lure. Looking at invertebrates would be a special study of the Applied Research Group. Does the Work Group have any strategies that are missing from the list? San Marcos is conducting PPCP study. Nathan Pence provided an overview of strategies discussed in Water Quality Work Group that may overlap with the Biological Monitoring Work Group, such as personal care products, and fish tissue sampling. A future joint meeting between Work Groups will focus on how to create synergies between the programs. Are there items that staff is missing that should be added to the list? ***Tyson Broad is to share an article with HCP staff regarding the effects of hand sanitizer on water quality. No further comments or objections to the approach as written. The Work Group unanimously approves the inclusion of EAHCP staff recommendations for the draft report.***

7. Presentation and discussion of the Draft Report.
   Rebecca Leonard presented a draft of the Work Group's final report. No additional comments.

8. Consider future meetings, dates, locations, and agendas.
   Doyle Mosier requests that the April 27 meeting be extended to its full duration. The Work

Group agrees to meet from noon to 3:00 p.m., to be held at the Dunbar Recreation Center, 801 W. MLK, San Marcos, TX 78666.

9. Questions and comments from the public.
   Ken Diehl asks if there are ongoing efforts for gill species. Ed Oborny states that parasite monitoring is done by New Braunfels. ***Each Work Group member is to email HCP staff any other articles about threats they may be aware of so that we can address and discuss at next meeting. HCP staff is to share with Doyle Mosier the recent report reviewing the NAS report.***

10. Adjourn.
   2:52

APRIL 27, 2016 MEETING MINUTES

Available at eahcp.org

As requested by the EAHCP Implementing Committee, the 2016 EAHCP Biological Monitoring Program Work Group (BioWG) and the 2016 EAHCP Expanded Water Quality Monitoring Program Work Group (WQWG) have been formed to produce final reports for review by the Implementing Committee providing their assessment of recommendations made for each of the EAHCP Monitoring Programs. The Work Groups are comprised of representatives from throughout the Edwards Aquifer Region.

The third meeting for the Water Quality Monitoring Work Group is scheduled for Wednesday, April 27, 2016, at 9 a.m. at the Dunbar Recreation Center, 801 W. Martin Luther King Drive, San Marcos, TX 78666. Please RSVP to dlarge@edwardsaquifer.org.

At this meeting, the following business may be considered and recommended for Work Group action:

1. Call to Order.
   9:07 a.m.

2. Public Comment.
   No comments or questions.

3. Recap of Work Group Meeting #2.
   Rebecca Leonard provided an overview of previous Meeting #2 activities. Alicia Reinmund-Martinez provided a recap of the datasets for establishing ten percent deviations discussions. The group confirmed no objections, and that there is still consensus on the ten percent deviation methodology. Alicia Reinmund-Martinez provided a recap of analytical criteria for water quality outcomes from Meeting #2. Passive diffusion sampling was determined to be beneficial as more species-driven. Ben Schwartz posed the question of whether measurements show that we are exceeding set baselines.

4. Presentation, discussion and possible recommendation of Scope of Work #3 for the EAHCP Water Quality Monitoring Program.
   Nathan Pence provided an overview of the Expanded Water Quality Program and the Scopes of Work (#1 and #2) presented to the Work Group at the second meeting, and the rationales for each option. The third presentation to be discussed today, Scope of Work #3 alternates the frequencies of sampling efforts. Scope of Work #3 also addresses a few techniques that are not required by the Habitat Conservation Plan, such as sampling for Personal Care Products, and how the Implementing Committee may consider accommodating these without increasing the program's budget. Charlie Kreitler asked for an explanation of why tissue sampling is recommended. Nathan Pence provided an overview of previous efforts and discussions that have led to the tissue sampling recommendation. Charlie Kreitler stated a concern that there has been a lot of data collected, but limited analysis has occurred. Nathan Pence shared with the group, that EAA gathers water quality data that allows for both baseline and trend analysis. EAHCP will be contracting with a team to analyze and share the database that incorporates data from various sources, such as the Clean Rivers Program. Steve Raabe stated that the HCP should engage with other entities, such as GBRA, to ensure monitoring and data collection efforts further the long-term goals of the HCP. As funding remains finite, and

data collection becomes more complex and expensive, this coordination will become more important. Key changes to the Scope of Work, as proposed in Scope of Work 3, are: remove of surface (base-flow) sampling parameters, remove sediment sampling, add real-time sampling, reduce stormwater sampling, add passive diffusion sampling (PDS), remove low-flow well sampling, and add tissue sampling. Benjamin Schwartz shared that one golf course in San Marcos might close, due to significant storm damage, and become recreational ball fields, which would have differing integrated pest management considerations. Charlie Kreitler asked the impact to the budget for tissue sampling. Nathan Pence shared that current efforts cost $520k. Scope of Work 3, includes tissue sampling, which EAHCP staff estimates could provide a savings of approximately $100k annually. Nathan Pence provided an overview of surface water quality parameters suspended in Scope of Work 3. ***Facilitators are to add "EAHCP Surface Water Quality Parameters Suspended in Scope of Work 3" be added as a section in the report.*** *Potassium is not typically viewed as nutrient by aquatics biology. Ben Schwartz and Melani Howard comment that because EAA already samples for potassium and the other detects on this list, they agree with the recommendation to suspend the surface water (base flow) suite of parameters as proposed in Scope of Work 3. AWRL detection levels differ from what EAHCP is currently doing. Nathan Pence provided an overview of tissue sampling. There are experts and literature that EAHCP staff are collecting and referencing. To date, the key findings are that two locations per system, with three species tested per system.* ***Meeting facilitators are to use the term "aquatic tissue sampling" instead of "fish tissue sampling" in final report.*** *Nathan Pence provided an overview of sediment sampling recommendation to continue this program less frequently. Steve Raabe requested that consistency in data allow for flexibility, but the topic of adding testing for specific constituent needs to be held until a specific issue occurs. Ben Schwartz stated that it's not a static system that you can wait for specific constituent to be in the same location every year. Alicia stated that stormwater sampling will provide the results of the deposition of the storm event. Ken Diehl stated that he agrees with the proposal in Scope of Work 3 and believes that the frequency is okay as proposed, as long as the rest of the group is in consensus. Charlie Kreitler stated that sediment sampling is looking at more gradual, longer-term changes that explore how metals are building up. Ben Schwartz supports the approach of sampling the stormwater, and then if contaminant is detected, go to aquatic tissue sampling to see if it is affecting the species. Ben Schwartz prefers to have the same sites tested at each year. Nathan Pence provided overview of real-time sampling recommendations in Scope of Work 3 and the rationale for the geographical locations of real-time sampling locations. A recommendation for the San Marcos location is pending further input from various program partners. Ben Schwartz stated that USGS is preparing to move their instruments; however, in the last storm event there was damage to the Aquarena station. Nathan Pence clarified that EAHCP does not have the jurisdiction to mandate USGS' determination of their relocation site. Nathan Pence provided an overview of stormwater sampling recommendations in Scope of Work 3. Clarification to slide text: "Sampling of IPMP is not required by EAHCP." He also recommended that the first flush is captured through sampling, and that EAHCP try to capture more samples earlier and later during each event. Nathan Pence – blue line is conductivity. First lead sample is pre-peak, during peak, and post-peak. For the most part, there is consistency between hydrographs for when samples are occurring during each event. The red line on the graph indicates temperature. Temperatures drop during storm event. Ben Schwartz recommended that additional samples be conducted more frequently (i.e. six samples instead of three, or one every five minutes as opposed to fifteen, per se) during the rising limb of the hydrograph. Pre-storm samples do not change much from baseline to baseline. Clarification –recommending instead of 3 samples x 7 locations = 21 total; doing 5 samples x 7 locations = 35 total. EAHCP can require in the sampling team's contract, that when the storm event allows, they collect more samples during the peak. Melani Howard stated that the Work Group can make recommendations of certain locations within each system where additional samples during each event should be collected to further the program. Ben Schwartz emphasized that less sites, more samples, and focus on the mouth of the tributary. Nathan Pence provided a summary of passive diffusion sampling recommendations in Scope of Work 3.*

Nathan Pence provided an overview of groundwater sampling recommendation in Scope of Work 3. EAA is doing monthly, quarterly, event sampling. During low flows, neither EAA nor EAHCP is able to pick in advance which wells will be sampled. Real-time conditions and the amount of water in the wells, constrain which ones are capable of being sampled and this cannot be predicted ahead of the event itself. No objections to this recommendation. Nathan Pence asks if the work group comfortable with Scope of Work 3 being included as the recommendation that is included in the final report. Charlie Kreitler requested a statement that addresses the concern about how all the data that is being collected will be researched and analyzed. Meeting facilitators to add a recommendation that the data is not just collected, but analyzed in a way that contributes to the body of knowledge regarding how water is moving through the system. ***Steve Raabe made motion to approve Scope of Work 3 to be included in report. Charlie Kreitler seconded. Ben Schwartz supported Charlie Kreitler's recommendation that a robust section describing how EAHCP use the data is included, and that efforts go beyond simply capturing the data. No objections to Scope of Work 3. The group agreed by consensus to recommend Scope of Work 3 in the report. Work Group approved Alternative #3, with the addition of:***

- ***Add two stormwater samples at each location to the initial rise of the hydrograph, keeping the same 3 original samples as identified (onset, peak, and tail) in the original SOW, for a total of 5 samples per location. It is understood that due to timing, 5 samples at each location may not be feasible; therefore, the 5 samples, rather than just 3, should be prioritized for locations near tributary outflows (making Sessoms and Purgatory the first priorities)***

5. Presentation and discussion of nutrient monitoring within the Comal and San Marcos systems through the EAHCP and other programs.
Alicia Reinmund-Martinez provided an overview of National Academy of Sciences (NAS) recommendations concerning nutrient monitoring. Bob Hall described characteristics of the systems and nutrients affecting species in each. Between EACHP WQ, BioMP, and CRP all three nutrients of concern (nitrate, ammonia, and soluble reactive phosphorus) are being sampled. Recommendation is to drop nutrient sampling from the Water Quality Program because nutrients of concern are being covered by BioMP Program and CRP. At the detection limit used for soluble reactive phosphorus (SRP), there have been 95% non-detects. Dilemma is that detection limit is too low. Ben Schwartz suggested that a more reasonable number between 2 micrograms/L and 50 micrograms/L and be considered for testing due to potential additional cost related to testing at 2 micrograms. Does work group agree to specific nutrients of concern? The Work Group requests that the next meeting agenda be to discuss research relating to the nutrients of concern. —nitrate, ammonia, and SRP—were agreed to; and further agreed that SRP was the only one worth pursuing further due to detection limits/ability to modify. Before an action would be taken, ***WG asked at next meeting to be presented with a breakdown of SRP results and table showing gradation of costs as detection limit is decreased; staff will meet with Weston Nowlin to get more details; staff will formulate a recommendation.***

6. Presentation and discussion of the Draft Report.
Work Group members are to review the draft and send comments by end of week, so that report can be revised and an updated report can be presented on May 11.

7. Consider future meetings, dates, locations, and agendas.
The Work Group's next meeting will be help May 11th at the San Marcos Activity Center (Room 1), 501 E. Hopkins, San Marcos, TX 78666.

8. Questions and comments from the public.
No questions or comments.

9. Adjourn.

11:59 a.m., Steve Raabe concluded the meeting.

NOTICE OF OPEN MEETING
Available at eahcp.org

APRIL 27, 2016 MEETING MINUTES

As requested by the EAHCP Implementing Committee, the 2016 EAHCP Biological Monitoring Program Work Group (BioWG) and the 2016 EAHCP Expanded Water Quality Monitoring Program Work Group (WQWG) have been formed to produce final reports for review by the Implementing Committee providing their assessment of recommendations made for each of the EAHCP Monitoring Programs. The Work Groups are comprised of representatives from throughout the Edwards Aquifer Region.

The third meeting for the Biological Monitoring Work Group is scheduled for Wednesday, April 27, 2016, at 12 p.m. at the Dunbar Recreation Center, 801 W. Martin Luther King Drive, San Marcos, TX 78666. Please RSVP to dlarge@edwardsaquifer.org. Lunch will be provided.

At this meeting, the following business may be considered and recommended for Work Group action:

1. Call to Order.
   Rebecca Leonard called the meeting to order at 12:45.

2. Public Comment.
   No questions or comments.

3. Recap of Work Group Meeting #2.
   Tyson Broad stated for the record that "stewarding dollars" is not the charge of the Work Group. Nathan Pence confirmed that this is correct, and that this operational guideline applies more to the Water Quality Work Group, but it was a guideline identified and discussed at the joint work group kick-off meeting that has been considered during the process. No further comments.

4. Presentation, discussion and possible recommendation of Scope of Work for the EAHCP Biological Monitoring Program.
   Nathan Pence provided an overview of program purpose. Flow partitioning within Landa Lake by EAA was discussed as a possibility to drop from program in Meeting 2. As an update since Meeting 2, EAA has agreed to conduct and manage flow partitioning within Landa Lake. This is reflected in the Scope of Work overview slide seen today. Mark Enders asked how WQ phosphorus sampling efforts differ from BioM. Nathan Pence clarified that EAHCP is recommending maintaining WQ component in BioM in lieu of doing surface grabs in water quality program. Coming out of the WQWG this morning, EAHCP has been tasked with doing more research, working with Texas State professors, who have been researching this issue. Soluble reactive phosphorus is only being tested through the BioM program. Anticipate that the WQ work group will identify a lowered detection limit. The BioM should be aware that this is an ongoing discussion and may affect recommendations of the BioMWG as well. Doyle Mosier stated that an important consideration will be to explore and address the logistics of conducting the sampling. Jacquelyn Duke asked if there are any rapid bioassessment methods that would affect riparian shading. It is a valuable opportunity for EAHCP to take some of the riparian related monitoring parameters and ensure that these promote the health of the species. This would link back as available habitat near water's

edge. Tyson Broad stated that Hardy's model looked at riparian habitat and shading, that could provide options. Nathan Pence stated that we can add, at certain key locations where we know restoration is going on, additional focused measurement efforts. Ed Oborny does not agree with the idea that adding light measurements would add much value to long-term analysis, unless it is done with thermistors and light measurements. Does the group feel we should add that as a recommendation that there could be some before and after light penetration measurements taken? Bob Hall provided a summary of proposed changes to monitoring using rapid bioassessment (RBA) and comparison of options for macroinvertebrate RBA methods. RBA option one is recommended by EAHCP staff as the most economical, able to provide the most valuable information, and is tailored for monitoring the health of the system. Doyle Mosier supported staff recommendation for Option 1. Option 2 would be much more challenging to ensure that the number of samples would be statistically valid. Option 1 is more pragmatic for long-term monitoring, as Option 1 provides both useful information and stewards dollars. Tyson Broad asked if there is any benefit to increasing frequency (sampling more than biannually). Ed Oborny stated that other sampling is being conducted biannually. It is ideal to consistently sample. Originally sampled four times a year, but found that only spring emergence and fall is when most changes occur and provides useful data. Taking grab samples immediately after a flood is not recommended because species will be disturbed, so your measurements will be skewed. Waiting one to three weeks after the critical period is the current practice because this allows time for the species to resettle. Remove flow partitioning in Landa Lake as it is done through EAA and use Option 1 for rapid bioassessment. Jacquelyn Duke requested that a riparian linkage is included as assessments are made of other variables. Asked if Jacquelyn Duke is in favor of contractors taking light measurement before, during and after restoration of an area? Jacquelyn Duke confirmed, yes. Other water quality variables may change – such as runoff and turbidity. Measure what has changed with riparian restoration, and planning to measure before or after to report on that. Jacquelyn Duke makes the motion ***to include EAHCP recommendation to remove flow partitioning, take RBA Option 1, add RBA sampling events to critical period monitoring (low and high flow, and require monitoring of before riparian conditions and after riparian conditions as part of the Riparian Work Plans (light penetration and potentially other measures, depending on the project footprint and design).*** *Doyle Mosier seconds the motion. No objections or concerns.*

5. Presentation and discussion of the Draft Report.
   Work Group members to review the draft report and provide comments by Wednesday, May 4, 2016. A new draft will be provided to the work group by May 13 for their review in advance of the meeting.

6. Consider future meetings, dates, locations, and agendas.
   The Work Group's next meeting will be held May 20th at the San Marcos Activity Center (Multipurpose Room), 501 E. Hopkins, San Marcos, TX 78666.

7. Questions and comments from the public.
   No questions or comments.

8. Adjourn.
   3:00 p.m. Rebecca Leonard concluded the meeting.

HABITAT
CONSERVATION
PLAN
EDWARDS
AQUIFER

MAY 11, 2016 MEETING MINUTES

Available at eahcp.org

At this meeting, the following business may be considered and recommended for Work Group action:

1. Call to Order.

9:05 a.m. Steve Raabe called the meeting to order. Nathan Pence introduced Chad Furl, new Chief Science Officer at EAHCP, who was formerly with UTSA, and before that, the Department of Ecology in Washington State.

2. Public Comment.

No public comment.

3. Recap of Work Group Meeting #3.

Nathan Pence presented a recap of Meeting #3. The Work Group approved Alternative #3 Scope of Work. The Work Group agreed on nutrients of concern. Real time stations provide some of the most useful data – recommendation is to add one station per system. Stormwater – continue the baseline, sampling once per year, concluded that alternating years to include golf course pesticide sampling (adding atrazine), also include PDS sampling. Groundwater – recommendation to remove from the EAHCP due to EAA doing the same sampling and to remove duplication. Tissue sampling conducted alternate years that are opposite from sediment sampling. Tissue program is not committed to specific species, but EAHCP will engage subject matter experts (SMEs) for sampling recommendations; SMEs to include professors who have conducted sampling and the U.S. Fish and Wildlife Service. Chad Furl will lead the tissue sample process.

4. Discussion and possible recommendation of staff-proposed changes to the nutrient monitoring program for the EAHCP Expanded Water Quality Monitoring Program (Attachment 1).

Alicia Reinmund-Martinez reviewed the nutrient sampling information. Last meeting established that nutrients of concern are nitrate, ammonia and soluble reactive phosphorous (SRP). Question left after the last meeting was if we should reduce the detection limit of SRP since there have been 95% non-detects. Alicia Reinmund-Martinez and Bob Hall met with Dr. Weston Nowlin who provided the graph on SRP. Weston recommends 3-5 micrograms/liter (instead of 50). The price is the same for lab results regardless of what the detection limit is.

Steve Raabe asked if the contractors would charge more to collect; Nathan Pence indicated that he hasn't heard there would be additional costs, but will confirm that there is no additional cost. Alicia Reinmund-Martinez made the recommendation that the current nutrient sampling conducted for the EAHCP program be discontinued, and continue to use the nutrient monitoring that is done by the BioMP and GBRA's Clean Rivers Program, with the recommendation that the BioMP reduce the SRP detection level to 3-5 micrograms/liter. Michael Urrutia asked if they would filter in the lab, or filter in the field. Alicia said that SRP sampling is a step before total phosphorous sampling analysis in the lab – it is more costly to do total phosphorus than it is to do SRP. Bob Hall said SRP has to be filtered in the lab.

Ben Schwartz said that we should move forward with staff's recommendation.

Michael Urrutia asked if we tell the lab 3 or 5 micrograms/liter. Nathan Pence said that they have no choice but to give them 5 because the lab stated that they could not guarantee 3 micrograms/liter. Daniel Large said that phosphorous analysis has a range in the lab no matter what. He recommended we set at range of 3 -5 micrograms. Nathan Pence said we can work on that when we get a quote from the lab. Recommendation is that it be set at "at least 5 micrograms/liter."

Ben Schwartz made a motion to change detection limit to at least 5 micrograms per liter in the BioMP. Michael Urrutia seconded. Consensus.

Ben Schwartz asked about the issue of lowering the detection limit for ammonia from 100 micrograms/liter to something else. Alicia Reinmund-Martinez said that EAHCP does not monitor that and would have to look at GBRA's Clean Rivers data. Ben Schwartz stated that ammonia doesn't stick around long. If we have detects, it could be a sign of other problems. He didn't have a recommendation, but said that Weston Nowlin was concerned about the 100 micrograms/liter. Daniel Large said the Groeger report does discuss ammonium. Nathan Pence said that he doesn't know why we couldn't have the BioMP contractor pull a lower detection limit on ammonia at the same time as SRP detection. Daniel Large said that the lab that does SRP does ammonia as the same package. Michael Urrutia said that if we are looking for contribution of sewer lines (leaks), it is going to be higher than 100 micrograms/liter. That is why CRP uses that detection limit. ***Nathan Pence said staff will research ammonia conditions, and appropriate detection limits, similar to the SRP issue. The WQWG will review this new information at the next meeting.***

5. Discussion of synergies and integration between monitoring programs.

Nathan Pence started the conversation about synergies. In depth conversation about synergies will continue with the two Work Groups during the May 20th meeting. Nathan Pence reviewed the slides and staff recommendations. Nathan Pence said that Jacquelyn Duke stated that the group is not doing a before and after monitoring for our riparian restoration work, with the point that it may not be within the BioMP where that is done, but in the riparian restoration work plans. This is an example of a possible synergy to consider.

Melani Howard suggests including Riparian review in the RBAs. Nathan Pence suggested this should be added to the "Other Possible Synergies slide. This should be discussed at the next meeting.

Ben Schwartz – riparian conditions, staff mentioned "light." Tom Hardy had data all down the river prior to the restoration. Nathan Pence said that there are stretches of the river that are not good for restoration because of the shade. He said BIO-WEST may have some information on this. Nathan Pence said at the next meeting we will have a map of monitoring sites and biological reaches. As well as a table that shows when they are collected. Also a recommendation to give the work groups a starting point of how feasible it is to link those together.

Ken Diehl asked if BIO-WEST does any detailed observation on changes in the system over the 15-year period – recreation uses, nutria-impacts, etc. Nathan Pence said yes. Bob Hall said they do as well. They take photos from each site N/S/E/W. You can go through time looking at photos from a given point and see how it has changed (example, Landa Lake and Aquarena Springs). Ken Diehl asked about impacts during peak recreational use periods. Nathan Pence said that BIO-WEST has wanted to put this into reports, but did not want to put the opinions and anecdotal evidence without real data. Dianne Wassenich with the San Marcos River Foundation, said her volunteers conduct periodic counts of the number of recreational users in the river counts.

Ken Diehl said that he is looking for dead zones for example. Nathan Pence says they pick up changes in flora and fauna and that is recorded, but does not want to speculate on a cause for the change in *flora and fauna, unless there is data that can confirm the point source. If anyone wants the data, there is a lot of it. But, EAHCP needs to stay objective.*

6. Presentation and discussion of the Draft Report.

Ben Schwartz asked if there will be two reports or one. Nathan Pence indicated that there would be two reports because of the different level of dialogue each group had, and wants to represent that the work groups had unique discussions. There will be one cover page, but two separate reports.

7. Consider future meetings, dates, locations, and agendas.

Joint Meeting of the 2016 Expanded Water Quality & Biological Monitoring Work Groups, Friday, May 20, 2016, 9-12 p.m., San Marcos Activity Center (Multipurpose Room)

Rebecca Leonard will adjust the invite to reflect that the next meeting will be from 9:00 a.m. – 12:00 p.m. Recommendations will go to the Implementation and Science Committees to be reviewed and adopted, and none of the recommended changes will be implemented until January 2017.

8. Questions and comments from the public.

No comment.

9. Adjourn.

10:15 a.m. Steve Raabe concluded the meeting.

May 20, 2016 MEETING MINUTES

Available at eahcp.org

As requested by the EAHCP Implementing Committee, the **2016 EAHCP Biological Monitoring Program Work Group** (BioWG) and the **2016 EAHCP Expanded Water Quality Monitoring Program Work Group** (WQWG) have been formed to produce final reports for review by the Implementing Committee providing their assessment of recommendations made for each of the EAHCP Monitoring Programs. The Work Groups are comprised of representatives from throughout the Edwards Aquifer Region.

A final joint meeting of both Work Groups was held on **Friday, May 20, 2016, at 9 a.m. at the San Marcos Activity Center (Multipurpose Room), 501 E. Hopkins, San Marcos, Texas 78666.**

At this meeting, the following business was considered and recommended for Work Group action:

1. Call to Order.
   Steve Raabe called the meeting to order at 9:05

2. Public Comment.
   No comments

3. Recap of Work Group Meetings #3 (Bio) and #4 (Water Quality).
   Alicia Reinmund-Martinez stated that the focus of this meeting is the discussion of the Work Group reports and to reach consensus on the conclusions and in such review the conclusions. Melani Howard asked if the study reaches are also monitoring take, Alicia responded yes. Charles Kreitler asked what is meant by flow partitioning within the Landa Lake. Bob Hall responded that EAA has capability now to do flow partitioning in house, therefore this sampling activity was being transferred to EAA. Melani Howard stated that there is take occurring outside of the study reaches, and reaching the goals as well as planting and removing outside of the study reaches. She asked if the intensive study reaches are adequately picking up those changes as well, statistically. Daniel Large answered that the NAS didn't recommend to expand the study reaches, but if using the data to generalize then would need to randomize the sampling approach. Jacquelyn Duke asked if you are doing work outside of the intensive reaches are there follow up monitoring studies on those. Alicia responded that for the Biological Monitoring Program that they are only looking at the intensive study reaches. Melani Howard said that they are tracking outside of the intensive study, but that it doesn't go toward credit for the biological goals.

   Water Quality Monitoring report. The WQWG recommendations were based on three alternatives that were presented. Consensus was reached at May 11th meeting for Alternative #3 as detailed in presentation. Surface water ambient flow conditions to remove that program because being done by Clean Rivers Program and water quality monitoring component of the Biological Monitoring Program.

   Doyle Mosier requested that the rationale for changes be brought into the tables within the Conclusions section of the report. Daniel Large clarified that for the changes to the stormwater monitoring, that during a storm, a priority for sample collection should be given the tributaries.

For PDS Sampling, Melani Howard and Ben Schwartz recommend that "most downstream site" be included in the report on page 17. For monitoring golf course runoff, Ken Diehl stated it would be good to include atrazine, on the chemical list for both golf courses. Melani Howard said that the golf course in San Marcos is being repurposed and that sampling should be revisited when that happens. Daniel Large said that is included in the report with the mention of land use changes. Mark Enders said it might be subject to change and revise what we're sampling for, and make it clear that it's the most recent IPMPs reviewed on a yearly basis with enough lead time for the lab and bottle types, etc. Ken Diehl said algaecides and fungicides would be included.

Alicia Reinmund-Martinez said that for the purposes of PDS there will be a membrane at the most downstream site of the system. Groundwater monitoring will be removed because of the EAA current monitoring program.

Fish/clam tissue sampling will be added to the program in the odd years and that the type of species and type of analysis will be determined by various experts. Ken Diehl asked if full approval is needed from Fish and Wildlife and would that effect the analysis? Chad said there are permit restrictions, but doesn't foresee a problem. Doyle Mosier said that they are taking very few samples. Bob Hall said, that since we will not be sampling for human consumption concerns, will not need a large sample-4 grams of fish (as an example). Alicia Reinmund-Martinez said they are providing their responses to the recommendations and NAS is aware that work groups are meeting and working on the reports.

Alicia Reinmund-Martinez summarized Table W8 Conclusions regarding fountain darter, drop net sampling to determine water quality conditions for invertebrate and salamander to determine long term historical average.

4. Discussion and possible recommendation of staff-proposed changes to the nutrient monitoring program for the EAHCP Expanded Water Quality Monitoring Program.

Chad Furl said that currently ammonia is measured by the CRP program in both systems using 100 micrograms per liter, or 0.1 milligram per liter detection limit. In the Comal system that's being monitored every other month and the San Marcos system it is monitored quarterly.

Ken Diehl pointed out a typo that at the bottom paragraph it should read Effects Concentration (EC)20 in the bottom paragraph of the Ammonia data chart handout. Ken Diehl asked if it is known if the EC value based upon growth and reproduction? Chad Furl answered that it is both, and the sampling included at 100 organisms in each pool. Chad Furl said that the CRP limits of 100 micrograms per liter are protective of the system and are adequate. No need to do monitoring at lower the detection levels.

Ben Schwartz if it is known how many of those data points were non-detect? Since 1998, Chad Furl said between 50 – 70 percent of them were detected. Daniel Large said that 100 micrograms per limit is CRP's universal possible limit, and that depending on what lab used some detections using lower detection levels than that, but that's what they put in print, is 100 micrograms per liter. Chad Furl said it's flow dependent, when water flowing nicely, there should be no detects. In drought years, there will more detects.

Charlie Kreitler said that he thought that ammonia was being discussed as a possible nutrient instead of toxicity - he did not think ammonia was an issue. Chad Furl answered that the systems are phosphorous limited and not really a nitrogen issue. We took the approach of looking at ammonia as plant growth issue, but as being protective of aquatic life. Daniel Large said that the systems are highly oxygenated and ammonia would dissipate.

Alicia Reinmund-Martinez summarized the following: the SRP detection limit of at least 5 micrograms per liter, ammonia detection limit should remain at 100 micrograms per liter and the nitrate detection limit remain at 50 micrograms per liter. Rebecca Leonard said that the Water Quality Work Group does need to make a formal recommendation on the nutrient sampling. Ben Schwartz made the motion to keep 100 micrograms per liter for ammonia. Charlie Kreitler *seconded. No opposition. Consensus.*

5. Discussion and possible recommendation of synergies and integration between monitoring programs.

   Melani Howard asked that when BioWest does bio-assessments to notify City of San Marcos, so that the City can pick up the riparian part of the RPA (rapid bio-assessment) at the same time. Mark Enders seconded this request.

   Chad Furl asked if changing Water Quality locations to match BioMonitoring location would provide any value to either programs? Analyzed why the sampling is done in the determined location – there was original justification. The conclusion is that there is no good reason to change sites as it is unlikely to provide any additional information. Recommending not to change for San Marcos. Steve Bereyso suggested adding to the report that some sites were adjusted based on sampling team safety factors. Ken Diehl asked approximately where the Clean Rivers Programs are sampling. Chad Furl said at I-35, far downstream site.

   Daniel Large said that PDS will continue at existing sites as well as downstream. Chad Furl said PDS is placed in springs every other month and stay there for a couple weeks. Jacquelyn Duke said that changing their locations wouldn't provide any better information than they already do. Ken Diehl asked if for PDS samplers would continue at existing sites, and then the furthest downstream site for PDS samplers, would have the pharmaceutical membrane too? Alicia said Yes.

   Charlie Kreitler asked for more information about the physical hydrology for two spring locations. Is there an understanding for the watersheds and how it affects species trying to protect? Alicia said that is maybe a research study for outside of the work groups. Melani Howard said that flooding is natural and good, but the impacts from urbanization is combination to be looked at. Jacquelyn Duke motioned to approve synergies with the addition of use of data to inform management, and provided to springs communities. Doyle Mosier seconded. No opposition. Consensus.

6. Presentation, discussion, and possible approval of the draft *Report of the 2016 Expanded Water Quality Monitoring Program Work Group.*

   Steve Raabe suggested bringing the body of the justifications into the table so that they're all there in the table. Ben Schwartz said this will help eliminate misinterpretation.

   Steve Raabe proposed that HCP staff will evaluate comments and determine if there is a substantive change and make a list to go back to the work group to approve and comment on suggested changes. Alicia Reinmund-Martinez said changes, edits and comments will be compiled and sent to the work groups for May 27 report review.

   Melanie Howard motioned to approve the Water Quality Report with the understanding that we will change incorrect information and incorporate certain style suggestions. Ben Schwartz seconded. No opposition. Consensus.

   Charlie Kreitler asked when the reports will be implemented? Alicia said 2017.

   Tyson Broad suggested including an attachment of the previous SOW to the reports as an appendix for both Work Groups. Alicia Reinmund-Martinez agreed.

   Tyson Broad suggested including brief description of what RBAs are, what is the flow partitioning, as well as SRP and other terminology not defined in the report as well as more discussion points as presented in meeting minutes. Doyle Mosier motioned to accept the current report with Tyson Broad's discussed modifications. Steve Raabe seconded. No opposition. Consensus.

7. Presentation, discussion, and possible approval of the draft *Report of the 2016 Biological Monitoring Program Work Group.*
   No questions. No comments.

8. Next steps for final review of the draft Reports of the Work Groups.

   - *May 27, 2016 - Revised final report incorporating discussion and recommendations from the May 20 meeting will be sent to Work Group members via e-mail.*

   - *June 8, 2016 - Deadline for final comments on revised final report (May 27 version) to be e-mailed by June 10, 2016 for incorporation into the final draft.*

   - *Absolute final report to be sent out the week of June 13, 2016.*

9. Questions and comments from the public.
   None.

10. Adjourn.
    RL adjourned at 11:00.

EXHIBIT A
SCOPE OF WORK
TO CONTRACT No. 13-656-HCP
BETWEEN THE
EDWARDS AQUIFER AUTHORITY
AND
SWCA ENVIRONMENTAL CONSULTANTS
FOR WATER QUALITY SAMPLING AND ANALYSIS PROGRAM FOR COMAL AND SAN MARCOS SPRINGS ECOSYSTEMS

SCOPE OF WORK

Task 1. Comal Springs Ecosystem Sampling

This task is divided into several subtasks consisting of surface water sampling, stormwater runoff sampling, well sampling, subsurface sediment sampling, and passive diffusion sampling.

Subtask 1.1 Surface Water Grab Sampling

The Contractor will collect grab samples from the five surface water sampling locations (see attached map), twice during the calendar year, approximately six months apart. Samples will be collected in March and August. Grab samples will be analyzed for the analytical parameters using the analytical methods provided in Table 1.

Subtask 1.2 Surface Water Passive Sampling

The Contractor will perform six sampling events using passive diffusion samplers (PDS) manufactured by Amplified Geochemical Imaging, LLC (or equivalent). A PDS will be placed in each of the sampling locations identified in the attached map for the Comal River. The PDS will be left in place for two weeks at each location. The sampling events will occur in February, April, June, August, October, and December. Purchase price of PDS from Amplified Geochemical includes analysis of a suite of organic compounds.

All analyses, other than those provided for PDS's and provided by Amplified Geochemical Imaging, LLC. will be conducted by a National Environmental Laboratory Accreditation Program (NELAP) laboratory.

Sample sites in the Landa Lake and Comal River area are listed below: (also see attached map)

Upper Springs (near Bleiders Creek);
Upper Landa Lake - (near Spring Island);
Lower Landa Lake - (above outfalls);
Upper Old Channel - (Elizabeth Street); and,
USGS Gauge - (above San Antonio Street Bridge)

Subtask 1.3 Storm Water Sampling

Two storm water sampling events will be performed each year. The Contractor shall schedule these sampling events so that they are approximately six months apart and are representative of different seasons of the year (preferably winter and summer). It is understood that this sampling is dependent on rainfall events; if it becomes apparent that this criteria for a sampling schedule is unable to be met, the Contractor shall propose a new sampling schedule to EAA staff to be approved by EAA. A storm water sampling event will be triggered when the flow rate at the U.S. Geological Survey (USGS) Comal Springs gauging station (#08169000) increases by 5% or there is a 20% change in three of the five water quality parameters measured in the downstream real time water quality monitoring probe. Samples will be collected from each stormwater sampling location during the sampling event.

Stormwater samples will be analyzed for the analytical parameters using the analytical methods provided in Table 1.

The following locations will be sampled for storm water (see attached map):

Upper Springs (near Blieders Creek);
New Channel - (below confluence with Dry Comal Creek);
Upper Old Channel - (at Elizabeth Street);
Lower Old Channel - (above Hinman Island); and,
Comal River - (above confluence with Guadalupe River)

Subtask 1.4 Groundwater Sample Collection for Extreme Low Flow Scenarios Comal Springs

In the event total springflow at Comal Springs (as measured by USGS Comal Springs gauging station (#08169000)) drops below 30 cubic feet per second (cfs), the Contractor will conduct weekly monitoring of three wells in the vicinity of the spring complex for dissolved oxygen (DO), conductivity, pH, and temperature. Should springflow drop below 20 cfs, additional weekly sampling analyses will include nutrients, total dissolved solids (TDS), and total organic compounds (TOC). EAA staff will assist the Contractor in selecting three wells that will be used for sampling. Groundwater samples will be analyzed for the analytical parameters using the analytical methods provided in Table 2.

Based on conditions during the drought of record (circa 1950s), sampling for a lower flow could last for up to 21 weeks.

Subtask 1.5 Sediment Sampling

One subsurface sediment sampling event will be conducted each June at each of the surface water sampling locations. Three samples will be collected at each sample site and composited into one sample for analysis. Sediment samples will be analyzed for the analytical parameters using the analytical methods provided in Table 3.

The Contractor shall provide prior notification to EAA no later than 5 business days of intent to conduct a surface or sediment sampling event. The Contractor shall provide 24 hour prior notification to the EAA of the intent to mobilize for a potential stormwater sampling.

After each sampling event, the Contractor shall provide the data within one week of receipt from the Laboratory and indicate which parameters 1) have exceeded TCEQ surface water standards for contact recreation and ecological health for storm, well, PDS and surface water samples and 2) have exceeded Probable Effect of Concentration to Benthic Organisms (PEC) for sediment samples.

The Contractor shall ensure collection of sufficient number of samples and sample volume per laboratory requirements for water and sediment samples.

Task 2. San Marcos Springs

This task is divided into of several subtasks consisting of surface sampling, stormwater runoff sampling, groundwater sampling, subsurface sediment sampling, and passive diffusion sampling.

Subtask 2.1 Surface Water Sampling Locations
The Contractor will collect grab samples from the seven surface water sampling locations (see attached map), twice during the calendar year, approximately six months apart. Samples will be collected in March and August. Grab samples will be analyzed for the analytical parameters using the analytical methods provided in Table 1.

Subtask 2.2 Surface Water Passive Sampling
The Contractor will perform six sampling events using passive diffusion samplers (PDS) manufactured by Amplified Geochemical Imaging, LLC (or equivalent). One PDS will be placed in each of the sampling locations identified in the attached map for the San Marcos River. The PDS will be left in place for two weeks at each location. The sampling events will occur in February, April, June, August, October, and December.

All analyses, other than those provided for PDS's and provided by Amplified Geochemical Imaging, LLC. will be conducted by a National Environmental Laboratory Accreditation Program (NELAP) laboratory.

Sample sites in the Spring Lake and San Marcos river area are listed below: (also see attached map)

Sink Creek;
Spring Lake;
Sessoms Creek;
City Park;
Rio Vista Dam;
I-35 reach; and
Capes Dam

Subtask 2.3 Storm Water Sampling

Two storm water sampling events will be performed each year. The Contractor shall schedule these sampling events so that they are approximately six months apart and are representative of different seasons of the year (preferably winter and summer). It is understood that this sampling is dependent on rainfall events; if it becomes apparent that this criteria for a sampling schedule is unable to be met, the Contractor shall propose a new sampling schedule to EAA staff to be approved by EAA. A storm water sampling event will be triggered when the flow rate at the USGS San Marcos Springs gauging station (#08170500) increases by 5% or there is a 20% change in three of the five water quality parameters measured in the downstream real time water quality monitoring probe. Samples will be collected and analyzed from each stormwater sampling location during the sampling event.

The following locations will be sampled for storm water (see attached map):

Sink Creek;
Sessoms Creek;
Dog Beach Outflow;
Hopkins Street Outflow;
Purgatory Creek (above San Marcos River);
I-35 Reach; and
Willow Creek (above San Marcos River)

Subtask 2.4 Groundwater Sample Collection for Extreme Low Flow Scenarios for San Marcos Springs

In the event total springflow at San Marcos Springs (as measured by USGS San Marcos Springs gauging station (#08170500)) drops below 30 cubic feet per second (cfs), the Contractor will conduct weekly monitoring of three wells in the vicinity of the spring complex for dissolved oxygen (DO), conductivity, pH, and temperature. Should springflow drop below 20 cfs, then additional weekly sampling analyses will include nutrients, total dissolved solids (TDS), and total organic compounds (TOC). The EAA will assist the Contractor in selecting three wells that will be used for sampling. Groundwater samples will be analyzed for the analytical parameters using the analytical methods provided in Table 2.

Based on conditions during the drought of record (circa 1950s), sampling for a lower flow scenario could last for up to 21 weeks.

Subtask 2.5 Sediment Sampling

One subsurface sediment sampling event will be conducted each June at each of the surface water sampling locations. Three samples will be collected at each sample site and composited into one sample for analysis. Sediment samples will be analyzed for the analytical parameters using the analytical methods provided in Appendix C. Results of sediment sampling analysis will be used to formulate future sediment sampling at Spring Lake and the San Marcos River.

The Contractor shall provide prior notification to EAA no later than 5 business days of intent to conduct a surface or sediment sampling event. The Contractor shall provide 24 hour prior notification to the EAA of the intent to mobilize for a potential stormwater sampling.

After each sampling event, the Contractor shall provide the data within one week of receipt from the Laboratory and indicate which parameters 1) have exceeded TCEQ surface water standards for contact recreation and ecological health for storm, well, PDS and surface water samples and 2) have exceeded Probable Effect of Concentration to Benthic Organisms (PEC) for sediment samples.

The Contractor shall ensure collection of sufficient number of samples and sample volume per laboratory requirements for water and sediment samples.

Table 1: Analytical Parameters for Assessing Water Quality from Storm Water and Surface Water Locations, Comal and San Marcos Springs

Analyses
Volatile Organic Compounds (VOCs)
Semi-volatile Organic Compounds (SVOCs)
Organochlorine Pesticides
Polychlorinated Biphenyls (PCBs)
Organophosphorous Pesticides
Herbicides
Metals (Al, Sb, As, Ba, Be, Cd, Cr (total), Cu, Fe, Pb, Mn, Hg, Ni, Se, Ag, Tl, and Zn)
General Chemistry (GWQP) Total Alkalinity (as CaCO3), Bicarbonate Alkalinity (as CaCO3), Carbonate Alkalinity (as CaCO3); (Cl, Br, NO_3, SO_4, Fl, pH, TDS, TSS, Ca, Mg, Na, K, Si, Sr, CO_3,)), and Total Suspended Solids (TSS).
Phosphorus (total)
Total Organic Carbon (TOC),
Dissolved Organic Carbon (DOC)
Kjeldahl Nitrogen
Bacteria Testing (*E coli*)
Caffeine

Table 2: Analytical Parameters for Critical Period Related (Low Flow) Sampling of Water Wells, Comal and San Marcos Springs

Analyses
General Chemistry (GWQP) Total Alkalinity (as CaCO3), Bicarbonate Alkalinity (as CaCO3), Carbonate Alkalinity (as CaCO3); (Cl, Br, NO_3, SO_4, Fl, pH, TDS, TSS, Ca, Mg, Na, K, Si, Sr, CO_3,)
Total Organic Carbon (TOC)
Total Dissolved Solids (TDS)

Table 3: Analytical Parameters for Assessing Water Quality from Sediment Sample Locations, Comal and San Marcos Springs

Analyses
Volatile Organic Compounds (VOCs)
Semi-volatile Organic Compounds (SVOCs)
Organochlorine Pesticides
Polychlorinated Biphenyls (PCBs)
Organophosphorous Pesticides
Herbicides
Metals (Al, Sb, As, Ba, Be, Cd, Cr (total), Cu, Fe, Pb, Mn, Hg, Ni, Se, Ag, Tl, and Zn)
General Chemistry Total Alkalinity (as CaCO3), Bicarbonate Alkalinity (as CaCO3), Carbonate
Phosphorus (total)
Total Organic Carbon (TOC),
Dissolved Organic Carbon (DOC)

Table 4: Method Descriptions

Method	Method Description	Protocol[1]
8260B	Volatile Organic Compounds	(GC/MS) SW846
8270C	Semivolatile Organic Compounds	(GC/MS) SW846
8081B	Organochlorine Pesticides	(GC) SW846
8082A	Polychlorinated Biphenyls (PCBs)	by Gas Chromatography SW846
8141A	Organophosphorous Pesticides	(GC) SW846
8151A	Herbicides	(GC) SW846
6010B	Metals	(ICP) SW846
6020	Metals	(ICP/MS) SW846
7470A	Mercury	(CVAA) SW846
300.0	Anions,	Ion Chromatography
340.2	Fluoride	MCAWW
365.4	Phosphorus,	Total EPA
9040C	pH	SW846
9060	Organic Carbon,	Total (TOC) SW846
SM 2320B	Alkalinity	SM
SM 2540C	Solids,	Total Dissolved (TDS) SM
SM 2540D	Solids, Total Suspended (TSS)	SM
351.2	Nitrogen, Total Kjeldahl	MCAWW
E1694	Caffeine	(HPLC/MS/MS) EPA

Task 3. Conclusions and Recommendations

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[1] **Protocol References:**

EPA = US Environmental Protection Agency

MCAWW = "Methods For Chemical Analysis Of Water And Wastes", EPA-600/4-79-020, March 1983 And Subsequent Revisions.

SM = "Standard Methods For The Examination Of Water And Wastewater",

SW846 = "Test Methods For Evaluating Solid Waste, Physical/Chemical Methods", Third Edition, November 1986 And Its Updates.

The Contractor will summarize observations regarding sample site locations, frequency of samples, number of samples, data results, and trends. The Contractor will discuss conclusions based on these items and provide recommendations to the EAA for consideration in the following year.

Task 4. Draft and Final Annual Reports

No later than November 1st of each calendar year, , the Contractor shall submit to the EAA two (2) copies of the draft project report. The report will include an evaluation of analytical data, graphs of water quality laboratory and field data sheets, photographs, sampling locations and rationale, description of sampling methods, and a description and rationale for any minor deviations from the Scope of Work due to logistics or safety issues.

After receipt and incorporation of the EAA's review comments, the Contractor will submit the final report to the EAA on or before December 31st of each calendar year.

Task 5. Meetings and Presentations

The Contractor will present the project results to the Implementing Committee on or about December of each calendar year and additionally when requested by the EAHCP Program Manager.

PROJECT REQUIREMENTS

A. No later than February 15, and each month thereafter, the Contractor shall submit a monthly "invoice packet" to the EAA for each previous month's activities. Each invoice packet shall contain, at a minimum:

(1) A progress report containing:
    - a description of the work completed in each Task during the billing cycle;
    - a monthly update of the work schedule as it relates to achievement of the deliverables;
    - an estimate of the percent completion of each Task;
    - a discussion of any issues or problems that may result in a change in the deliverable due date;

(2) Documentation of all costs and expenses incurred during the billing cycle, supporting documentation; and

(3) A certified invoice summary sheet.

B. The monthly invoice packet will be submitted electronically in Adobe Acrobat (pdf) format via email to the Senior HCP Coordinator.

C. Data Submission, Statement of Assumptions, Project Notebook

(1) All spreadsheets, laboratory data sheets, QA/QC verification, field sample sheets, and project notebooks developed as a part of this project, are due on the same date as the final report.

(2) All analytical data collected and/or generated during this study shall be submitted to the EAA in an electronic format which will be provided to the Contractor. Data shall be delivered via pre-approved digital media and shall be labeled to provide sufficient detail to access the information.

(3) All databases, and spreadsheets developed herein (written and digital formats) are due on the same date as the final report.

(4) To facilitate the EAA's accurate evaluation of the Contractor's work product, computations, conclusions and recommendations, the Contractor shall:

- Prepare a project notebook containing a description of the assumptions and methodologies used in the study analysis. The notebook shall be organized in such a way as to allow replication of the steps, calculations, and procedures used by the Contractor to reach conclusions, described in the draft final report. The project notebook shall be submitted with the draft final report.

D. The Contractor shall take digital photographs throughout the term of the study representative of each task. Digital photos shall be submitted with the draft final report.

Appendix G: Scope of Work Contract No. 14-689-HCP between the Edwards Aquifer Authority and Bio-West, Inc. for a Comprehensive Biological Monitoring Program for Comal and San Marcos Springs Ecosystems

EXHIBIT A
SCOPE OF WORK
CONTRACT No. 14-689-HCP
BETWEEN THE
EDWARDS AQUIFER AUTHORITY
AND
BIO-WEST, INC.
FOR A COMPREHENSIVE BIOLOGICAL MONITORING PROGRAM FOR COMAL AND SAN MARCOS SPRINGS ECOSYSTEMS

SCOPE OF WORK

There are four components to this Scope of Work:

1. The Comprehensive Sampling Program (Schedules depicted in Tables 1 & 2).
2. The Critical Period Sampling Program (Schedules depicted in Tables 3 & 4).
3. EAHCP Low Flow Sampling Program (Schedules depicted in Tables 5 & 6).
4. EAHCP Habitat Baseline, Disturbance, and Take Determination.

COMPREHENSIVE SAMPLING PROGRAM

Task 1. Literature Review

The purpose of the literature review is to familiarize the Contractor with the Biomonitoring program's history and recent relevant studies. The literature review includes: search, compilation and annotation of historical data and information related to spring water quality and variable flow and to the composition, diversity and distribution of aquatic biota in subterranean, orifice and spring pool/run habitats, focusing on the sensitivity of indicator species and Covered Species to variable flow, water quality and habitat conditions. The bibliography of sources utilized for the literature review will be delivered on a separate CD with the annual report.

Task 2. Aquatic Vegetation Mapping

The Contractor will conduct aquatic vegetation mapping in four representative reaches in the Comal Springs system (Figure 1, Table 7) and in three representative reaches in the San Marcos Springs system (Figure 2, Table 7) during Comprehensive mapping as per defined protocols.

Mapping will be conducted using a GPS unit with real-time differential correction that can provide sub-meter accuracy. Aquatic vegetation will be identified and the perimeter of each vegetation type mapped at the water's surface. Vegetation stands that measure between 0.5 - 1.0 meters (m) in diameter will be mapped by recording a single point. Vegetation stands less than 0.5m are not required to be mapped.

Task 3. Texas wild-rice Mapping

The Contractor will map all Texas wild-rice from Spring Lake downstream to the confluence of the Blanco River on an annual basis. The annual mapping will occur during the summer (August) Comprehensive Biomonitoring sampling event. Using the kayak method described in Task 2, the location of every stand of wild-rice will be recorded using a GPS unit with real-time differential correction that can provide sub-meter accuracy. For this mapping, a stand of Texas wild-rice is defined as a contiguous group of plants that are growing no closer than 0.5 m from any other stand(s) of wild-rice.

In addition, during both the Spring and Fall Comprehensive sampling events, surveys in designated "vulnerable" areas of Sewell Park, as well as, sections of the San Marcos River upstream and downstream of I-35 (Figures 3, 4 & 5, respectively), will also identify, map and record Texas wild-rice stands. A "vulnerable" stand exhibits one or more of the following conditions: 1) it occurs in water with a depth of less than one foot, 2) it has extreme root exposure due to scouring of substrate, or 3) it appears to be in poor condition. Each sampling activity conducted in a designated vulnerable area will include detailed physical observations (i.e. depth, leaf length, rootball exposure, etc.). Measurements taken at each stand of Texas wild-rice that is located in a designated vulnerable area will include a maximum length and a maximum width of each stand. The length will be taken at the surface parallel to the stream current and extended from the base of the roots to the tip of the longest leaf. The width will be measured the same way, only perpendicular to the stream current and usually will not include roots. The area of each stand will be calculated by creating an imaginary rectangle over the stand using the maximum length and maximum width. From this, the percent cover of wild-rice will be estimated to give estimated area. Point velocity measurements will be taken at the upstream edge along with a minimum and maximum water depth at each identified stand of Texas wild-rice. In addition to recording the point velocity and water depth at each stand, a cross-section of the river at each designated area will be conducted which includes cross-section measurements of velocity, depth and substrate at 1 meter intervals across the entire width of the river.

Anomalies may be observed and will be noted during field efforts, such as stands that possess signs of extreme predation on the foliage, appear to shaded out by other floating vegetation, possess abundant algae build up on foliage, or are currently in bloom. Notes will be taken on any observable adverse impacts to the wild-rice and the possible sources of the impacts. Regardless of condition, no Texas wild-rice plants will be collected.

The Contractor will also provide an on-going evaluation of new plants for inclusion should vulnerable stands be lost during high-flow or low-flow events.

Task 4. Fountain Darter Sampling

The Contractor will conduct drop and dip netting and visual aquatic surveys with SCUBA during the Spring and Fall sampling events. Additional dip net sampling will be conducted during the Summer sampling event. Aquatic vegetation as per Task 2 will be mapped in the reaches prior to drop and dip net activities.

Subtask 4.1 Drop Net Sampling

Identified reaches of the rivers (Figures 1 & 2) will be sampled (Table 7). Drop nets will be used in specific aquatic vegetation types that have been selected through stratified random methods.

Drop nets must be constructed by the Contractor to follow a U.S. Fish & Wildlife Service (FWS) design and methodology for fountain darter sampling. The basic design of the drop net encloses a 2 m^2 area with adjustable depth to allow thorough sampling by preventing escape of fishes in the drop net area. A 1 m^2 dip net is used within the drop net and is swept along the length of the river substrate 15 times to ensure complete capture of all of the fish within the drop net.

The drop nets will be used in specific aquatic vegetation types that will be selected through the following stratified random method:

1. The aquatic vegetation will be mapped in the reaches prior to drop net activities.
2. The vegetation maps are then divided into 2 m^2 sections, broken down by the aquatic vegetation present and bare bottom area.
3. The Contractor will select the most abundant vegetation types that provide potential fountain darter habitat.
4. A random number generator will be used to select two sites within each vegetation community in a reach.

Fountain darters have not been found occupying bare substrate sites in any sizable numbers for over 12 years in the Comal or San Marcos rivers. As such, bare substrate sites are replaced with vegetated sites during Comprehensive monitoring. During Critical Period monitoring, bare substrate sites will be reinstated to evaluate potential shifts in habitat usage. Under the current vegetation assemblage, the following types of vegetation will be sampled in the respective reaches for each section.

System Reaches and Vegetation to be Monitored (See Figures 1 & 2)

Reach	Number of Sites	Vegetation
San Marcos River		
City Park Reach	8	hygrophila, hydrilla, vegetation complexes
IH-35 reach	8	hygrophila, hydrilla, cabomba
Spring Lake Dam Reach	8	hygrophila, hydrilla, vegetation complexes
Comal River		
Upper Spring Run Reach	6	hygrophila, sagittaria, bryophytes
Landa Lake Reach	10	hygrophila, ludwigia, vallisneria, cabomba, bryophytes
Old Channel Reach	6	algae, ludwigia, hygrophila

Fountain darters will be identified, counted, measured, and returned to the river at the point of collection. All fountain darters collected by drop net monitoring will be examined visually for evidence of gill parasites. Other fish will be identified and released or preserved and identified in a laboratory. All live ramshorn snails will be counted, measured, and destroyed. Exotic Asian snails (*Melanoides tuberculata* and *Thiara granifera*) and Asian clam (*Corbicula sp.*) will be identified, general abundance recorded, then destroyed. At each location, the vegetation type, height, areal coverage, substrate type, mean column velocity, velocity at 15 centimeters (cm) above the bottom, water temperature, conductivity, and dissolved oxygen levels will be recorded.

Subtask 4.2 Dip Net Sampling

The Contractor will conduct dip net timed surveys as well as presence/absence surveys in specified reaches throughout the spatial extent of both systems (below). All fountain darters collected by dip net monitoring will be examined visually for evidence of gill parasites. Dip nets of approximately 40 cm x 40 cm (1.6 mm mesh) will be used for both timed surveys as well as presence/absence surveys. Dip netting for timed surveys will be conducted in all habitat types within each reach, moving upstream during the sampling process, up to a depth of 1.4 m. All habitat types within a reach will be sampled, with prime darter habitat receiving the most effort.

- Timed Surveys: To balance the sampling efforts, the following predetermined time constraints will be used for each reach to provide consistent timed surveys: San Marcos River system - Hotel Reach-0.5 hour, City Park Reach-1.0 hour, I-35 Reach-1.0 hour, Lower San Marcos River/Todd Island-1.0 hour; Comal River - Upper Spring Run-0.5 hour, Spring Island area-0.5 hour, Landa Lake-1.0 hour, new Channel-1.0 hour, Old Channel-1.0 hour, Garden Street-1.0 hour. Fountain darters will be identified, counted, measured, and returned to the river at the point of collection.

Presence/absence surveys will be conducted by taking 4 dip net sweeps at 50 permanent sample site locations within the four representative reaches at Comal Springs (Upper Spring reach (5 locations), Landa Lake reach (20 locations), Old Channel reach (20 locations), and New Channel reach (5 locations)) and the 50 permanent sample site locations within the three representative reaches in San Marcos Springs (Spring Lake Dam reach (15 locations), City Park reach (20 locations), and IH-35 reach (15 locations)).

Subtask 4.3 Visual Fountain Darter survey

Visual aquatic surveys will be conducted using SCUBA in a fixed location in Landa Lake to identify fountain darters at depths deeper than conventional sampling methods allow. The fixed location in Landa Lake runs from the upstream thermistor in Landa Lake to the downstream thermistor in Landa Lake, the deepest portion of the lake (thermistor locations listed in Task 9).

Task 5. Comal Springs Invertebrate Sampling

The Contractor will conduct sampling for Comal Springs invertebrates during the Spring and Fall sampling events.

- One drift net each will be placed over the main spring orifice of Spring Run 1, Spring Run 3, and Spring Run 7 at Comal Springs. The drift nets are anchored with rebar and have a mesh size of 350 µm, 0.45m x 0.30m rectangular opening and taper to detachable 0.28 m long cylindrical bucket of 300 µm. The buckets will be removed at 6 hour intervals and the contents sorted in the field. All endangered invertebrates will be identified and counted in the field, and returned to the orifice they were collected upon completion of the 24 hour sample period. All other invertebrates will be preserved and transported to an off-site laboratory for taxonomic classification. Coordination with the USFWS San Marcos Aquatic Resources Center (ARC) will take place each time to assist with refugia collections when needed.
- Comal Springs riffle beetle sampling will be conducted in three locations (Spring Run 3, western shoreline of Landa Lake, and Spring Island area.) Ten springs within each of the three locations will be identified by the Contractor and sampled using the cotton lure method (below) or a Contractor suggested and EAHCP staff approved alternate method. Lures will be set and left in place for approximately four weeks, then retrieved. Comal Springs riffle beetles and other endangered invertebrates will be identified and counted in the field, and returned to the orifice they were collected. Coordination with the ARC will take place each time to assist with refugia collections or research activities when needed.
    - The cotton lure quantitative survey method consists of bed sheets (50% cotton, 50% polyester) that are cut into 15cm x 15cm squares (i.e. lures). At each Comal Springs location (Spring Run 3, Spring Island, western shore of Landa Lake), 10 springs found in potential habitat will be selected and will be sampled with a lure. Depth (m), current velocity (m/s), and landmark distance measurements will be taken at each spring. Each square will have the corners folded inward and placed in the spring. To help in relocation, a brightly colored piece of aquarium gravel will be placed on top. Rocks will be loosely stacked over the square to keep it in place and serve as camouflage without deterring flow through the area. Approximately four weeks later, squares will be relocated and removed followed by depth and current velocity measurements. Beetles will be identified, counted, and returned to their spring of origin. Other spring invertebrates collected on the squares will also be noted. These include two other riffle beetles (*Microcylloepus sp.* and *Stenelmis sp.*), Comal Springs dryopid beetles (*Stygoparnus comalensis*), and Peck's cave amphipods (*Stygobromus pecki*).

Task 6. Salamander Visual Observations

The Contractor will conduct salamander sampling during each Spring and Fall sampling event. Comal Salamander surveys will be timed and conducted by observation from the surface or dive mask and snorkel. The timed surveys at Comal consist of 1 hour at Spring Run 1, 1 hour at Spring Run 3, 30 minutes at the Spring Island spring runs and 30 minutes at the eastern outfall at Spring Island.

San Marcos salamander surveys will follow the quantitative sampling method described in Nelson, J. (M.S. Thesis, Texas State University, 1993). Observations for the San Marcos salamander will be done by dive mask and snorkel or SCUBA for three, 5-minute timed surveys per area. San Marcos salamanders will be counted, measured and the overall substrate where they were found documented.

Salamander sampling will occur in the following locations:

Salamander survey points for snorkel surveys[1]

Comal River				
Name	**X (downstream)**	**Y (downstream)**	**X (upstream)**	**Y (upstream)**
Spring Run 1	583430.64	3287208.59	583422.86	3287289.12
Spring Run 3	583526.03	3287419.03	583478.60	3287364.89
Spring Island (spring run)	583980.04	3287825.94	583966.88	3287816.94
Spring Island (east outfall)	583997.04	3287806.21	583970.05	3287792.86
San Marcos River				
Name	**X (downstream)**	**Y (downstream)**	**X (upstream)**	**Y (upstream)**
Hotel Reach	603289.29	3307517.29	603296.86	3307523.55
Riverbed Reach	603127.66	3307398.79	603136.88	3307411.29
Spring Lake Dam U2	602939.04	3307097.91	602943.98	3307103.51
Spring Lake Dam U1	602945.29	3307090.67	602951.55	3307093.63
Spring Lake Dam L1/L2	602932.45	3307065.98	602924.88	3307057.10

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[1] Unless otherwise indicated, all coordinates displayed in this Contract are projected in NAD83 UTM Zone 14N

- In both systems, sampling will require turning over rocks in the sample site for set periods of time in order to expose the salamanders and obtain a visual count. Whenever possible, all rocks will be returned to their original location. For this monitoring, salamanders will only be observed and no collections will occur.

Task 7. Comal Springs Discharge Measurements

The Contractor will conduct discharge measurements on Comal Springs during the Spring and Fall sampling events (locations below). Discharge measurements will be conducted at Spring Runs 1, 2, and 3, Upper Spring Run Reach, and the Old Channel below Elizabeth Street. The measurements will be used to establish the contributions of each major spring run to total discharge in the river and to establish the relative proportion of water flowing in the Old and New Channels.

Comal Springs cross section survey points:

Location	**X**	**Y**
Spring Run 1	583469.37	3287203.91
Spring Run 2	583451.47	3287282.48
Spring Run 3 (upstream)	583480.19	3287366.62
Spring Run 3 (downstream)	583544.38	3287435.88
Upper Spring Run	584131.40	3287944.42
Old Channel	584276.86	3286977.60

Task 8. Water Quality Sampling

For continuity of long-term baseline data, the Contractor will continue to maintain and download existing thermistors located throughout each system. Standard water quality parameters (water temperature, conductivity compensated to 25°C, pH, dissolved oxygen, water depth at sampling point, and observations of local conditions) will continue to be taken during drop net sampling and fish community sampling activities.

Task 9. Fixed Station Photography

The Contractor will continue photo documentation at each established fixed station photograph site. Photographs will typically involve an upstream, across, and downstream picture of the reach and capture key changes in the habitat in the reach. Any identified changes will be recorded.

Fixed station photography and thermistor sites: (Photos are taken upstream, across stream and downstream - aligned with previous year photos)

Comal River		
Location	**X**	**Y**
Bleider's Creek	584472.53	3288153.69
Heidelberg	584325.63	3288160.63
BV Far	583932.44	3287823.54
BV Near	583965.56	3287802.70
Spring Run #3	583509.78	3287392.17
Spring Run #2	583455.06	3287303.04
Spring Run #1	583414.76	3287256.54
New Channel Upstream	583790.39	3286910.64
New Channel Downstream	584781.50	3286729.82
Other Place	585369.33	3285956.82
Old Channel	584298.82	3286988.45
Landa Lake Downstream	583758.14	3287616.07
Landa Lake Upstream	583777.25	3287640.09
San Marcos River		
Location	**X**	**Y**
Chute	602903.38	3307110.24
Dam	602935.53	3307082.49
Sessoms Creek	602753.48	3307047.57
City Park	602754.88	3306729.47
Rio Vista	603062.45	3305999.59
I-35	603160.70	3305570.90
Animal Shelter	603650.14	3304204.63
Thompson's Island Artificial	603381.08	3304755.78
Thompson's Island Natural	603339.49	3304700.53
Spring Lake Hotel	603298.97	3307519.93
Spring Lake Deep	603139.35	3307414.39

Task 10. Flow Partitioning within Landa Lake

The Contractor will conduct flow partitioning measurements within Landa Lake during Spring and Fall sampling events. This element will provide a better understanding of the spring flow influence within Landa Lake as upwelling flow within Landa Lake plays a role in understanding Comal Springs riffle beetle survival during low-flow events.

- An Acoustic Doppler profiler (or similar device) will be used to measure the flow patterns and current velocities from Spring Island through the upper portion of

Landa Lake and will be measured concurrently with discharge measurements at Comal Springs.

Task 11. Macroinvertebrate Food Source Monitoring

Macroinvertebrate food source monitoring will be conducted during Spring and Fall sampling events to better understand the food source base for fountain darters in each system and how that food base responds to varying flow conditions.

The Contractor will utilize the most current data on dominant aquatic vegetation known to be fountain darter habitat and sample within the City Park, IH-35 and Spring Lake Dam reaches on the San Marcos River, and the Upper Spring Run, Landa Lake, New Channel, and Old Channel reaches on the Comal River.

Dominant vegetation types for consideration in macroinvertebrate food source monitoring.

Based on 2013 findings to date and Science Team input. 2014 sampling may be adjusted.

Comal						
Location	**Dominant Vegetation**					
Old Channel	Hygrophila	Ludwigia	Bryophytes	Cabomba	Sagittaria	
Landa Lake	Hygrophila	Ludwigia	Bryophytes	Cabomba	Sagittaria	Vallisnaria
New Channel	Hygrophila	Ludwigia	Cabomba			
Upper Spring Run Reach	Hygrophila	Sagittaria	Bryophytes	Ludwigia		

San Marcos						
Location	**Dominant Vegetation**					
Spring Lake Dam	Hygrophila	Potamogeton	Hydrilla	Vallisneria	Sagittaria	
City Park	Hygrophila	Potamogeton	Hydrilla	Sagittaria	Cabomba	
I-35	Cabomba	Hygrophila	Hydrilla	Ludwigia		

The macroinvertebrate sampling will gather baseline data on the two non-listed macroinvertebrate species, the Edwards Aquifer diving beetle and Texas troglobitic water slater that are covered in the EAHCP.

- Macroinvertebrate sampling will be conducted using a modified Ekman sampler within each of the seven study reaches (4 reaches in the Comal system and 3 reaches in the San Marcos system, described above) to characterize food sources available for fountain darters.

- Samples will be collected in triplicate from designated aquatic vegetation types (based on majority of species present or adjusted based on fountain darter habitat quality) within each of the seven study reaches of the two ecosystems. Upon collection, macroinvertebrate samples will be preserved and transferred to a laboratory for processing.

- Sample methods will minimize habitat disturbance to the maximum extent possible.

Task 12. Fish Community Sampling

The Contractor will conduct fish community sampling for native and exotic fish during Spring and Fall sampling events to provide a holistic fishery evaluation of the aquatic ecosystem. The information will assist in describing cause and effect relationships with fountain darter abundances over time.

Using seines and SCUBA, fisheries surveys in both the Comal and San Marcos systems will be conducted as follows:

SAN MARCOS SYSTEM

Two locations within Spring Lake associated with San Marcos Salamander surveys (Big Riverbed and Hotel Area) will be sampled for fish as well as one location just upstream of the dam near the eastern spillway. All three locations will involve SCUBA transect surveys.

Three additional SCUBA transects are located in each river section (Upper, Mid, and Lower) of the San Marcos River, located in representative deep areas where seining has proven to be inefficient. The exact location of the SCUBA transects within each section may change slightly based on conditions at the time of the sampling event.

At all SCUBA transects, at least one cross-stream count will be conducted perpendicular to the river flow to count larger fish in the middle portions of the water column. Four 5 m "micro" transects will then conducted parallel to river flow in the same area to count the smaller benthic fish, such as fountain darters.

Five locations spatially located between Spring Lake Dam and the confluence of the Blanco River will also be sampled by seining. Seining will be conducted with a 15' long, 6' tall common sense seine with a 1" mesh to evaluate and track native and exotic fish populations in the San Marcos River over time. The seine is pulled at least 10 hauls per site, with no set length. There is no set number of pulls or length as the goal is to adequately cover all shallow habitat areas. Each pull it based on what the habitat allows. The number and length of the siene haul will be recorded by measuring right after the pull. Fish within each transect will be identified, measured, examined for disease, and native fish returned to the river. Exotics will be removed from the system as per scientific permit. In addition to collected data on fish, each seine haul will include data on the velocity, depth, substrate composition, in-stream coverage, climatic conditions, and mesohabitat typing of the site at the time of the observation.

Fish community sampling locations in the San Marcos River.
Includes SCUBA surveys and seining locations.

Name	X	Y
Spring Lake SCUBA Transect 1	603299.79	3307514.70
Spring Lake SCUBA Transect 2	603119.28	3307383.42
Spring Lake SCUBA Transect 3	602983.97	3307113.09
Upper River SCUBA Transect 1	602884.41	3306848.05
Upper River SCUBA Transect 2	602849.54	3306239.86
Upper River SCUBA Transect 3	602992.10	3305992.68
Upper River Seine Transect 1	602889.27	3307029.76
Upper River Seine Transect 2	602911.49	3306994.04
Upper River Seine Transect 3	602758.19	3306672.94
Upper River Seine Transect 4	602795.95	3306383.78
Upper River Seine Transect 5	603032.32	3305702.80
Upper River Seine Transect 6	603103.76	3305563.42
Upper River Seine Transect 7	603169.48	3305495.16
Middle River SCUBA Transect 1	603173.63	3305192.70
Middle River SCUBA Transect 2	603217.74	3305221.42
Middle River SCUBA Transect 3	603185.94	3305297.31
Middle River Seine Transect 1	603122.56	3305122.90
Middle River Seine Transect 2	603155.50	3305073.66
Middle River Seine Transect 3	603044.12	3304971.62
Middle River Seine Transect 4	603221.68	3304763.08
Middle River Seine Transect 5	603264.02	3304728.46
Lower River SCUBA Transect 1	604031.05	3303806.06
Lower River SCUBA Transect 2	604112.08	3304030.67
Lower River SCUBA Transect 3	603938.75	3303954.78
Lower River Seine Transect 1	603709.76	3304204.74
Lower River Seine Transect 2	603899.41	3304105.77
Lower River Seine Transect 3	603895.64	3304020.12
Lower River Seine Transect 4	604050.13	3303975.37
Lower River Seine Transect 5	604084.63	3303737.24
Lower River Seine Transect 6	604111.09	3303719.26
Lower River Seine Transect 7	604204.95	3303547.00

COMAL SYSTEM

Three locations within Landa Lake will be sampled via SCUBA transect surveys. In particular, one of the SCUBA transects in Landa Lake will be in the same location as the ongoing fountain darter belt transect survey. In addition, SCUBA transects will be conducted within the Upper Spring Run, Old Channel, and New Channel sections of the

Comal River. At each SCUBA transect, at least one cross-stream count will be conducted perpendicular to the river flow to count larger fish in the middle portions of the water column. Four 5 m "micro" transects will then conducted parallel to river flow in the same area to count the smaller benthic fish, such as fountain darters.

In addition to SCUBA surveys, three locations (Upper Spring Run, New Channel, and Old Channel) will be sampled via seines to evaluate and track fish populations in the Comal River. Seining will be conducted with a 15' long, 6' tall common sense seine with a 1" mesh to evaluate and track native and exotic fish populations in the San Marcos River over time. The seine is pulled at least 10 hauls per site, with no set length. There is no set number of pulls or length as the goal is to adequately cover all shallow habitat areas. Each pull it based on what the habitat allows. The number and length of the siene haul will be recorded by measuring right after the pull. Fish within each transect will be identified, measured, examined for disease, and native fish returned to the river. Exotics will be removed from the system as per scientific permit. In addition to collected data on fish, each seine haul will include data on the velocity, depth, substrate composition, in-stream coverage, climatic conditions, and mesohabitat typing of the site at the time of the observation.

Fish community sampling locations in the Comal River.
Includes SCUBA surveys and seining locations.

Location	**X**	**Y**
Landa Lake Reach SCUBA Transect 1	583769.63	3287629.11
Landa Lake Reach SCUBA Transect 2	583636.63	3287434.05
Landa Lake Reach SCUBA Transect 3	583655.84	3287189.48
Upper Spring Run SCUBA Transect 1	584334.42	3288181.21
Upper Spring Run SCUBA Transect 2	584206.31	3288036.96
Upper Spring Run SCUBA Transect 3	583849.48	3287723.78
Upper Spring Run Seine Transect 1	584043.07	3287869.93
Upper Spring Run Seine Transect 3	584079.14	3287901.25
Upper Spring Run Seine Transect 2	584308.80	3288152.74
Old Channel Reach SCUBA Transect 2	584908.98	3287046.14
Old Channel Reach SCUBA Transect 1	584855.78	3287075.69
Old Channel Reach SCUBA Transect 3	584780.42	3287096.38
Old Channel Reach Seine Transect 1	584789.28	3286815.61
Old Channel Reach Seine Transect 2	584787.07	3286865.85
Old Channel Reach Seine Transect 3	584814.41	3286904.27
Old Channel Reach Seine Transect 4	584907.51	3286930.13
Old Channel Reach Seine Transect 5	584918.59	3286983.33
Old Channel Reach Seine Transect 6	584920.07	3287001.80
New Channel Reach SCUBA Transect 1	584495.46	3286728.99

New Channel Reach SCUBA Transect 2	584385.12	3286744.76
New Channel Reach Seine Transect 1	584219.61	3286759.21
New Channel Reach Seine Transect 2	584180.20	3286742.13
New Channel Reach Seine Transect 3	584148.68	3286719.80
New Channel Reach Seine Transect 4	584127.49	3286566.28

Task 13. EAHCP Habitat Baseline and Disturbance Determination

This determination is intended to fulfill Section M 1a and 2a of the Incidental Take Permit.

Subtask 13.1 Document Baseline Habitat Conditions

For the covered HCP species the Contractor will prepare maps of occupied habitat in GIS representing January 1 of the contract year. The Contractor will use bio-monitoring data and other existing sources to establish occupied habitat for the HCP Covered Species. The Contractor will be provided with a definition of "occupied" habitat from the USFWS at the start of this exercise by EAA staff. Specific to Item M (1a and 2a) of the ITP, only occupied habitat within the Comal and San Marcos Springs/River ecosystems will be included.

Subtask 13.2 Document HCP Mitigation Areal Extent Per Project

The Contractor will work with staff and contractors from the City of New Braunfels, City of San Marcos and Texas State University, coordinating through EAA staff, to describe in map form, representing a snapshot in time on December 31 of the contract year, via GIS the areal extent of all direct HCP mitigation and restoration activities in the Comal and San Marcos springs systems.

If the individual contractors do not have GIS files of their project/affected areas, the Contractor will either: 1) map those areas directly with high grade GPS in real-time, or 2) use existing areal imagery to pinpoint and outline locations with subsequent, supplemental GPS ground truth mapping.

The Contractor will ensure that areas represented on all maps are representative of actual mitigation, not a concept area. This is important as the size of area represented will be a component of determining Take.

Subtask 13.3 Assessment of Net Disturbance

The Contractor will evaluate the baseline maps versus the HCP project maps and quantify the area of direct disturbance that may have potential effects from mitigation and restoration activities as described in Item M (1a and 2a) of the ITP. The focus will be on quantifying the direct impacts (removal of non-native vegetation, etc.) via areal coverage of habitat, but will also describe potential indirect impacts (turbidity, etc.) qualitatively. This task is not intended to meet the requirements for any Item T (Final Report) bullet item laid out in the permit. This analysis will not extend beyond comparisons of areal coverage of occupied habitat.

Task 14. Annual "Take"[2] Estimation

Utilizing the information generated by Subtask 13.1, 13.2 and 13.3 of this contract, the information and guidance in Chapter 4 of the HCP, the information and guidance in Chapter 6 of the HCP, the information and baseline in the Biological and Conference Opinion issued by USFWS, and any other relevant information, the Contractor shall estimate Take for each of the Covered Species. The purpose of this Take estimation is to ensure compliance with Section H of the ITP. This Take estimation shall be completed for the year 2013 by February 10, 2014[3]; and on each year thereafter following the same schedule.

CRITICAL PERIOD SAMPLING PROGRAM

The Critical Period Monitoring component, if triggered, will be performed on both systems and be based upon established flow trigger levels for each. The type and extent of sampling conducted is dependent on the respective trigger level as discussed in detail below. The sampling is designed to be duplicative of full biomonitoring sampling (Task 15) as described below, as well as include species-specific sampling based on flow triggers as described in Task 16.

Task 15. High/Low Flow Monitoring

The Contractor will conduct high flow critical period monitoring only after the following triggering criteria are met:

a) The daily average flow exceeds 385 cubic feet per second (cfs) in the San Marcos aquatic ecosystem or 500 cfs in the Comal aquatic ecosystem (total flow through the ecosystem as measured at the USGS gauging station located immediately downstream of the ecosystem); and

b) After conducting a joint visual inspection of the aquatic ecosystem with the Contractor, EAA staff determines that high flow critical period monitoring is warranted and approved.

Additionally, before high flow critical period monitoring is conducted, the monitoring

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[2] Take is defined as "harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct." Includes "significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering."

[3] Data in Subtask 17.1, 17.2 and 17.3 of this Contract that shall be produced by the Contractor in future years.

parameters must be recommended by the Contractor and pre-approved by EAA staff, based on professional judgment, and may include any parameter from the full biomonitoring sampling, with the exception of gill net sampling.

The low flow trigger levels and associated sampling parameters are presented in Table 3 and Table 4 for the San Marcos and Comal systems, respectively.

Subtask 15.1 San Marcos System Sampling

As shown in Table 3, low flow Critical Period Monitoring for the San Marcos River is triggered at 120 cfs. When flow rate is 120 cfs Contractor will begin of Texas wild-rice vulnerable stand monitoring as described in Task 3 of the Comprehensive Sampling Program. Monitoring will occur at 5 cfs declines or a maximum of once per week. The first Full Sampling Event (see Table 3, Parameter Descriptions) is triggered at 100 cfs with subsequent declining Full Sampling Events triggering at 85, 60, 25, and 10-0 cfs for a total of five declining Full Sampling Events. In addition, two recovery Full Sampling Events would be conducted as the system rebounds from the low-flow period. Between Full Sampling Events, habitat evaluations, per every 5 cfs decline, would be conducted again not to exceed weekly monitoring.

Subtask 15.2 Comal System Sampling

As shown in Table 4, low flow Critical Period Monitoring for the Comal River is triggered at 200 cfs. This triggers the first Full Sampling Event with four subsequent Full Sampling Events being triggered at 150, 100, 50, and 10-0 cfs, respectively. As with San Marcos, two recovery Full Sampling Events are scheduled as the flows rebound from drought conditions. The recovery events will be dependent on flow stabilization. Typically, these systems rebound from drought conditions with the help of a tropical depression or some weather pattern that produces a large amount of rainfall over the watershed. The flows typically come up rapidly and need a period of stabilization before the collection of biological data would be meaningful. The Comal system also has habitat evaluations scheduled between Full Sampling Events; however, at 10 cfs increments again not to exceed weekly observation. An additional component for the Comal system is the detailed riffle beetle habitat evaluation and spring orifice condition documentation that is triggered at 120 cfs and continued at 10 cfs increments during decline. A wetted area will be measured at the spring headwaters upon the event that the main spring orifices cease flow.

A review of historic flow records indicate that the lower the flow, the lower the chance an even lower flow event will occur, thus reducing the chances of a complete decline and recovery as outlined above. The more likely scenario is to go past the initial trigger level several times and then rebound above that level so that the initial trigger level would be sampled more than once. In such an event, the Contractor will sample such an occurrence a maximum of three times over time to allow for a representation of the system at that flow level. This means that the fourth time the system falls past that level, a sampling event would not occur until the next trigger level had been reached, unless requested by the EAA. There are endless number of scenarios for a low-flow period, and thus the Contractor will need to maintain the ability to mobilize rapidly and have available a crew capable to conduct Full Sampling Events on both systems simultaneously if necessary during critical periods.

Subtask 15.3 Gill Net Evaluation

In addition to the full sampling activities outlined in 15.1 and 15.2, the Contractor will conduct gill net evaluations in Spring Lake (adjacent to the Meadows Center) and Landa Lake, only in the immediate vicinity of the fountain darter SCUBA survey - from the upstream thermistor to the downstream thermistor. The Spring Lake evaluation will be triggered at 85 cfs and lower triggers, while the Landa Lake assessment will be triggered at 100 cfs and lower triggers. The survey is designed to examine exotic fish concentrations and stomach content analyses with respect to predation of listed species. Gill-netting will be conducted with a 150' gill net, with mesh sizes ranging from ¾ to 3". The net will be placed in the lake late in the afternoon and retrieved 12 hours later (following morning). The number of each species (native and non-native) collected in the gill net will be recorded. Gill net data will be converted to catch per unit effort.

Subtask 15.4 Water Quality Grab Sampling

At the established triggers in 15.1 and 15.2, the Contractor will collect water quality grab samples for Suite I and Suite II water quality parameters (shown below) each at eighteen stations longitudinally distributed in the San Marcos system (Fig. 7) and twelve stations longitudinally distributed in the Comal system (Fig. 8). The parameters will be measured at the surface, mid-depth and near bottom.

Collection Methodology

- All water samples will consist of grab samples from just below the water surface.
- The water samples will be stored in ice chests that are cooled with crushed ice until transported to the Chemistry Contractor.
- Strict Chain of Custody procedures are to be followed with signatures required for each sample transfer.
- Field instruments are calibrated daily for quality assurance.
- At least 10% of sample stations per trip are duplicated: (1) one set of sample is treated normally; and (2) one set of samples is assigned a different station number and submitted to the Chemistry Contractor to determine handling, preservation, transport and analysis variation.

Water Quality Sampling Parameters

Water Quality Parameters	
SUITE I	
	Water temperature (°C)
	Conductivity compensated to 25°C
	pH
	Dissolved oxygen (DO) (mg/L)
	Water depth at sampling point
	Observations of conditions (wind, sky, weather conditions, appearance of water)
	Flow (velocity and direction)
SUITE II - Parameters, analytical methodology, minimum analytical levels, and minimum detection limits for water chemistry analyses conducted on water quality grab samples.	

PARAMETER	METHOD	MINIMUM ANALYTICAL LEVELS (per liter)	MINIMUM DETECTION LIMITS (per liter)
Nitrate Nitrogen	UV Spectroscopy	10.0 μg[a]	3.0 μg
Total Nitrogen	UV Spectroscopy	10.0 μg	<5.0 μg
Ammonium	Fluorometric	7 μg	2 μg
Soluble Reactive Phosphorous	Spectroscopy	3 μg	0.5 μg
Total Phosphorous	Spectroscopy	5 μg	3 μg
Alkalinity	Potentiometric	Appropriate	
Total Suspended Solids	Gravimetric	Appropriate	

[a] micrograms.

Task 16. EAHCP Low Flow Sampling Program

Chapter 6 of the EAHCP contains specific flow requirements for the Covered Species (Tables 5 & 6) that trigger sampling. This sampling is in addition to the Comprehensive and Critical Period components and consists of an increased frequency of sampling for aquatic vegetation, Texas wild-rice mapping, as well as fountain darter, Comal Springs riffle beetle, and salamander sampling.

It is likely that some of the sampling dates of the three components of this project will coincide with each other during low flow periods. Attempts should be made to coordinate sampling events when they are closely-related temporally to prevent duplicative sampling events and reduce unnecessary costs.

TABLE 1
COMPREHENSIVE SAMPLING SCHEDULE
(Revised 1/2013)

EVENT	**SYSTEM/DATES**		**SAMPLE TYPE**
	UPPER SAN MARCOS RIVER	COMAL RIVER	
SPRING	early April/May	mid April/May	All Parameters
SUMMER	late July	early August	Texas wildrice Full System Mapping, and Fountain Darter Dip Net Sampling
FALL	late October	early November	All Parameters

TABLE 2
COMPREHENSIVE SAMPLING PARAMETER BY SYSTEM
(Revised 1/2013)

PARAMETER	**SAN MARCOS**	**COMAL**	**COMMENTS**
Water Quality - Thermistors	X	X	
Aquatic Vegetation Mapping - including Texas wild-rice vulnerable stands	X	X	
	X		
Texas wild-rice Mapping	X		Summer only
Fountain Darter Sampling	X	X	Drop-Net Sampling will include live Ramshorn snail counts and removal and live Asian snail identification, counts and removal.
Drop Net, Dip Net, Visual Parasite Evaluations	X	X	
Fish Community Sampling	X	X	
Macroinvertebrate Sampling	X	X	Modified Ekman in aquatic vegetation
Comal Invertebrate Sampling		X	Cotton lures – 10 lures at three locations (Spring Run 3, Western Shoreline, and Spring Island) Drift net sampling over major spring (SR1, SR3, and SR7) orifices
Edwards Aquifer Diving Beetle	X	X	Incorporated in macroinvertebrate sampling
Texas Troglobitic Water Slater	X	X	Incorporated in macroinvertebrate sampling
Salamander Sampling - Visual	X	X	SCUBA/Snorkel; San Marcos, Comal
Spring discharge measurements			
		X	Discharge measurements (5 locations) - Upper Spring Run, Spring Runs 1, 2, and 3, and Old Channel.
Flow Partitioning - Landa Lake		X	

TABLE 3
UPPER SAN MARCOS RIVER/SPRINGS
Critical Period Monitoring – Schedule and Parameters

FLOW TRIGGER (+ or - 5 cfs)	**PARAMETERS**
120 cfs	Wild Rice vulnerable stands - Every 5 cfs decline (maximum weekly)
100 cfs	Full Sampling Event
100 cfs - 85 cfs	Habitat Evaluations - Every 5 cfs decline (maximum weekly)
85 cfs	Full Sampling Event
85 cfs - 60 cfs	Habitat Evaluations - Every 5 cfs decline (maximum weekly)
60 cfs	Full Sampling Event
60 cfs - 25 cfs	Habitat Evaluations - Every 5 cfs decline (maximum weekly)
25 cfs	Full Sampling Event
25 cfs - 0 cfs	Habitat Evaluations - Every 5 cfs decline (maximum weekly)
10 - 0 cfs	Full Sampling Event
RECOVERY	
25 cfs - 85 cfs	Full Sampling Event (dependant on flow stabilization)
85 cfs - 125 cfs	Full Sampling Event (dependant on flow stabilization)

PARAMETER DESCRIPTION

Wild Rice Monitoring	Physical changes vulnerable stands
Full Sampling Event	Aquatic Vegetation Mapping - including Texas Wild-Rice Fountain Darter Sampling Drop Net, Dip net (Presence/Absence), and Visual Parasite evaluations Fish Community Sampling Salamander Sampling - Visual Fish sampling - Exotics / Predation (85 cfs and below) Water Quality - Suite I and Suite II
Habitat Evaluations	Photographs

TABLE 4
COMAL RIVER/SPRINGS
Critical Period Monitoring – Schedule and Parameters

FLOW TRIGGER (+ or - 10 cfs)	**PARAMETER**
200 cfs	Full Sampling Event
150 cfs	Full Sampling Event
120 cfs - 80 cfs	Riffle Beetles and spring discharge - Every 10 cfs decline (maximum weekly)
100 cfs	Full Sampling Event
100 cfs - 50 cfs	Habitat Evaluations - Every 10 cfs decline (maximum weekly)
50 cfs	Full Sampling Event
50 cfs - 0 cfs	Habitat Evaluations - Every 10 cfs decline (maximum weekly)
10 - 0 cfs	Full Sampling Event
RECOVERY	
25 cfs - 100 cfs	Full Sampling Event (dependant on flow stabilization)
100 cfs - 200 cfs	Full Sampling Event (dependant on flow stabilization)

PARAMETER DESCRIPTION

Full Sampling Event	Aquatic Vegetation Mapping Fountain Darter Sampling Drop Net, Dip net (Presence/Absence), and Visual Parasite evaluations Fish Community Sampling Salamander Sampling - Visual Riffle beetle - Cotton lure sampling Fish sampling - Exotics / Predation (100 cfs and below) Water Quality - Suite I and Suite II Flow partitioning - Landa Lake
Riffle Beetle Monitoring	Spring Discharge and wetted perimeter measurements
Habitat Evaluations	Photographs

TABLE 5
UPPER SAN MARCOS RIVER/SPRINGS
EAHCP MONITORING
LOW FLOW SCHEDULE (Added 2/2013)

Flow Rate (+ or - 10 cfs)	Species	Frequency	Parameter
≤80 cfs or ≥ 50 cfs continuing until flow rate restores to ≥100 cfs	fountain darter	every other month	Aquatic vegetation mapping at Spring Lake Dam reach, City Park reach, and IH-35 reach
≤80 cfs or ≥ 50 cfs continuing until flow rate restores to ≥100 cfs	fountain darter	every other month	Conduct dip net sampling/visual parasite evaluations at 50 sites in high quality habitat to include twenty (20) sites in Spring Lake; ten (10) sites in Spring Lake Dam reach; ten (10) sites in City Park reach, and ten (10) sites in IH-35 reach.
≤50 cfs	fountain darter	monthly	Aquatic vegetation mapping at Spring Lake Dam reach, City Park reach, and IH-35 reach
≤50 cfs	fountain darter	weekly	Conduct Dip net presence/absence sampling/visual parasite evaluations at 50 sites in high quality habitat to include twenty (20) sites in Spring Lake; ten (10) sites in Spring Lake Dam reach; ten (10) sites in City Park reach, and ten (10) sites in IH-35 reach.
≤80 cfs or ≥ 50 cfs	San Marcos salamander	every other week	Salamander surveys (SCUBA and snorkel) will be conducted at the Hotel Area, Riverbed area, and eastern spillway of Spring Lake Dam
<50 cfs	San Marcos salamander	weekly	Salamander surveys (SCUBA and snorkel) will be conducted at the Hotel Area, Riverbed area, and eastern spillway of Spring Lake Dam
100 cfs	Texas wild-rice	once	Mapping of Texas wild-rice coverage for the entire San Marcos River will be conducted
≤100 cfs or ≥60 cfs	Texas wild-rice	every other week	Physical parameters of Texas wild-rice will be monitored in designated "vulnerable" areas
<80 cfs	Texas wild-rice	monthly	Mapping of Texas wild-rice coverage for the entire San Marcos River will be conducted
<80 cfs	Texas wild-rice	weekly	Physical visual observations of Texas wild-rice will occur

TABLE 6
COMAL RIVER / SPRINGS
EAHCP MONITORING FLOW SCHEDULE (Revised 1/2013)

Flow Rate (+ or - 5 cfs)	Species	Frequency	Parameter
≤150 or ≥80 cfs	fountain darter	every other month	Aquatic vegetation mapping to include Upper Spring Run reach, Landa Lake, Old Channel reach, and New Channel reach
≤150 or ≥80 cfs	fountain darter	every other month	Conduct Dip net sampling/visual parasite evaluations at five (5) sites in the Upper Spring Reach; twenty (20) sites in Landa Lake; twenty (20) sites in the Old Channel reach and; at five (5) sites in the New Channel reach.
≤60 cfs	fountain darter	weekly	Conduct Dip net sampling/visual parasite evaluations at five (5) sites in the Upper Spring Reach; twenty (20) sites in Landa Lake; twenty (20) sites in the Old Channel reach and; at five (5) sites in the New Channel reach.
≤60 cfs	fountain darter	monthly	Aquatic vegetation mapping at Upper Spring Run reach, Landa Lake, Old Channel reach, and New Channel reach
≤120 cfs	riffle beetle	every 2 weeks	Monitoring via cotton lures at Spring Run 3, western shore of Landa Lake, and Spring Island upwelling
≤120 cfs or ≥80 cfs	salamander	every other week	Salamander snorkel surveys will be conducted at three sites (Spring Runs 1 and 3 and the Spring Island area)
≤80 cfs	salamander	weekly	Salamander snorkel surveys will be conducted at three sites (Spring Runs 1 and 3 and the Spring Island area)

TABLE 7
GENERAL BIOLOGICAL SAMPLING STATIONS

SAN MARCOS		COMAL	
COMPONENT	LOCATION	COMPONENT	LOCATION
Aquatic vegetation Full system (once every 5 years)	Upper River to Blanco Confluence	Aquatic Vegetation Full system (once every 5 years)	Entire River
Aquatic vegetation – reach mapping	City Park reach, I-35 reach, Spring Lake Dam reach	Aquatic Vegetation – reach mapping	Upper Spring Run reach, Landa Lake reach, New Channel reach, Old Channel reach
Fountain Darter Sampling	City Park reach, I-35 reach, Spring Lake Dam reach, Hotel reach, Todd Island reach	Fountain Darter Sampling	Upper Spring Run reach, Landa Lake reach, New Channel reach, Old Channel reach, Garden Street reach
Parasite Evaluation	City Park reach, I-35 reach, Spring Lake Dam reach, Hotel reach, Todd Island reach	Parasite Evaluation	Upper Spring Run reach, Landa Lake reach, New Channel reach, Old Channel reach, Garden Street reach
Fish Community Sampling	Upper River & Spring Lake	Fish Community Sampling	Entire River
Macroinvertebrate Food Source Sampling	City Park reach, I-35 reach, Spring Lake Dam reach	Macroinvertebrate Food Source Sampling	Upper Spring Run reach, Landa Lake reach, New Channel reach, Old Channel reach
San Marcos Salamander	Spring Lake 1) Hotel area 2) Big Riverbed San Marcos River 3) Eastern Spillway	Comal Springs Salamander	Spring Run 1 Spring Run 3 Spring Island reach
		Macroinvertebrate Drift Net Sampling	Major Comal spring orifices
Exotics/Predation	Spring Lake	Exotics/Predation	Landa Lake
Texas wild-rice	Entire River	Riffle Beetles	Spring Run 3 Western Shoreline Spring Island

Fig. 1. Comal Springs/River sample “reaches.”

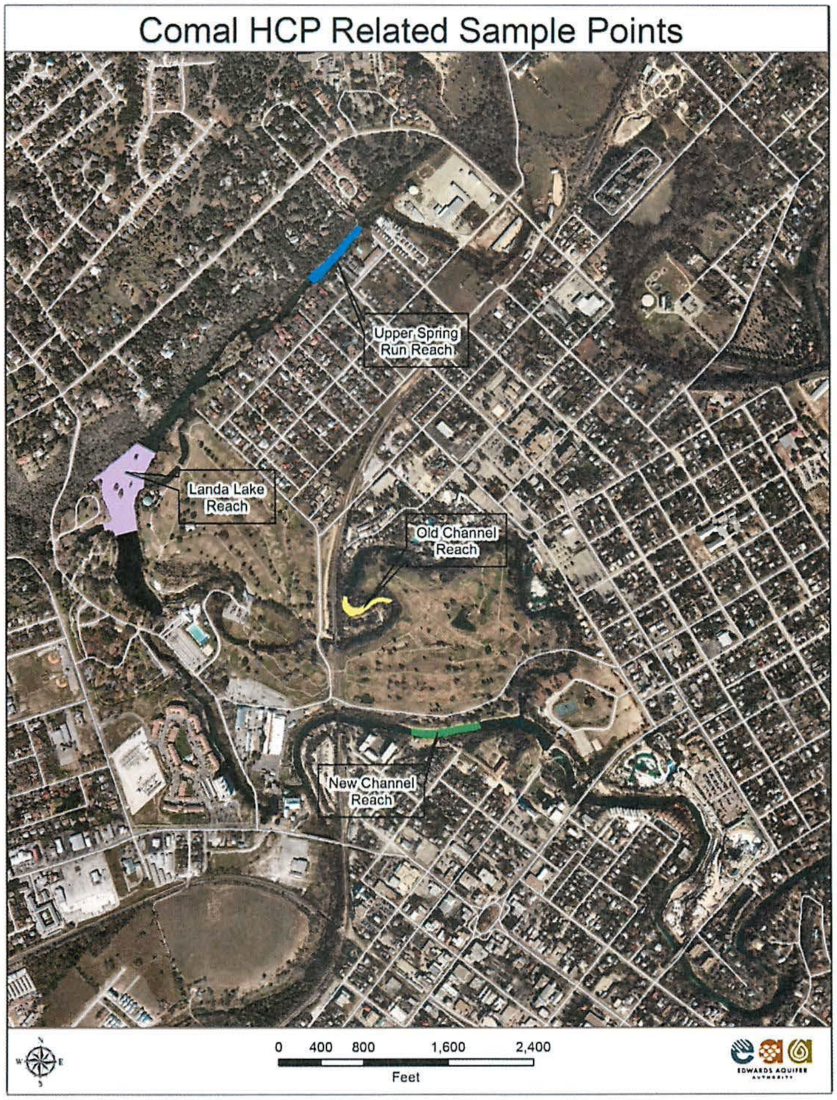


Fig. 2. San Marcos Springs/River ecosystem “reaches.”

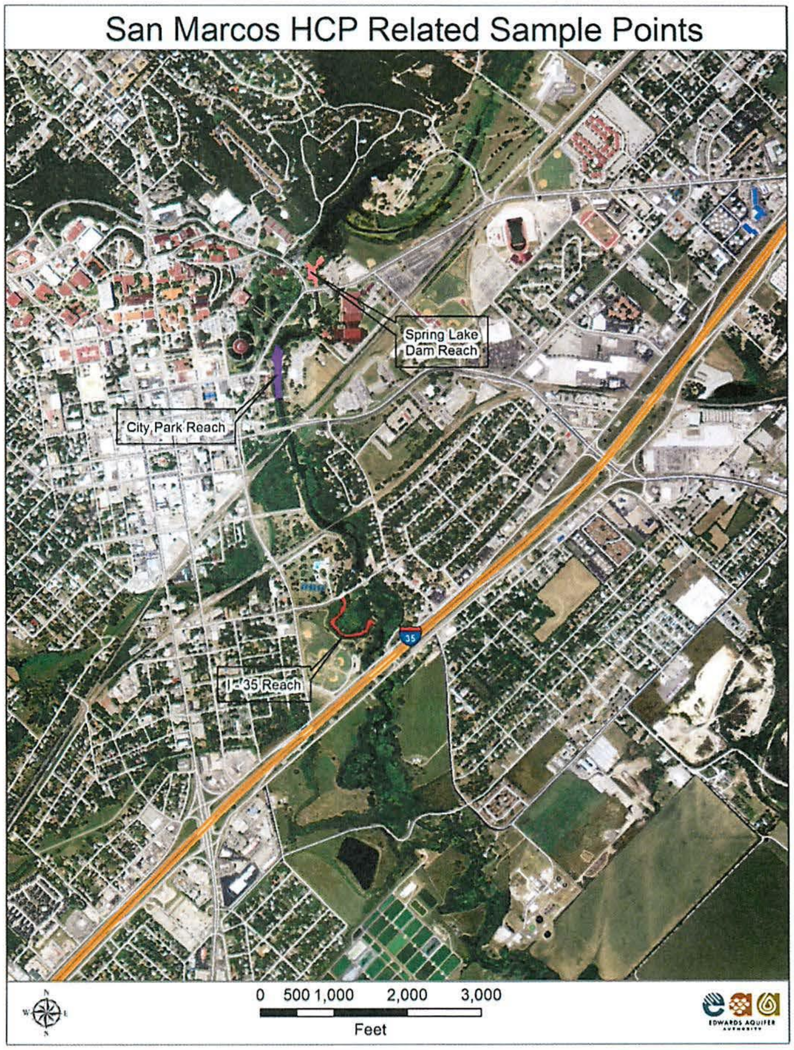


Fig. 3. Sewell Park Texas wild-rice vulnerable stands.

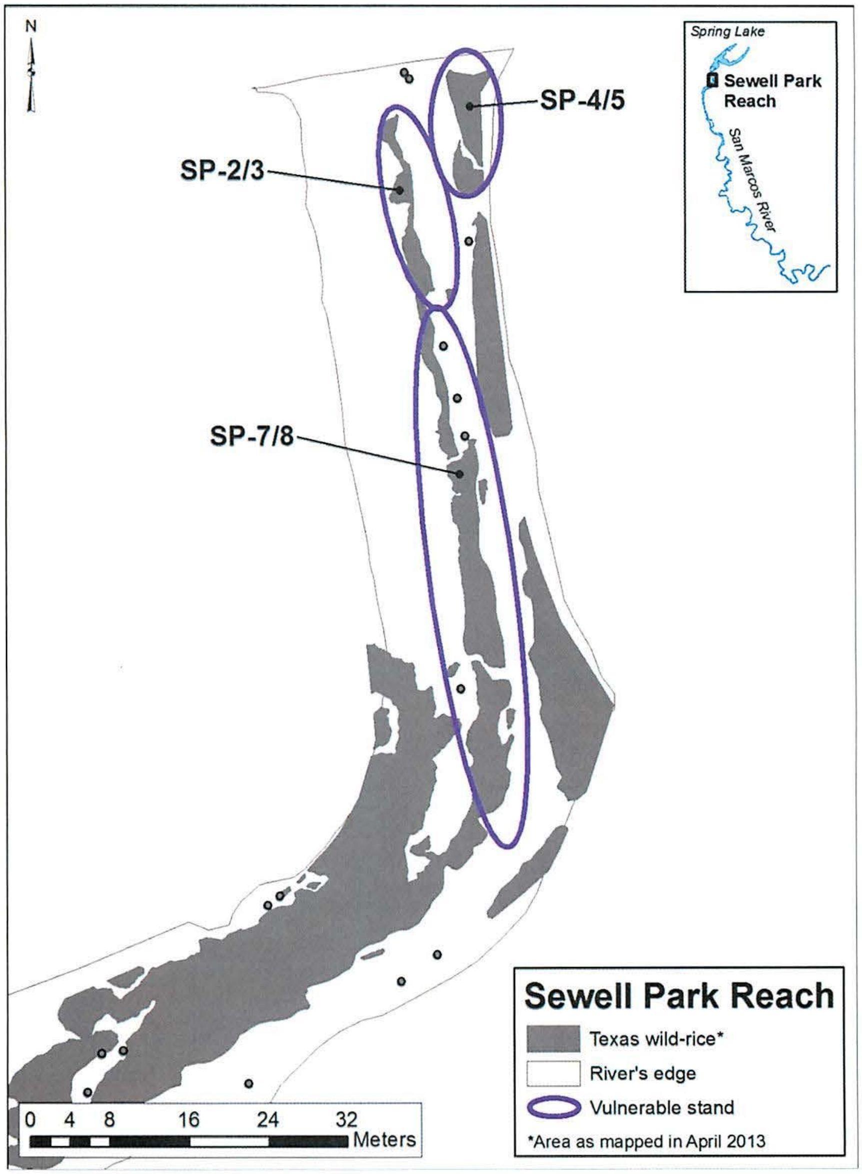


Fig. 4. Upper I-35 Texas wild-rice vulnerable areas.

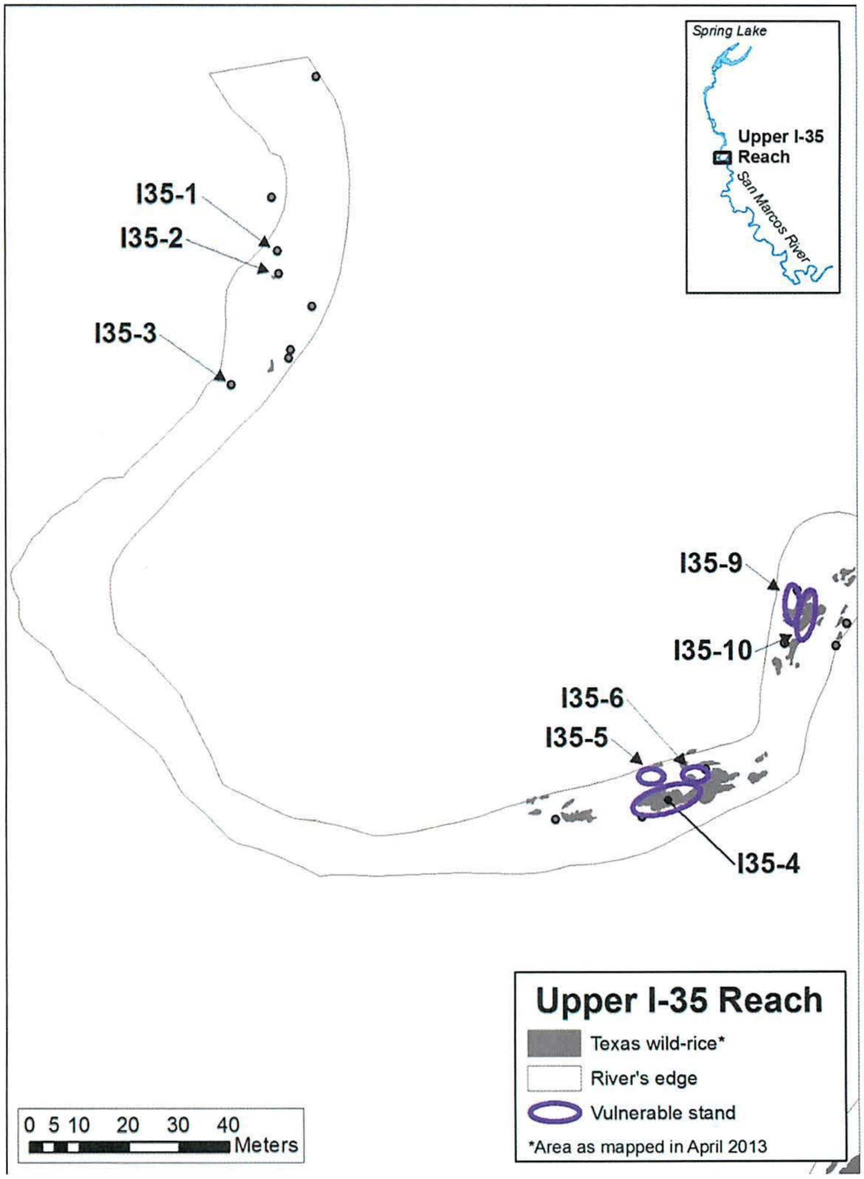


Fig. 5. Lower I-35 Texas wild-rice vulnerable stands.

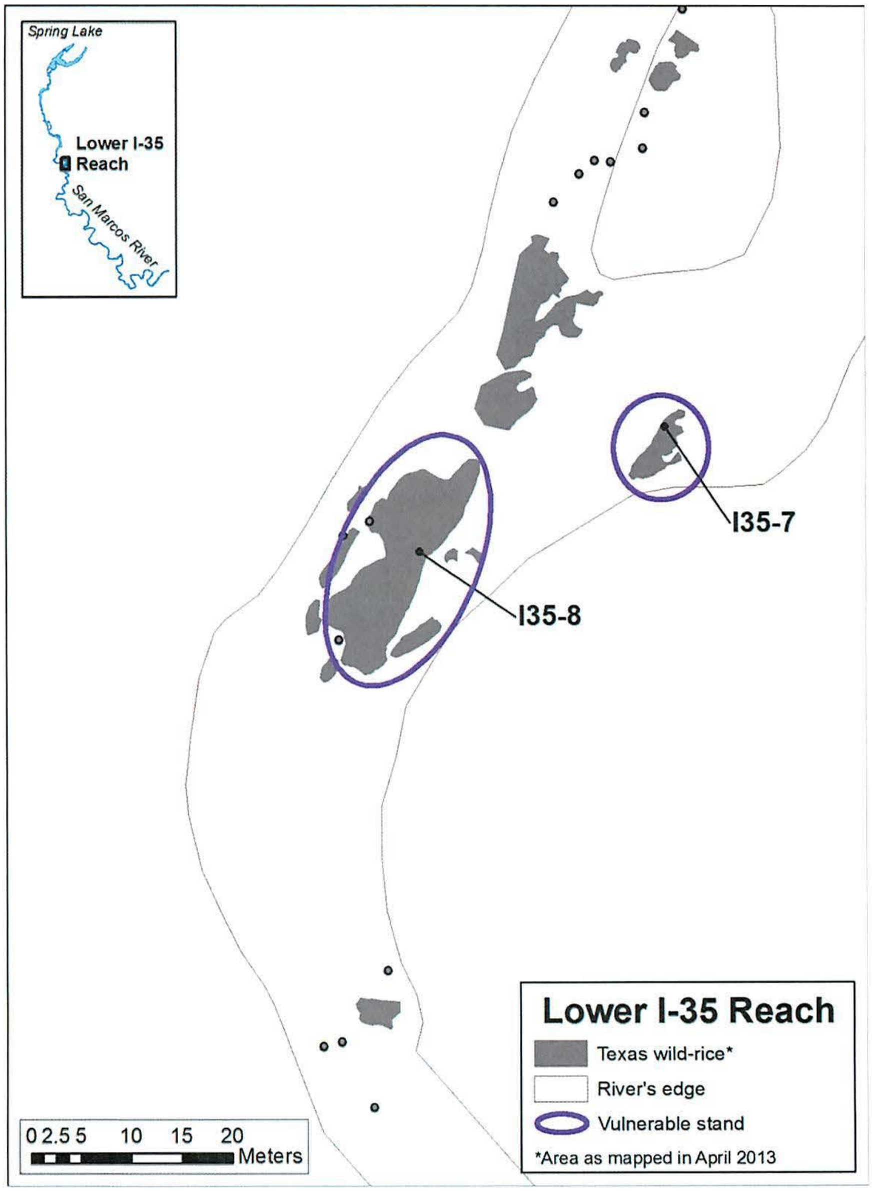


Fig. 6. Drift net locations in the Comal Springs system.

Fig. 7. San Marcos system water quality sample sites.

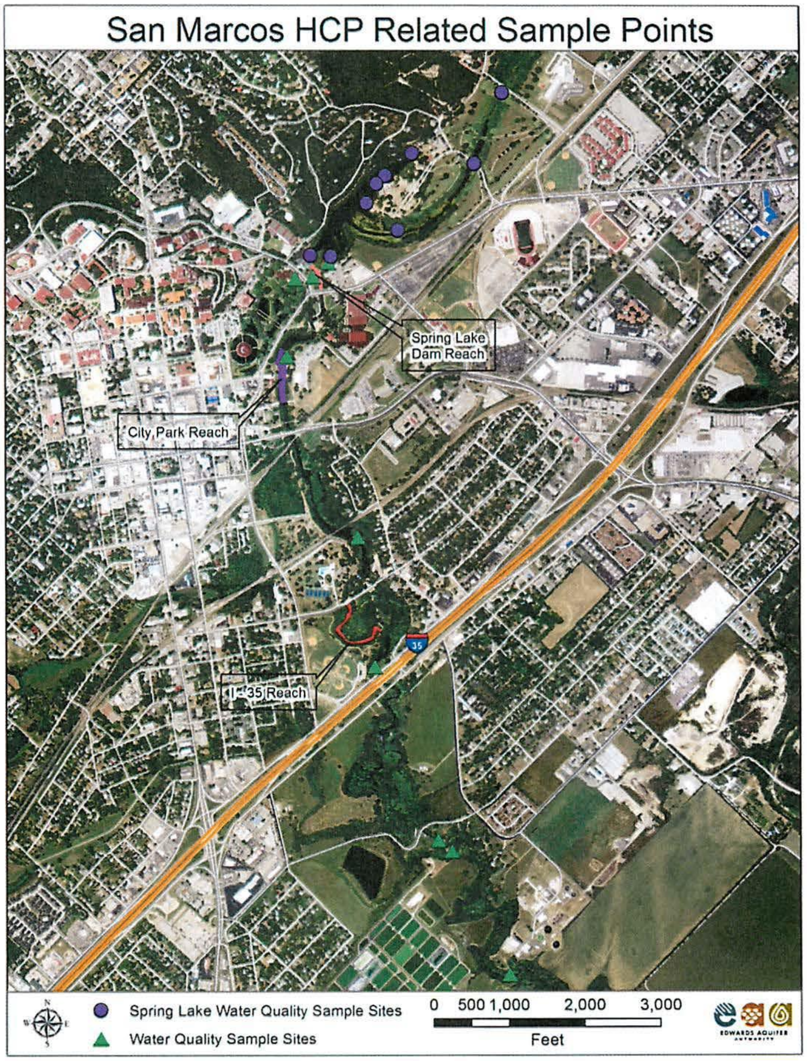
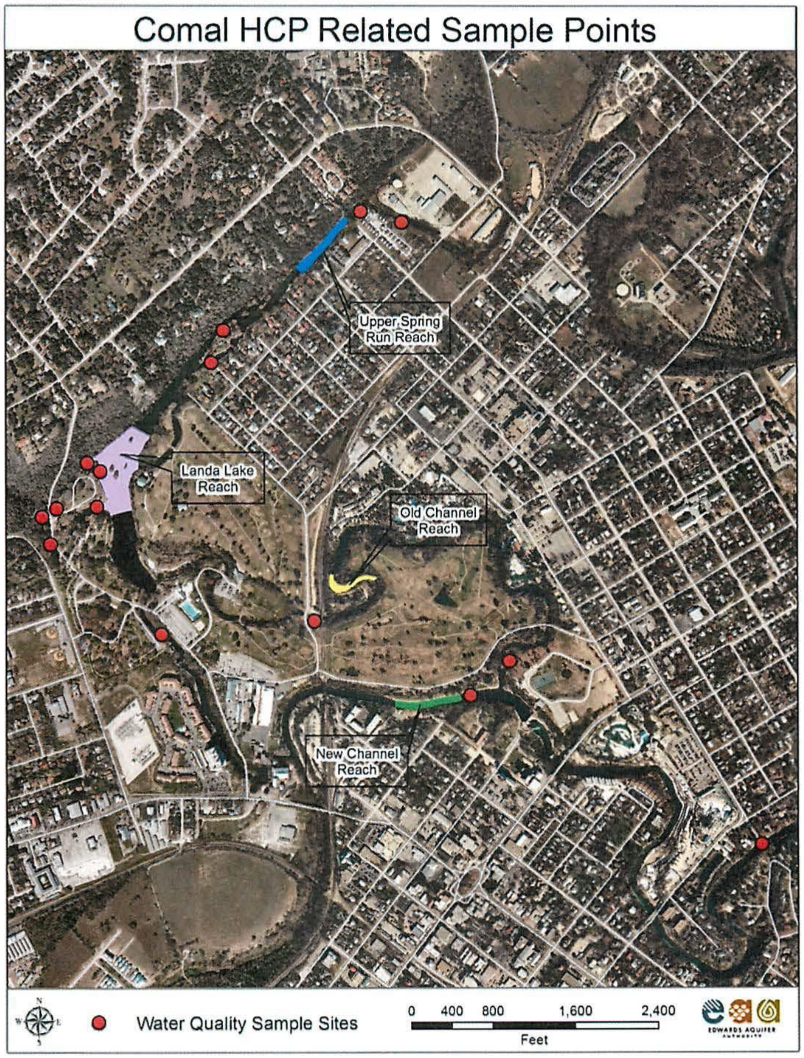


Fig. 8. Comal Springs/River system sample points.



PROJECT REQUIREMENTS

A. No later than April 15, and each month thereafter, the Contractor shall submit a monthly "invoice packet" to the EAA for each previous month's activities. Each invoice packet shall contain, at a minimum:

(1) A progress report containing:
  - a description of the work completed in each Task during the billing cycle;
  - a monthly update of the work schedule as it relates to achievement of the deliverables;
  - an estimate of the percent completion of each Task;
  - a discussion of any issues or problems that may result in a change in the deliverable due date;

(2) Documentation of all costs and expenses incurred during the billing cycle, including supporting documentation; and

(3) A signed invoice summary sheet.

B. The monthly invoice packet will be submitted electronically in Adobe Acrobat (pdf) format via email to the Senior HCP Coordinator.

C. Data Submission, Statement of Assumptions, Project Notebook

(1) All spreadsheets, laboratory data sheets, QA/QC verification, field sample sheets, and project notebooks developed as a part of this project, are due on the same date as the final report.

(2) All analytical data collected and/or generated during this study shall be submitted to the EAA in an electronic format which will be provided to the Contractor. Data shall be delivered via pre-approved digital media and shall be labeled to provide sufficient detail to access the information.

(3) All databases, and spreadsheets developed herein (written and digital formats) are due on the same date as the final report.

(4) To facilitate the EAA's accurate evaluation of the Contractor's work product, computations, conclusions and recommendations, the Contractor shall:
  - Prepare a project notebook containing a description of the assumptions and methodologies used in the study analysis. The notebook shall be organized in such a way as to allow replication of the steps, calculations, and procedures used by the Contractor to reach conclusions, described in the draft final report. The project notebook shall be submitted with the draft final report.

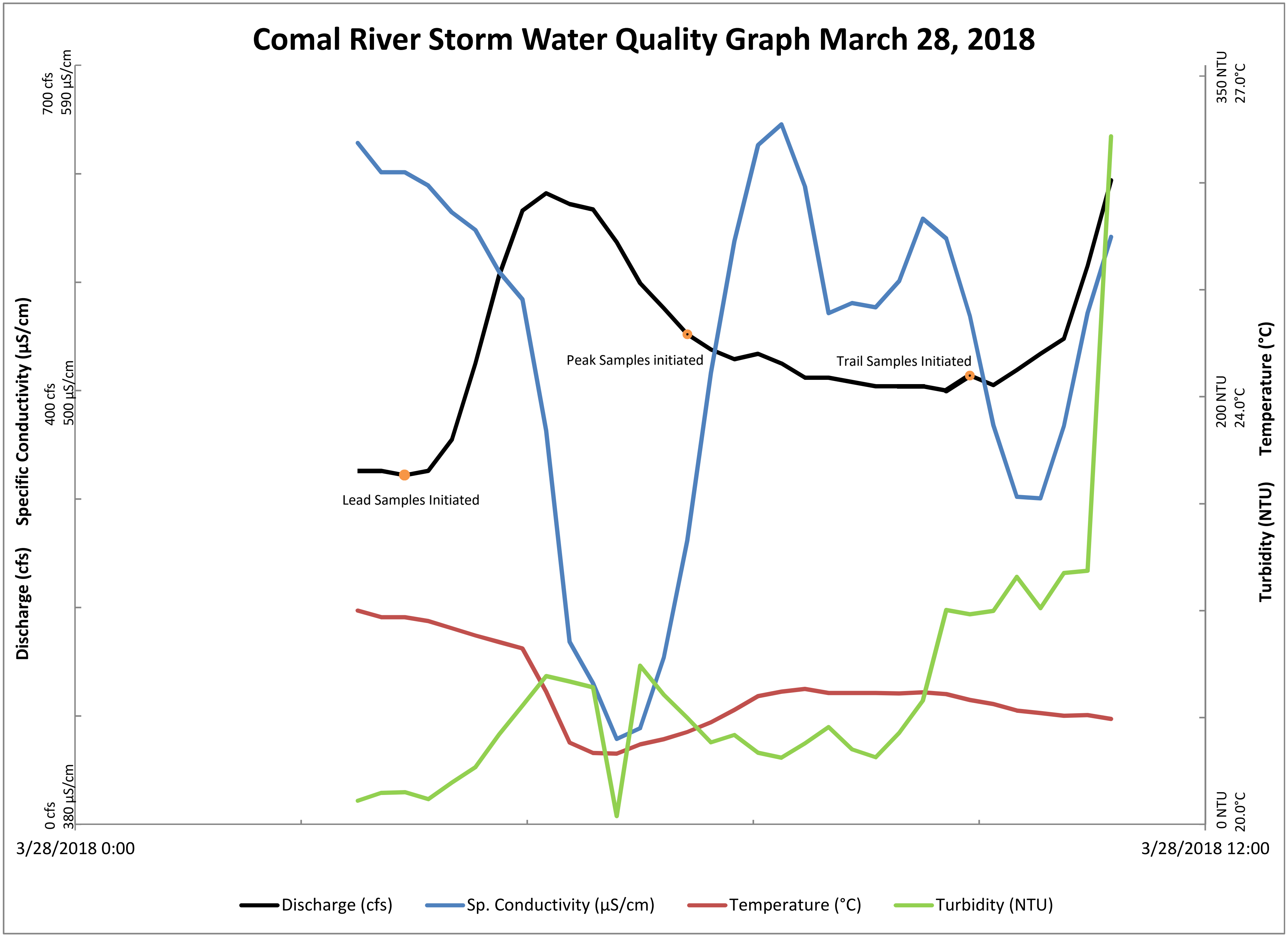
D. The Contractor shall take digital photographs throughout the term of the study representative of each task. Digital photos shall be submitted with the draft final report.

E. Annual Report

At the end of the study, the Final Report will be submitted to the EAA in triplicate hard copies (and on CD-ROM in pdf format) by February 1. The Final Report described in the Monitoring Plan shall include all results, data, work performed, habitat disturbance determination, take estimation, and conclusions or recommendations based on the contractors observations and data processing.

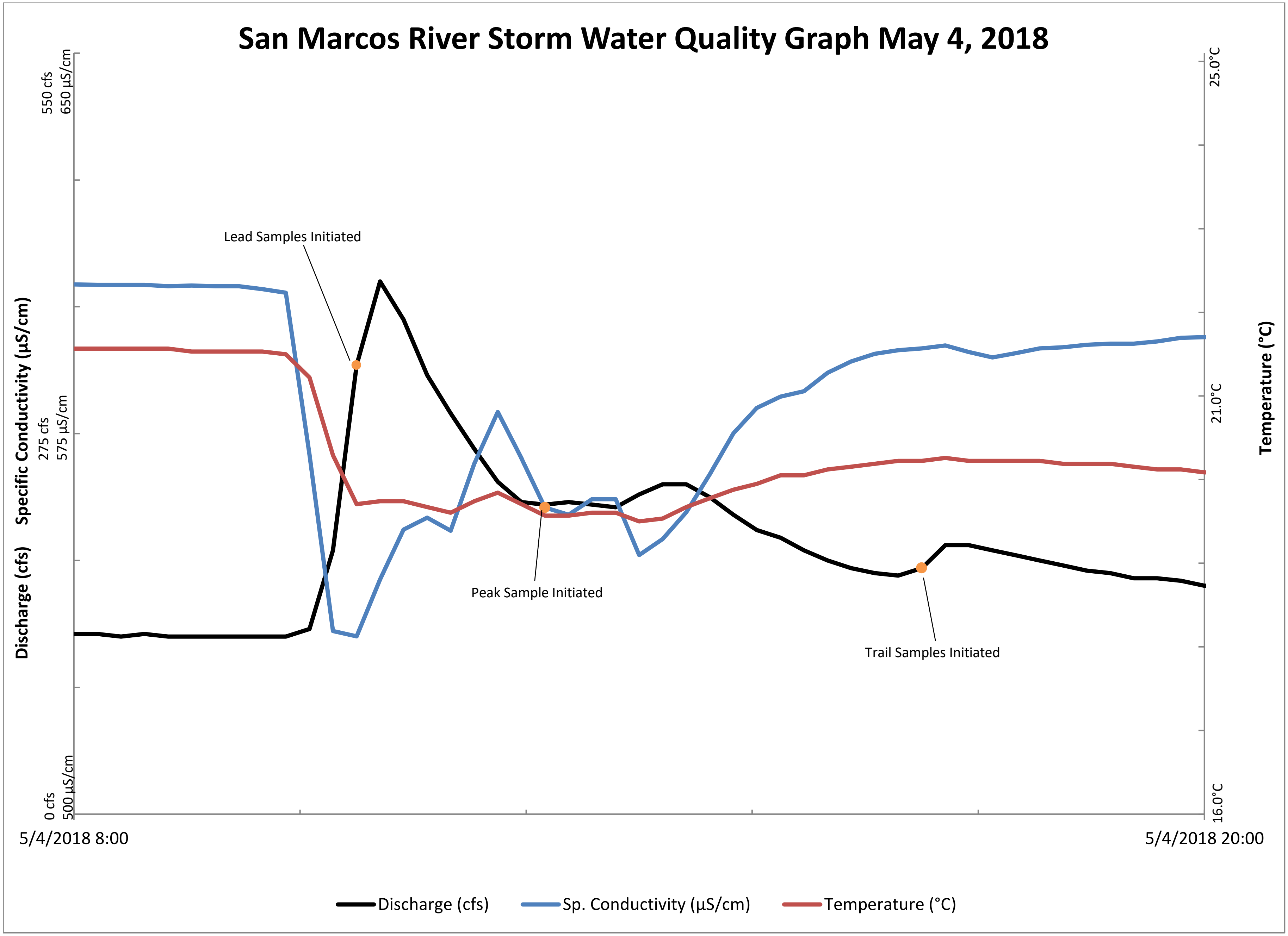
APPENDIX B

HYDROGRAPHS



Comal River Storm Water Quality Graph March 28, 2018

Data Source: Environet 2018, USGS 2018, Weather Underground 2018



San Marcos River Storm Water Quality Graph May 4, 2018

Data Source: Environet 2018, USGS 2018, Weather Underground 2018

APPENDIX C

DISCUSSION OF DEVIATIONS

Appendix C Discussion of Deviations

Comal Springs

Stormwater

March 28, 2018, Event

A stormwater event was sampled on March 28, 2018, in the Comal Springs complex. Five locations were sampled, HCS210, which is upstream of the Landa Park Golf Course, HCS240, HCS250, HCS260, and HCS270. Stormwater sampling locations did not deviate from those proposed in the EAHCP Work Group Report.

Rain began to fall at around 03:20 on March 28, 2018, and lead sampling was initiated at 03:30 after real-time instruments installed in Comal River indicated a change in water quality had occurred as a result of stormwater runoff entering the river. Peak sampling was initiated at approximately 06:30 on March 28, 2018, after the specific conductivity measurements from RTIs indicated a rise in readings had occurred. Trail sampling was initiated at approximately 09:30. A second wave of strong thunderstorms began to move the through area as before all of the trail samples were collected. After the trail sample was collected, the sample teams returned to the SWCA San Antonio office with the samples in order to package them for shipment.

Passive Diffusion Samplers

Passive diffusion samplers (PDSs) were deployed at each of the surface water sample collection sites. When at all possible, deployment locations coincided with the 2018 surface water locations. Some adjustments had to be made to account for river depth, accessibility by SWCA staff for installation and retrieval, and potential interference by the public. PDSs were deployed for two-week periods during the months of February, April, June, August, October, and December 2018.

Any alterations to sample locations or lost PDS are discussed below.

When the PDS were retrieved on August,15, 018, an SWCA employee suffered a broken ankle when she tripped carrying a sample holder and the holder dropped on her leg. Therefore, only one sampler was collected on that day. SWCA staff returned the following day and retrieved the remaining samplers. Therefore, all of the samplers except for HCS410 remained in the water for 15 days instead of 14 days.

In August 2018, two samplers were tampered with. HSM440 (City Park and Hopkins Street) had been pulled up into very shallow water, which left the PDS exposed to air. HSM450 (Rio Vista) had been cut open. The top of the sampler and PDS were left next to the deployment device. Therefore, these samples were not analyzed. HSM450 was also the filed duplicate sampler. Therefore, the laboratory was asked to cut one of the other samplers in half and analyze both pieces as the original and duplicate.

POCIS Sampling

POCIS samplers were deployed at the farthest downstream location HCS460 in the Comal Springs Complex. Deployment locations coincided with the PDS sampler locations. POCIS deployment devices were deployed for 30-day periods during the months of February, April, June, August, October, and December 2018.

Any alterations to sample locations or lost POCIS are discussed below.

February 2018 – The deployment device for sample HCS460 could not be not found. It was assumed this was due to human tampering and the sampler was not analyzed.

June 2018 – The deployment device for sample HCS460 could not be found. It was assumed this was due to human tampering and the sampler was not analyzed.

August 2018 - SWCA began using two stainless-steel colanders to hold the POCIS membranes. Upon arrival at each sample location for retrieval of the PDS, SWCA staff removed the POCIS carrier from the original container and then inserted the carrier into a stainless-steel colander. SWCA staff then inverted a second stainless steel colander and locked both colanders from both sides using a master lock. The stainless-steel colanders were then locked onto the chain with buoys that spans the Comal River above the tube chute at location HCS460.

San Marcos

Stormwater

May 4, 2018, Event

A stormwater event was sampled on May 4, 2018, in the San Marcos River complex. Seven locations were sampled, HSM210, HSM230, HSM231, HSM240, HSM250, HSM260, and HSM270. Stormwater sampling locations did not deviate from those proposed in the EAHCP Work Group Report.

Rain began to fall at around 10:30 on May 4, 2018, and lead sampling was initiated at 11:00 after real-time instruments installed in San Marcos River indicated a change in water quality had occurred as a result of stormwater runoff entering the river. Peak sampling was initiated at approximately 13:00 on May 4, 2018, after the specific conductivity measurements from RTIs indicated a rise in readings had occurred. Trail sampling was initiated at approximately 17:00. After the trail sample was collected, the sample teams returned to the SWCA San Antonio office with the samples in order to package them for shipment. Because the stormwater event occurred on Friday, May 4, 2018, the samples were picked up on Monday, May 7, 2018 by a Test America Laboratories personnel. SWCA iced samples throughout the weekend.

Passive Diffusion Sampling

Passive diffusion samplers were deployed at each of the surface water sample collection sites. When at all possible, deployment locations coincided with the 2017 surface water locations. Some adjustments had to be made to account for river depth, accessibility by SWCA staff for installation and retrieval, and potential interference by the public. PDSs were deployed for two-week periods during the months of February, April, June, August, October and December 2018. In 2014, SWCA staff designed and constructed a concrete and stainless steel deployment device to hold the PDS. Use of the devices continued throughout 2018. Any alterations to sample locations or lost PDS are discussed below.

HSM420

August – 2018 – Because the field duplicate FDHSM450 was not analyzed due to human tampering of the sampler, the lab was instructed to use HSM420 as a field duplicate.

HSM440

August 2018-The deployment device was exposed. The sampler was not analyzed due to the sampler being exposed to air for an unknown period of time.

HSM450

August 2018 – The canister located on the deployment device was found open and detached from sampler. It was assumed it was due to human tampering and the sampler was not analyzed.

FDHSM450

August 2018 – The canister located on the deployment device was found open and detached from the sampler. It was assumed it was due to human tampering and the sampler was not analyzed.

HSM470

October 2018 – The deployment device could not be located on October 15, 2018. Water conditions were murky, poor visibility, and high water flow in the sample location made it difficult to locate sampler. On October 17, 2018, SWCA returned to the sample location to attempt to locate the sampler. During that time, water was clear and water flow was low. The sampler was then located 5 feet downstream from where it was originally placed.

POCIS Sampling

POCIS samplers were deployed at the farthest downstream location HSM470 in the San Marcos Spring Complex. The deployment location coincided with the PDS sampler location. POCIS deployment devices were deployed for 30-day periods during the months of February, April, June, August, October, and December 2018.

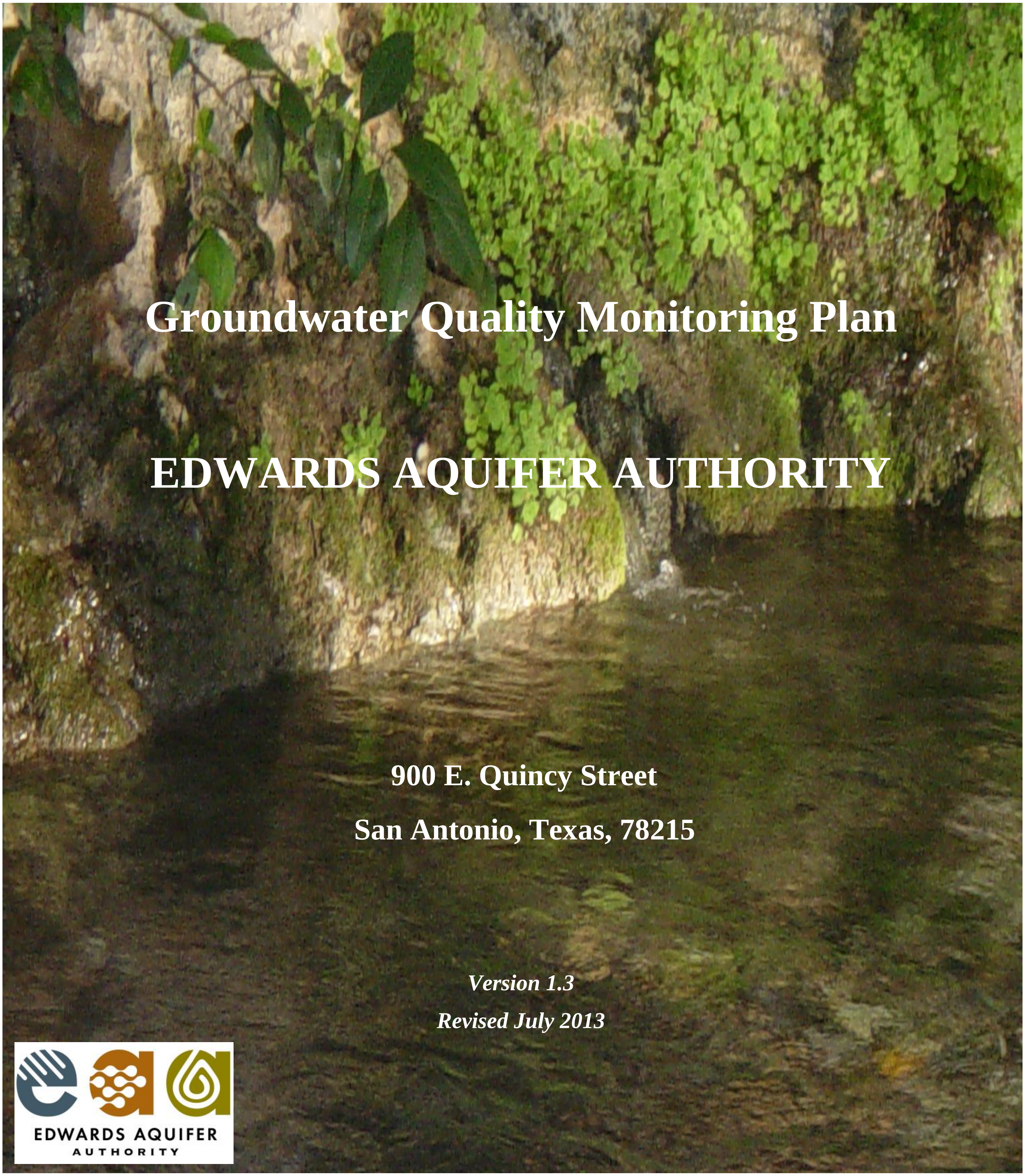
HSM470

June 2018 - The HSM470 sampler was collected by SWCA and submitted to EST Laboratories. EST Laboratories then shipped the eluted sample to Weck Laboratories, Inc. Weck Laboratories received the sample; however, Weck Laboratories lost the sample and could not provide analyses results.

August 2018 - SWCA began using two colanders to hold the POCIS membrane. Upon arrival at each sample location, SWCA staff removed the POCIS carrier from the metal container and then inserted the carrier into a stainless-steel colander. SWCA staff then inverted a second stainless steel colander and locked both colanders from both sides using a master lock. The stainless-steel colander encasement was locked onto the Passive Diffusive Sampler deployment device.

APPENDIX D

GROUNDWATER QUALITY MONITORING PLAN



Groundwater Quality Monitoring Plan

EDWARDS AQUIFER AUTHORITY

900 E. Quincy Street
San Antonio, Texas, 78215

Version 1.3
Revised July 2013

CONTENTS

LIST OF TABLES

APPENDICIES

ACRONYMS AND ABBREVIATIONS

ASTM	American Society of Testing and Materials
bgs	below ground surface
COC	chain of custody
DQO	data quality objective
EAA	Edwards Aquifer Authority
EAHCP	Edwards Aquifer Habitat Conservation Plan
e-line	electronic water level measurement device
GW	groundwater
MSL	mean sea level
NAWQA	national water quality assessment
PPCP	pharmaceutical and personal care products
psi	pounds per square inch
QA	quality assurance
QC	quality control
SOP	standard operating procedure
TWDB	Texas Water Development Board
USGS	United States Geological Survey
U.S. EPA	United States Environmental Protection Agency
VOA	volatile organic analysis
VOC	volatile organic compound

SECTION 1

PURPOSE AND OBJECTIVES

1.1 PURPOSE AND OBJECTIVES OF THE PLAN

Data derived from water quality sampling and analysis provide the primary indicator of the state of water quality in the Edwards Aquifer. These data are also a key component of assessing water quality changes over time. Water quality data also compose the primary source of information for our understanding and monitoring of contaminant loading and migration in the Edwards Aquifer. As such, analytical samples collected for assessing water quality must be collected under a set of standard operating procedures (SOPs), which are outlined in this plan. Included herein are sections on data quality objectives (DQOs), sampling programs, analytical methods, field procedures, and guidelines for plan review.

The purpose of this plan is to provide an SOP document ensuring that useful, consistent, and defensible water quality data are produced by implementation of appropriate procedures and methods when water quality samples are being collected and analyzed. Water quality samples are currently collected under various sampling programs at the Edwards Aquifer Authority (EAA). Data quality requirements vary by program and are discussed in Sections 2 and 3.

Section 2 of this plan provides a description of DQOs in general, as well as DQOs for this program. Section 3 provides detailed information for each of the sampling programs. Section 4 provides a listing of analytical methods used by the EAA, as well as data-flagging requirements, information for sample containers, hold times, and sample preservation. Section 5 outlines field procedures; Section 6 discusses staff training and field audits. Section 7 provides information regarding annual plan review, and Section 8 provides a list of references cited in the document. The appendices (A–G) provide maps of sample locations, a glossary of terms, instrument operation and calibration information, field forms, information on regulatory limits for various compounds, stormwater sample-collection details, and equipment-decontamination procedures.

The purpose of this plan can be achieved by implementation of the objectives listed below and discussed in detail in Sections 2–7 of the plan. Each EAA staff member charged with the responsibility of collecting water quality or other analytical samples is required to be familiar with this plan, along with the objectives and procedures outlined in it. The objectives of this plan are to

- Obtain quality data that are defensible for their intended purpose,

- Analyze field samples in an appropriate and consistent manner such that the results are accurate and repeatable (see calibration procedures in Appendix C),
- Collect samples for laboratory analysis in an appropriate and consistent manner that will ensure accurate and reliable analytical results with a minimal number of anomalous data,
- Select sample sites and time periods that will provide representative water quality data for a range of aquifer conditions, and
- Review the plan annually and revise as needed.

SECTION 2

DATA QUALITY OBJECTIVES

The U.S. Environmental Protection Agency (U.S. EPA) has developed criteria for data quality objectives utilizing a seven-step process that optimizes sample collection and analysis on the basis of data uses, fiscal budget, sample quantity, and other parameters (U.S. EPA, 2000). The process is iterative and may be modified by the planning team to incorporate changes as required:

1. **State the Problem**
   Define the problem, identify the planning team, and examine the budget and schedule.
2. **Identify the Decision**
   State the decision, identify study questions, and define alternative actions.
3. **Identify Inputs to the Decision**
   Identify information needed for the decision, such as information sources, bases for action level, and sampling and analysis methods.
4. **Define the Boundaries of Study**
   Specify sample characteristics, and define spatial/temporal limits and units of decision making.
5. **Develop a Decision Rule**
   Define parameters for decision rules, specify action levels, and develop logic for action.
6. **Specify Tolerable Limits on Decision Errors**
   Set acceptable limits for decision errors relative to consequences (health effects, costs, other impacts).
7. **Optimize the Design for Obtaining Data**
   Select a resource-effective sampling and analysis plan that meets performance criteria.

2.1 U.S. EPA DQO Process as Applied to EAA Analytical Programs

2.1.1 DQO—State the Problem

Collect and analyze groundwater, spring water, and surface water samples that are contained in, issue from, or provide recharge to the Edwards Aquifer. In addition, collect stormwater and sediment samples as needed to satisfy program requirements. Sampling activities are to be conducted such that sufficient funding is held in reserve to collect confirmation samples if needed. In addition, the program must be flexible enough to collect samples in the event of a contingency (spill or other event) that affects or could potentially affect water quality of the Edwards Aquifer. The planning team includes the

Chief Technical Officer (CTO) and supervisory staff of the Aquifer Science Team of the EAA. Budget is proposed by the team and presented for board approval annually. The schedule is annual, with a general goal of collecting a minimum of 80 samples from wells, sampling all major springs (monthly or quarterly, depending on hydrologic conditions), and sampling surface waters twice annually while maintaining a budget reserve sufficient to address other needs (confirmation and contingency sampling).

Under a separate budget, the same team is charged with collecting surface water, stormwater, and sediment samples in support of the Edwards Aquifer Habitat Conservation Plan (EAHCP). Surface water, stormwater, and sediment samples are collected upstream, within, and downstream of Comal and San Marcos springs. Comal Springs has five designated sample locations, whereas San Marcos Springs has seven. Surface water and stormwater samples are to be collected twice annually, whereas sediment samples are collected once annually for the first year (to obtain baseline sediment quality information). Subsequent years may vary depending on results. See *Water Quality Monitoring Program Strategy for Comal Springs and San Marcos Springs in Support of the Edwards Aquifer Habitat Conservation Plan* (EAHCP Workplan).

2.1.2 DQO—Identify the Decision

The decision is to collect the samples as described earlier under the sampling programs and protocols outlined in detail in this document. Study questions are:

- Can the quality of water entering into, residing in, and issuing forth from the Edwards Aquifer be representatively monitored?
- For the allowed budget, how many analytical parameters can be collected?
- What analytical parameters are the most informative with regard to water quality?
- Can a relevant data set that provides historical and current water quality information as relates to the Edwards Aquifer, be developed and maintained?
- Can the data indicate trends in water quality over time?
- Can contingency sampling functionally define contaminant flowpaths and ultimately help in the prevention of public exposure to contaminants in the event of a spill?
- How does the EAA functionally share the information collected with stakeholders and the public?

Alternative actions are to

- Modify the analytical parameter list to accommodate budget constraints,
- Reduce the number of sample points and sample frequency if needed to accommodate budget constraints, and

- Continually review results to assess the need for, and feasibility of, modifying the parameter list such that analytical parameters collected provide the most information for the program, as well as cost-effective information.

2.1.3 DQO—Identify Inputs to the Decision

Sample frequency, sample type, and analytical program are all based on many inputs. The EAA strategic plan dictates minimum sample numbers, for example. Other inputs of importance include findings from karst researchers worldwide regarding the varying nuances of sampling in karst environments (i.e., multiple samples from a single location are generally more valuable than single samples from multiple locations). Assimilating and incorporating information gleaned from EAA sample results annually provide significant inputs to the process as well.

Action levels as defined for this study are not directly comparable to action levels for hazardous waste cleanup. In this program, action levels generally depend on sample type and program: for example, stormwater samples are triggered by specific stormwater events. Action levels may also be related to contingencies. If a contaminant of concern is detected in relation to a contingency, then additional sampling may be triggered. In other cases, an action level may be reached if an anthropogenic compound is detected above a regulatory limit. The resulting action will generally be to utilize additional sampling so as to delineate a possible source if a “contaminant” is the trigger.

Sampling and analysis methods are specific to each sampling program and are designed to provide data on water quality and changes to water quality that may occur over time. Results of each program are reviewed regularly, and changes to the parameters for each program may be made on the basis of these reviews or other needs. All programs are generally analyzed for field parameters (conductivity, dissolved oxygen [DO], turbidity, pH, and temperature) at the time the sample is collected. Other laboratory analytical parameters are then designated on the basis of the program.

2.1.4 DQO—Define Boundaries of the Study

Spatially the study is limited to the Edwards Aquifer Region, which includes contributing area, recharge zone, and artesian zone of the aquifer, as well as contiguous areas that may be pertinent to data collection. Temporal limits are defined by sample program and hydrologic condition. Temporal parameters are described in more detail under sample programs.

2.1.5 DQO—Develop a Decision Rule

Decision rules are defined by multiple factors:

- Strategic plan,
- Board directives,
- Approved budget,

- Data analyses and results,
- Historical data for a particular site, and
- EAHCP requirements.

2.1.6 DQO—Specify Tolerable Limits on Decision Errors

Decision-error limits are dictated by sample program. Whereas all results are considered important, contingency samples have an elevated priority because of the potential to provide a warning to the public in the event water quality is impacted. As such, in the event of a major contingency that requires long-term sampling and analysis, the budget impact would be significant. In some scenarios, additional laboratory funding would be requested from the board to cover these costs. Other sample programs are expected to be well planned and orchestrated such that no budget overruns occur.

The goal of the program in general is to collect a number of samples adequate to monitor the health of the Edwards Aquifer with high confidence that results are representative and accurate. These samples are collected through various sampling programs, as outlined in the next section.

2.1.7 DQO—Optimize the Design for Obtaining Data

The sampling plan as designed provides a resource-effective plan that meets performance criteria through data review, data assessment, and program requirements. The design is optimized by the data needs of each sample program, in which analytical parameters are specific to a program and designed to provide a maximum number of data cost-effectively.

2.2 Additional Inputs for DQO Process

Another definition of DQOs is provided by the Air Force Center for Environmental Excellence (AFCEE) in its *Quality Assurance Project Plan* (QAPP), which states that "DQOs specify the data type, quality, quantity, and uses needed to make decisions and are the basis for designing data collection activities" (AFCEE, 2001). The U.S. EPA and the AFCEE both generally utilize DQOs for hazardous waste clean-up sites, which often represent a threat to public health and the environment. However, sampling programs at the EAA differ in that most samples taken are "clean" and are not used to assess the success of a clean-up action.

Therefore, for the purposes of this plan, DQOs are met by assigning a level of precision and procedural techniques and parameter suites that are appropriate for the sample type and monitoring program. Whereas it is the purpose of this plan for all data produced to be representative and fully defensible, all data do not necessarily need to be analyzed by reference methods in the analytical laboratory utilizing a full suite of QA/QC samples. Most water quality samples collected are intended for monitoring the general status of water quality within the Edwards Aquifer, with one potential exception. In some cases, contingency sampling may be used to assess the impact of an event (i.e., a spill) to the Edwards Aquifer that has the potential for public health implications.

Therefore, DQOs developed for this document are designed to provide data of quality and quantity adequate to reflect the needs of the sample program under which a particular sample is collected. Most analytical data collected are designed to assess

- The presence or absence of anthropogenic compounds in the sample.
- Changes to chemical quality of the sample point when compared with prior data,
- Development of data adequate to establish a record of water quality such that future changes to water quality can be measured,
- Measurement of changes to water quality against changes in hydrologic conditions, and
- In the case of confirmation samples, assessment with a high degree of confidence the presence or absence of a compound of interest.

SECTION 3

SAMPLING PROGRAMS AND OBJECTIVES

Water quality samples are collected under one of the EAA sample programs described in detail in this section. Sample parameters vary with the sample program. For a better understanding of the sampling programs and sample distribution, typical water quality sample locations, see Appendix A, which is a listing of sample type and program. EAHCP sample locations are also provided.

3.1 SAMPLE TYPES AND SAMPLE PROGRAMS

Sample type is simply defined by source and media. The EAA collects samples from wells, springs, surface water, and, at times, groundwater in caves. Samples of soil or sediment may also be collected under some circumstances. As such, sample types are:

- Wells (applies to groundwater samples and includes water collected in caves),
- Springs,
- Surface water,
- Soil or sediment, and
- Stormwater.

Sample programs exist for each sample type, driving the DQO process for a given sample. Each sample program has a defined sample frequency and analytical parameter list. However, the analytical parameter list is always subject to future revision to accommodate changing circumstances. Table 3-1 summarizes current sample types and individual sample programs conducted by the EAA.

Table 3-1. Sample Types and Sample Programs

Sample Type	Sample Program	Sample Frequency	Analytical Parameters
Wells	Passive	Quarterly	FP, GWQP, VOC, TPH, TOC, PAH, metals, bacteria
	NAWQA	Annually	FP, GWQP, VOC, 8081B, 8141A, 8151A, 8082A, TOC, PAH, metals, bacteria
	Routine	Annually	FP, GWQP, VOC, 8081B, 8141A, 8151A, TOC, PAH, metals, bacteria
	TWDB	Annually	FP, GWQP, VOC, 8081B, 8141A, 8151A, TOC, PAH, metals, bacteria
	PPCP	Annual	FP, PPCP (limited to nine wells annually)
	Contingency	As needed	Defined by contingency event
	Confirmation	As needed	Defined by detection needing confirmation
	QA/QC	Per QA needs	Defined by QA program
	EAHCP	Water level dependant	FP, GWQP, TOC, TDS
Springs	Primary	Quarterly (noncritical period) Monthly (critical period)	FP, GWQP, SVOC, VOC, 8081B, 8141A, 8151A, 8082A, TOC, metals, total phosphorous, bacteria, orthophosphate as P
	Secondary	Annually	FP, GWQP, SVOC, VOC, 8081B, 8141A, 8151A, 8082A, TOC, metals, total phosphorous, bacteria
	PPCP	Annually	FP, PPCP (limited to six spring samples annually)
	Contingency	As needed	Defined by contingency event
	Confirmation	As needed	Defined by detection needing confirmation
	QA/QC	Per QA needs	Defined by QA program
Surface water	Primary	Twice annually	FP, GWQP, 8081B, 8141A, 8151A, 8082A, TOC, PAH, metals, total phosphorous, bacteria
	Secondary	Annual	FP, GWQP, 8081B, 8141A, 8151A, 8082A, TOC, PAH, metals, total phosphorous, bacteria
	EAHCP	Twice annually	FP, GWQP, VOC, SVOC, 8081B, 8141A, 8151A, 8082A, TOC, metals, total phosphorous, bacteria, TKN, DOC
	PPCP	Annually	FP, PPCP (limited to two surface water samples annually)
	Contingency	As needed	Defined by contingency event
	Confirmation	As needed	Defined by detection requiring confirmation
	QA/QC	Per QA needs	Defined by QA program
Soil/sediment	EAHCP	Annually	FP, GWQP, VOC, SVOC, 8081B, 8141A, 8151A, 8082A, TOC, metals, total phosphorous
	Contingency	As needed	Defined by contingency event
	Confirmation	As needed	Defined by detection requiring confirmation
	QA/QC	Per QA needs	Defined by QA program
Stormwater	EAHCP	Twice annually	FP, GWQP, VOC, SVOC, 8081B, 8141A, 8151A, 8082A, TOC, metals, total phosphorous, bacteria, TKN
	Confirmation	As needed	Defined by detection requiring confirmation
	QA/QC	Per QA needs	Defined by QA program

FP=field parameter, GWQP=general water quality parameters, SVOC=semivolatile organic compound, VOC=volatile organic compound, TOC=total organic carbon, TKN=total kjeldahl nitrogen, PPCP=personal care and pharmaceutical products., PAH=polynuclear aromatic hydrocarbons, TPH=total petroleum hydrocarbons, DOC=dissolved organic compounds

3.2 SAMPLE PROGRAM DETAIL

The sample types and programs summarized in Table 3-1 comprise the various analytical samples collected and analyzed by the EAA. Specific details of each program are provided in this section.

Sample Programs for Well Sample Types

1. **Passive Sampling Program**
   The passive sampling program is a program to provide continuous monitoring of particular wells (referred to as sentinel wells) through the use of a passive sampling device. The device currently used is the Amplified Geochemical Imaging (AGI), LLC passive diffuse sample module (aka, Gore Module). This device utilizes a sorbent material encased in GoreTex® fabric that is capable of detecting certain analytes for volatile and semivolatile compounds, as well as petroleum hydrocarbon compounds. The Gore Modules are hung at sp ecific intervals continuously in a sentinel well and replaced each month. The module is then shipped to AGI, LLC. for analysis (which is included as part of the module cost). Currently six wells designated as sentinel wells are located in Medina, Bexar, and Hays counties. These wells are sampled via grab sample quarterly. Sample parameter selection for this sample type is generally based on collecting parameters that are also detectable by the Gore Module, plus some additional parameters of value to an understanding of long-term trends in water quality. Sample frequency is also selected to detect temporal changes in water quality at a single sample point.

2. **National Water Quality Assessment (NAWQA) Program**
   The NAWQA wells are a series of thirty wells installed by the USGS for long-term assessment of water quality on a regional and national scale. Ten of these wells (all in the recharge zone of Bexar County) are sampled annually. The sample parameter list is selected on the basis of the NAWQA program and is used to contribute data to that study, as well as to build a historical record of water quality for the EAA data set. Ten out of 30 NAWQA wells are sampled annually, and every well must be sampled within a three-year period.

3. **Routine Water Quality Monitoring**
   Routine water quality samples are collected from a variety of well types (monitoring, domestic, agricultural, industrial, and municipal) to provide a data set for water quality regionwide for different well types. Sample parameters are broad in spectrum and designed to detect the most common anthropogenic compounds, as well as to document changes in concentrations of common cations and anions. These wells are generally sampled annually or less frequently.

4. **Texas Water Development Board (TWDB)**
   Twenty TWDB samples are collected at designated wells using a split-sample technique, such that a sample set is sent to the TWDB contract laboratory (at no cost to the EAA). The remaining sample is sent to the EAA contract laboratory and analyzed for some of the same (TWDB) parameters, as well as additional parameters. This sample type provides a cost-effective tool for evaluation and comparison of analytical results for certain parameters (metals and anions). These wells (or springs, in some cases) are sampled annually under this program for a wide variety of parameters and are also used to assess the health of the system and to establish potential changes or trends in quality.

5. **Pharmaceuticals and Personal Care Products (PPCPs)**
   These parameters detect various compounds found in common personal care products, as well as medications and household items. The primary value in this sample group is the conclusiveness of the data. Because the detection limits are low and the percentage of detections (at low concentrations) to date is high, this sample program appears to provide the most conclusive evidence of anthropogenic impacts on the Edwards Aquifer. The current sample budget allows for nine wells, six springs, and two surface waters to be sampled annually for these parameters. The same locations are sampled each year (with some exceptions) to provide a temporal record of water quality changes associated with the compounds. This program is being evaluated for an increase in sample frequency at some locations.

6. **Contingency Samples**
   Contingency samples are collected only on an as-needed basis to assess potential contamination events related to spills or similar contingencies that have a high potential for affecting water quality in the Edwards Aquifer. Sample parameters and sample frequency are determined on the basis of type of spill (or other contingency), as well as the size of the event. Sample parameters and frequency are decided on by management. EAA staff members are subsequently directed to an appropriate course of action on the basis of assessment of the event by management.

7. **Confirmation Samples**
   Confirmation samples are samples collected in response to an unexpected detection at a site where additional confirmation is needed in order to assess the probability that detection is not a sampling artifact or otherwise false detection. Confirmation detections are method and analyte specific and are taken at the direction of management.

8. **QA/QC Samples**
   QA/QC samples are discussed in detail in Section 3.3.

9. **EAHCP Drought Contingency-Sampling of transect wells and Springs**
   Well samples collected for the EAHCP are collected only when certain springflow criteria are met—specifically, low-flow situations at Comal and San Marcos springs. For Comal Springs, when flows fall below 30 cubic feet per second (cfs), weekly monitoring at three wells is to be conducted for DO, conductivity, pH, and temperature. The next trigger at Comal Springs is 20 cfs, and weekly monitoring is conducted using the same parameters plus nutrients, TDS, and TOC. For San Marcos Springs, the first trigger is 50 cfs, and the second trigger is 30 cfs.

Sample Programs for Spring Sample Types

1. **Primary Springs**
   Primary springs are Comal, Hueco, and San Marcos. They are sampled monthly during critical periods (critical period = a ten-day average when water levels at Bexar, County, index well J-17 of below 660 feet msl, and/or a ten-day average springflow rate at either Comal or San Marcos springs is less than 225 cfs for Comal Springs and less than 96 cfs for San Marcos Springs). During noncritical periods, sampling is generally conducted quarterly. Sample parameters are extensive because the springs represent a composite sample of aquifer water and are directly associated with habitat for threatened and endangered species.

2. **Secondary Springs**
   Secondary springs generally produce a smaller volume of springflow and may or may not be located within the San Antonio Segment of the Edwards Aquifer. These springs are Las Moras (Fort Clark Springs), San Pedro, San Antonio, Government Canyon, and other springs that may be designated for infrequent sampling. Las Moras is generally sampled annually, whereas the others are sampled quarterly or annually if flowing. Sample parameters are the same as those for the primary springs, except that sample frequency differs between primary and secondary.

3. **Pharmaceuticals and Personal Care Products (PPCPs)**
   These parameters detect various compounds found in common personal care products, as well as medications and household items. The primary value in this sample group is the conclusiveness of the data. Because the detection limits are low and the percent of detections (at low concentrations) to date are high, this sample program appears to provide the most conclusive evidence of anthropogenic impacts on the aquifer. The current sample budget allows for nine wells, six springs, and two surface waters to be sampled annually for these parameters. The same locations are sampled each year (with some exceptions)

to provide a temporal record of water quality changes associated with the compounds. This program is being evaluated for an increase in sample frequency at some locations.

4. **Contingency Samples**
   Contingency samples are collected only on an as-needed basis to assess potential contamination events related to spills or similar contingencies that have a high potential for affecting water quality in the Edwards Aquifer. Sample parameters and sample frequency are determined on the basis of type of spill (or other contingency), as well as the size of the event. Sample parameters and frequency are decided on by management. EAA staff members are subsequently directed to an appropriate course of action on the basis of assessment of the event by management.

5. **Confirmation Samples**
   Confirmation samples are samples collected in response to an unexpected detection at a site where additional confirmation is needed in order to assess the probability that detection is not a sampling artifact or otherwise false detection. Confirmation detections are method and analyte specific and are taken at the direction of management.

6. **QA/QC Samples**
   QA/QC samples are discussed in detail in Section 3.3.

7. **Drought Contingency-Sampling of transect wells and Springs**

Sample Programs for Surface Water Sample Types

1. **Primary Surface Water**
   Primary surface waters are collected twice annually from eight locations: Nueces River at Laguna, Dry Frio River at Reagan Wells, Frio River at Concan, Sabinal River near Sabinal, Seco Creek at Miller Ranch, Hondo Creek near Tarpley, Medina River at Bandera, and Blanco River at Wimberley. These sample locations have a significant historical sample record and provide information regarding the quality of waters that effectively provide recharge to the Edwards Aquifer. Sample parameter lists are fairly significant, but do not generally include VOCs because of the low probability of detection of these compounds in a surface water environment.

2. **Secondary Surface Water**
   Secondary surface water sites may have varying locations and are generally sampled only annually. They are generally sites of interest because of their ability to provide recharge to the aquifer, or they may be indicators of water

quality from springs issuing forth from the Trinity Aquifer. Sample parameter lists are fairly significant but do not generally include VOCs because of the low probability of detection of these compounds in a surface water environment.

3. **EAHCP Surface Water Samples**

   EAHCP surface water samples are collected at Comal and San Marcos springs; Comal Springs has five sample locations, whereas San Marcos has seven sample locations, which are situated upstream and downstream of the spring orifice locations. Parameters provide a broad spectrum of analyses so that water quality might be better understood in detail at these locations. The parameters list will also be used to study trends in water quality at these locations over time. Sample frequency is twice annually.

4. **Pharmaceuticals and Personal Care Products (PPCPs)**

   These parameters detect various compounds found in common personal care products, as well as medications and household items. The primary value in this sample group is the conclusiveness of the data. Because the detection limits are low and the percent of detections (at low concentrations) to date high, this sample program appears to provide the most conclusive evidence of anthropogenic impacts on the aquifer. The current sampling budget allows for nine wells, six springs, and two surface waters to be sampled annually for these parameters. The same locations are sampled each year (with some exceptions) to provide a temporal record of water quality changes associated with the compounds. This program is being evaluated for an increase in sample frequency at some locations.

5. **Contingency Samples**

   Contingency samples are collected only on an as-needed basis to assess potential contamination events related to spills or similar contingencies that have a high potential for affecting water quality in the Edwards Aquifer. Sample parameters and sample frequency are determined on the basis of type of spill (or other contingency), as well as the size of the event. Sample parameters and frequency are decided on by management. EAA staff members are subsequently directed to an appropriate course of action on the basis of assessment of the event by management.

6. **Confirmation Samples**

   Confirmation samples are samples collected in response to an unexpected detection at a site where additional confirmation is needed in order to assess the probability that detection is not a sampling artifact or otherwise false detection. Confirmation detections are method and analyte specific and are taken at the direction of management.

7. **QA/QC Samples**

   QA/QC samples are discussed in detail in Section 3.3.

Sample Programs for Sediment Sample Types

1. **EAHCP Sediment Samples**

   EAHCP sediment samples will be collected for a broad spectrum of parameters to establish a base-line data set for sediments in and around Comal and San Marcos springs. These sample data are important to an understanding of potential issues with disturbing sediments in these areas.

2. **Contingency Samples**

   Contingency samples are collected only on an as-needed basis to assess potential contamination events related to spills or similar contingencies that have a high potential for affecting water quality in the Edwards Aquifer. Sample parameters and sample frequency are determined on the basis of type of spill (or other contingency), as well as the size of the event. Sample parameters and frequency are decided on by management. EAA staff members are subsequently directed to an appropriate course of action on the basis of assessment of the event by management.

3. **Confirmation Samples**

   Confirmation samples are samples collected in response to an unexpected detection at a site where additional confirmation is needed in order to assess the probability that detection is not a sampling artifact or otherwise false detection. Confirmation detections are method and analyte specific and are taken at the direction of management.

4. **QA/QC Samples**

   QA/QC samples are discussed in detail in Section 3.3

Sample Programs for Stormwater Sample Types

1. **EAHCP Stormwater Samples**

   EAHCP stormwater samples are collected twice annually for a broad spectrum of parameters to establish a base-line data set for stormwater quality in and around Comal and San Marcos springs. Stormwater samples are collected across the hydrograph at three points (rising, peak, and recession) to ascertain changes in water quality associated with storm flow.

2. **Confirmation Samples**
   Confirmation samples are samples collected in response to an unexpected detection at a site where additional confirmation is needed in order to assess the probability that detection is not a sampling artifact or otherwise false detection. Confirmation detections are method and analyte specific and are taken at the direction of management.

3. **QA/QC Samples**
   QA/QC samples are discussed in detail in Section 3.3

3.3 QUALITY CONTROL AND QUALITY ASSURANCE SAMPLES (QA/QC)

So that the data quality process is adhered to, additional samples for QA/QC must be taken and analyzed on occasion so that the quality of the sample collection and analysis process might be assessed. The various types of QA/QC samples applicable to this plan are outlined in the following paragraphs. Approximately ten percent of all samples will be QA/QC samples.

3.3.1 Matrix Spike and Matrix Spike Duplicate

Matrix spike and matrix spike duplicate samples (MS/MSD) are used to assess the effects of the sample matrix on the analytical process. The MS/MSD is a split (or replicate) of a parent sample collected in the field concurrently during the normal sample-collection process. Ideally, one MS/MSD is collected for each media type (soil, water, sludge, etc.) every 20 samples for each analysis being performed. For most sampling, no media changes will be encountered; i.e., most samples will be water. However, should the samples vary significantly in turbidity, collection of a specific MS/MSD for a sample with elevated turbidity may be advisable.

The MS/MSD is spiked and analyzed, and if the spiked analytes are recovered within a method-specific percentage, then matrix effects will be deemed minimal and no matrix data flag will be attached to the results. However, if spike recovery does not fall within the designated percentage, then analytical results will be flagged with an M-flag, indicating that a matrix effect is present. The sample name for MS/MSDs is identical to that of the parent sample, with the MS/MSD attached as a modifier at the end of the sample name. The MS/MSD will also be noted on the chain of custody (COC).

3.3.2 Ambient Blanks

Ambient blanks are taken to assess the possibility of site-specific atmospheric contamination of VOC samples. Ambient blanks are taken only when an area is suspected of having detectable quantities of atmospheric VOCs present (e.g., if VOC samples are being collected near a fueling operation). Ambient blanks are prepared by pouring ASTM

II, reagent-grade water directly into a 40-milliliter (mL), VOA container at the sample site during collection. The VOA is allowed to remain open and exposed to the atmosphere for the duration of the sample-collection process. The water is treated and analyzed as a sample from this point forward, with the designation *AB* on the COC. Ambient blanks are applicable to VOC samples.

3.3.3 Equipment Blanks

Equipment blanks consist of ASTM II, reagent-grade water poured over/through any sampling equipment used for collection of definitive samples. Most sample-collection equipment is disposable; however, in some cases, an equipment blank may be required. Equipment blanks are used to assess the effectiveness of decontamination procedures (for new materials provided to the EAA or from EAA decontamination processes) and are designated as *EB* on the COC. The frequency of collection of equipment blanks will depend on the sampling routine and sampling equipment in use.

3.3.4 Trip Blanks

Trip blanks are applicable only to VOC samples and are prepared and supplied by the contracted analytical laboratory. Trip blanks are to be shipped from the laboratory and maintained along with the VOC samples collected in the field. The purpose of trip blanks is to assess any potential contamination that may be introduced during shipping and sample handling. Trip blanks are designated on the COC as *TB*. Trip blanks are not to be opened in the field.

3.3.5 Duplicate or Replicate Samples

Duplicate and replicate samples are intended to assess the precision or repeatability of the analytical process. Typically one in ten samples should have a duplicate sample collected. The collection frequency of one duplicate per ten samples is generally acceptable. Note, however, that if a confirmation sampling event involves only three wells, then the duplicate (as well as other) QA/QC samples are still required. In other words, duplicates compose 10% of the sample set such that a sample population of ten would contain one duplicate. However, a sample population of 11 would contain two duplicates. The calculated number of duplicates is always rounded to the next whole number. Duplicates will generally be collected only at the 10% level for EAHCP analysis. For other programs, duplicate analysis is covered generally by the application of a TWDB sample set. Exceptions may apply and will be designated by management.

A duplicate sample is a second sample collected at the same location as that of the parent, either simultaneously or immediately following collection of the first sample (AFCEE, 2001). Both samples are collected, stored, and transported identically. A replicate sample, sometimes called a *split sample* is defined as a single sample divided into two samples (AFCEE, 2001). As with a duplicate, collection, storage, and transport of the resulting samples must be identical. Duplicate and replicate samples each have unique identifiers (see Section 4).

3.3.6 Spike Samples

Spike samples are used as part of EAA's quality control on the contracted laboratory. EAA sampling staff members collect and subsequently spike twelve liters of water at one of the major springs, the spike containing a known percentage of a substance (contaminant). The spiked sample is then submitted to the contracted laboratory for analysis. If the contracted laboratory reports the findings within the specified amount, then EAA has confidence in their data. However, if the contracted laboratory is unable to detect or report the spikes, then EAA will pursue corrective action with the help of laboratory personnel to resolve the discrepancy. The corrective-action process will be initiated by the Hydrogeology Supervisor.

3.3.7 Recording QA/QC Samples in Analytical Workbook

Samples collected for QA/QC or spiked samples are to be recorded in chronological order in the laboratory notebook. The laboratory notebook is to be kept in the EAA Camden Building in the water quality area with the calibration notebook.

SECTION 4

ANALYTICAL METHODS, SAMPLE IDENTIFICATION, AND CUSTODY PROCEDURES

This section will discuss analytical methods applicable to the EAA sampling program, as well as provide a summary of analytical hold times, acceptable sample containers, and preservation techniques. In addition, a discussion of proper identification and sample custody procedures is provided herein.

4.1 ANALYTICAL METHODS

A variety of analytical methods are used in the various water quality and sediment sampling programs. Table 4-1 lists standard analytical reference methods that have possible application to the various programs. Recall, too, that Table 3-1 provides a current listing of analytical methods/parameters for each sample type and program.

Table 4-1. Analytical Reference Methods

Analysis	Method
VOC	SW-8260b
SVOC	SW-8270c
Chlorinated herbicides	SW-8151a
Organophosphorus compounds	SW-8141a
Nonvolatile compounds by HPLC	SW-8321
Organochlorine pesticides	SW-8081b
Polychlorinated biphenyls (PCBs)	SW-8082a
PAH	SW-8310
Determination of triazine pesticides	EPA-619
Organonitrogen pesticides in industrial/municipal wastewater	EPA-633
Oryzalin in industrial/municipal wastewater	EPA-638
TPH	TX-1005
Metals (except mercury)	SW-6010b or SW-6020
Mercury	SW-7470A
Cyanide	SW-9010B

Table 4-1. Analytical Reference Methods (continued)

Analysis	Method
Alkalinity	EPA-310.1
Common anions	SW-9056
Sulfate (SO_4)	EPA 300.0
pH	SW-9040B
Total dissolved solids (TDS)	EPA 160.1
Total suspended solids (TSS)	EPA 160.2
Ortho-phosphate	EPA 365.3
Nitrate/nitrite (both as N)	EPA 353.2
Ammonia (as N)	EPA 350.3
Kjeldahl (as N)	EPA 351.3
Total organic carbon (TOC)	EPA 415.1 or SW-9060
Sulfide	EPA 376.2
Dissolved organic compound	SM 5310C-2000
E-coli most probable number (MPN)	SM9223B-2004
Dissolved orthophosphate lab	EPA 365.3-1978
Ammonia as N-nondistilled	SMA4500 NH3D-1997
Bromide	EPA 300.0-1993
Chloride	EPA 300.0-1993
Nitrate as N	EPA 300.0-1993
Total phosphorous	EPA 365.3-1978
Enterococci	ENTEROLERT
Eshcerichia coli-colilert	SM 9223B 20Ed
Total coliform_colilert	SM 9223B 20Ed
TWDB anions	EPA 300.1
TWDB cations	EPA 200
TWDB nitrate	EPA 353.2
Anti-bacterial agents	1694
Pharmaceuticals	1694
Steroids/hormones	1698

SIM analysis	MS-SIM-GX/MS
Nonylphenols	WS-MS-0010
General water quality parameters (GWQP), general chemistry—(alkalinity, bicarbonate, carbonate, Ca, Mg, Na, K, Cl, SO_4, F, Si, Sr, bromide, nitrate as N, pH, TDS, and TSS)	Methods listed in table

4.2 DATA-FLAGGING CONVENTIONS

Analytical data must be qualified by the EAA-contracted analytical laboratory, which is done summarily by the addition of data flags to the data result. Table 4-2 provides a summary of the data-flagging convention used in this plan (modified from AFCEE, 2001).

Table 4-2. Data Flags

Flag	Description
J	Analyte positively identified. Quantitation is an estimation because the associated numerical value is below the reporting limit (RL).
U or ND	Analyte analyzed for, but not detected. Associated numerical value at or below method detection limit (MDL).
R	Data rejected because of deficiencies in ability to analyze sample and meet QC criteria.
B	Analyte found in associated blank, as well as in sample.
M	Matrix effect present.
T	Tentatively identified compound (using GC/MS).
No flag	Analyte detected at reported concentration.

4.3 SAMPLE CONTAINERS AND HOLD TIMES

Samples sent to the analytical laboratory must be properly containerized, preserved, and analyzed within specified hold times for the method for the data to be of defensible quality. In addition to the requirement for samples to be chilled to 4°C, ±2°, some analytical methods require the sample to be maintained at specific pH values. As such, Table 4-3 lists acceptable container types, preservatives, and hold times for common analytical methods. The table includes all scheduled analyses for the various sampling programs. In the event an analysis is required that is not included in the table, Aquifer Science Team members listed herein (hydrogeology supervisor or hydrologic data coordinator) will communicate with the EAA contracted laboratory regarding appropriate containers, preservatives, and hold times for the methods in question.

Table 4-3. Sample Containers, Preservatives, and Hold Times

Analyte or Method[1]	**Container**	**Preservation**	**Minimum Sample Volume**	**Holding Times**
Volatile organic compounds (SW8260B)	G, Teflon®-lined septum, T	4ºC, HCl to pH <two	3× 40 mL with no head space or (1) 250 mL amber bottle with no head space	14 days (water and soil); seven days if unpreserved by acid
Semivolatile organic compounds (SW8270C)	G, Teflon®-lined cap, T	4ºC	1L or 8 ounces/soil	Seven days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Chlorinated herbicides (SW8151a)	G, Teflon®-lined cap, T	4ºC	1L or 8 ounces/soil	Seven days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Organophosphorus compounds (SW8141A)	G, Teflon®-lined cap, T	4ºC	1L or 8 ounces/soil	Seven days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Organochlorine pesticides (SW8081)	G, Teflon®-lined cap, T	4ºC	1L or 8 ounces/soil	Seven days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Polychlorinated biphenyls (SW8082)	G, Teflon®-lined cap, T	4ºC	1L or 8 ounces/soil	Seven days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)

Analyte or Method[1]	Container	Preservation	Minimum Sample Volume	Holding Times
Polynuclear aromatic hydrocarbons (SW8310)	G, Teflon®-lined cap, T	4ºC	1L or 8 ounces/soil	Seven days until extraction and 40 days after extraction (water); 14 days until extraction and 40 days after extraction (soil)
Total petroleum hydrocarbons (TX1005)	G, Teflon®-lined septum, T	4ºC, HCl to pH <2	3× 40 mL with no head space or (1) 250 mL amber bottle with no head space	14 days (water); to extraction, and 14 days after extraction
General water quality parameters (alkalinity, bicarbonate, carbonate, Ca, Mg, Na, K, Cl, SO_4, F, Si, Sr, bromide, nitrate (as N), pH, TDS, and TSS)	P, G	4ºC	250 mL	28 days
Cyanide	P, B	4ºC; NaOH to pH >12	500 mL or four ounces /soil	14 days (water and soil)
Ortho-phosphate (as P)	P, G	4ºC	50 mL	48 days
Nitrate (as N) and nitrite (as N)	P, G	4ºC	250 mL	48 days
Ammonia (as N)	P, G	4ºC	250 mL	28 days
Kjeldahl (as N)	P,G	4ºC	250 mL	28 days
Total organic carbon	P,G	4ºC, H_2SO_4 to pH <2	250 mL	28 days
Dissolved organic carbon	P,G	4ºC, H_2SO_4	400 mL	28 days
Phosphorus	P,G	4ºC, H_2SO_4	500 mL	28 days
Alkalinity E310.1	P, G	4ºC	50 mL	14 days
Common anions SW9056	P, G	None required	50 mL	28 days for Br^-, F^-, Cl^-, and SO_4^{-2}; 48 hours for NO_3^-, NO_2^-, and PO_4^{-3}
Cyanide, total and amenable to chlorination SW9010A SW9012	P, G, T	4ºC; NaOH to pH >12, 0.6 g ascorbic acid	500 mL or four ounces /soil	14 days (water and soil)
Total dissolved solids (TDS) E160.1	P, G	4ºC	100 mL	Seven days
Total suspended solids (TSS) E160.2	P, G	4ºC	100 mL	Seven days
Biological oxygen demand (BOD), five-day	P, G	4ºC	1L	48 hours
Sulfide	P, G	4ºC	1L	Seven days

Analyte or Method[1]	Container	Preservation	Minimum Sample Volume	Holding Times
Total inorganic carbon	P, G	4ºC	250 mL	28 days
Escherichia coli-colilert	P, G, WP	4ºC, dark, sodium thiosulfate, one-inch headspace	100–250 mL	Six + two h (this holding time represents six field hours and two lab hours
Enterococci	P, G, WP	4ºC, dark, sodium thiosulfate, one-inch headspace	100–250 mL	Six + two h (this holding time represents six field hours and two lab hours
Total coliform-colilert	P, G, WP	4ºC, dark, sodium thiosulfate, one-inch headspace	100–250 mL	Six + two h (this holding time represents six field hours and two lab hours
TWDB anions	P, G	4ºC, filtered on site	500 mL	28 days
TWDB cations	P, G	4ºC, HNO_3, filtered on site	250 mL	28 days
TWDB nitrate	P, G	4ºC, H_2SO_4, filtered on site	500 mL	28 days
1694 Pharmaceuticals (LCMS/MS) Acetaminophen Caffeine Carbamazepine Cotinine DEET Diltiazem Fluoxetine Gemfibrozil Ibuprofen Lincomycin Naproxen Sulfamethoxazole Trimethoprim Tylosin Iopromide	G, Teflon®-lined cap, T	4ºC	1L or 8 ounces/soil	Seven days (unpreserved), 14 (days preserved)
1694 Antibacterial (LCMS/MS) Triclobarban Triclosan	G, Teflon®-lined cap, T	4ºC	1L or 8 ounces/soil	Seven days (unpreserved), 14 (days preserved)

Analyte or Method[1]	**Container**	**Preservation**	**Minimum Sample Volume**	**Holding Times**
1698 Steroids/hormones (LCMS/MS) 17a-Estradiol 17a-Ethynyl estradiol 17b-Estradiol Equilenin Estriol Estrone Progesterone Testosterone	G, Teflon®-lined cap, T	4ºC, H_2SO_4	1L or 8 ounces/soil	Seven days (unpreserved), 14 (days preserved)
Nonylphenols/ethoxylates/bisphenol-A (GCMS) Bisphenol-A Nonylphenol diethoxylate (tech.) Nonylphenol monoethoxylate (tech.) p-Nonyphenol (tech.) p-tert-octylphenol para-n-nonylphenol	G, Teflon®-lined cap, T	4ºC, H_2SO_4	1L or 8 ounces/soil	Seven days (unpreserved), 14 (days preserved)
Selected metals—6020 (Al, Sb, As, Ba, Be, Cd, Cr (total), Cu, Fe, Pb, Mn, Hg, Ni, Se, Ag, Tl, and Zn)	P, G, T	HNO_3 to pH <2, 4ºC	500 mL or 8 ounces/soil	180 days (water and soil)
Hg—Cold vapor 7470.7471	P, G	HNO_3 to pH <2, 4ºC	250 mL	28 days (14 days if in plastic bottle)
Selected metals—(ICP unless otherwise noted) 6020/7470/7471 (Al, Sb-ICP-MS or GFAA, As, Ba, Be, Cd, Cr (total), Cu, Fe, Pb, Mn, Hg-ICP-MS or CVAA, Ni, Se-ICP-MS or GFAA, Ag, Tl-ICP-MS or GFAA, and Zn)	P, G, T	HNO_3 to pH <2, 4ºC	500 mL or 8 ounces/soil	180 days (water and soil)
Hg- ICP-MS or CVAA **7470/7471**	P, G	HNO_3 to pH <2, 4ºC	250 mL	28 days (14 days if in plastic bottle)

a. Polyethylene (P); glass (G); brass sleeves in sample barrel, sometimes called California brass (T).
b. No pH adjustment for soil.
c. Preservation with 0.008 percent $Na_2S_2O_3$ only required when residual chlorine present.

4.4 SAMPLE IDENTIFICATION

Each sample must have a unique identifier so that it can be differentiated from other samples. In addition, sample names must meet the required criteria for entry into the data base and subsequent electronic storage and retrieval of the data. Therefore, sample names must conform to the guidelines herein.

4.4.1 Sample Identification, for Non-EAHCP Samples

The primary method for non-EAHCP sample identification will be to use the state well registration number for wells (and springs as applicable) or the site name for surface water samples. When no well number is available for a spring, then an abbreviation for the spring name and orifice will be used. For example,

- The unique identifier, for use on the COC for Comal Springs, Orifice 1 is DX 68-23-301,
- The unique identifier for use on the COC for Comal Springs Orifice 3 (no state well number) is CS3,
- The unique identifier for use on the COC for the Nueces River at Laguna is Nueces@Laguna, and
- For wells that are sampled in more than one location within the borehole, the interval number is attached to the well name. For example, well LR-67-09-101 is regularly sampled at two intervals, so the COC name is LR-67-09-101-1 (interval 1 or upper interval) and LR-67-09-101-4 (interval 4, or the deepest interval).

Note that to the extent possible, custody forms and sample-container labels will be preprinted by the laboratory.

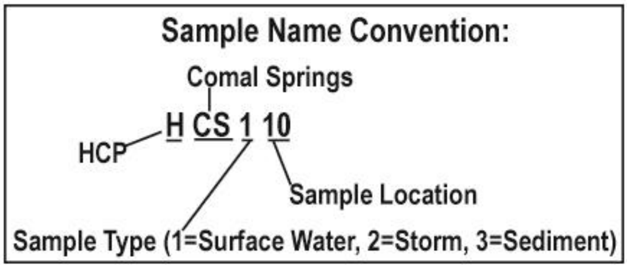
In some cases no well number or other recognized registration number will exist for the sample point. Then documentation for the sample location will require location (latitude/longitude and address if available) and name of well owner. Photographic documentation is also required. The subsequent sample name will be a *pseudo* state well number derived from the well location and owner name. For example,

> The unique identifier for a sample taken from the Mary Smith residence in San Antonio, a private well with no state well registration number and located in Bexar County (abbreviation AY) at state well grid location 68-23-8, would be AY-68-23-8MS.

When wells of this type are sampled, proper documentation to include collection location, sample name, sample parameters, date, and time is extremely important and will be recorded in the field log for cross reference to the COC.

4.4.2 Sample Identification, for EAHCP Samples

For samples collected under the EAHCP, sample names are designed to provide additional data regarding sample type. Specifically the sample name will indicate the sample as an EAHCP-related sample, the spring group (Comal or San Marcos), sample type (surface water, stormwater, or sediment), and sample location. In the example below, the sample name refers to an EAHCP sample at Comal Springs, collected for surface water, at location 10. Sample locations are noted on the sample-collection maps for the EAHCP (included in Appendix A with calendar year 2013 non-EAHCP sample locations.



4.4.3 Sample Identification, QA/QC

For QA/QC samples, a modifier is added to the sample name to indicate the QA/QC type, for example, DX-68-23-301 (Comal Spring 1). If an MS/MSD sample were collected, a separate set of samples named DX-68-23-301MS/MSD would be collected. The appropriate modifier for each QA/QC sample is listed in Table 4-4.

Table 4-4. QA/QC Sample Nomenclature

Sample Type	Modifier
Matrix spike/matrix spike duplicate	MS/MSD*
Ambient blank	AB#
Equipment blank	EB#
Trip blank	TB#
Duplicate	FD*
Replicate	FR*

* Requires sample, with same sample name as parent + modifier at end.

Numerical suffix to be attached and referenced in laboratory notebook; suffix starts at 1 at beginning of each calendar year. Details for location, etc. included in field notebook documentation.

4.5 SAMPLE CUSTODY

All samples shipped to the analytical laboratory must have proper custody documentation. One person on each sampling team is to have primary responsibility for sample custody (generally the lead sampler). This person will be designated as the *sample custodian* for sample collection. A person has custody of a sample group if samples are (1) in his/her possession, (2) in his/her view after being in his/her possession, (3) placed in a secure area by the sample custodian.

Furthermore, the laboratory COC form is to be filled out completely by the sample custodian in the field. The form must contain all required information for proper sample identification (if not preprinted) and must contain appropriate signatures. In addition, samples must remain in control of the sample custodian. Once collected, samples must be under the supervision of the sample custodian or secured in a manner such that no reasonable chance of unauthorized access to the samples exists. Furthermore, samples shipped by a common courier (i.e., Federal Express), require that the sample custodian note on the COC when the samples were released to the courier and why. The contracted analytical laboratory will sign the COC upon receipt. A breach of sample custody can invalidate the defensibility of the sample set.

4.6 DATA VALIDATION

Analytical data require review in order to be validated prior to publication. The amount of review (or level of review) is a function of the sample type. Field-collected data results are reviewed in the field by the analyst. One of the best ways for the field analyst to assess the acceptability of field data and subsequently validate them is to compare the results with historical data. This comparison, combined with proper equipment calibration, maintenance, and analytical technique, will provide an adequate validation process for field-parameter data. In the event that the analyst finds a discrepancy in the field data, a second analysis for the parameter in question should be performed. If the analyst feels that the data may be inaccurate because of issues with the field analysis, this fact is to be noted on the sample field sheet.

Contract analytical-laboratory data will receive a 100% analyst review at the analytical laboratory prior to posting of analytical results. A subsequent analytical laboratory review by the QA/QC section is required prior to the analytical laboratory’s certification of the results. A subsequent 10% review by EAA staff of the analytical data is required upon receipt of the final analytical report. The analytical report will contain numerical analytical results for the laboratory QA/QC samples (i.e., LCS, method blanks, etc.). These laboratory analytical data are to have data flags assigned by the analytical laboratory.

SECTION 5

FIELD PROCEDURES AND SAMPLE COLLECTION

Possibly the most significant part of any successful sample collection is the field procedures and documentation that occur in the field. Field procedures to include sample equipment decontamination; sample-collection procedures for well, spring, surface water, and sediment samples; a listing of potential sources of contamination; and the proper use of field notebooks are included in this section.

5.1 RESPONSIBILITIES

The CTO and hydrogeology supervisor for the data-collection program will ensure that the samples obtained represent the environment being investigated. The hydrologic data coordinator will ensure that all field crews are provided with the necessary information, equipment, and supplies to successfully schedule and complete sampling. The hydrologic data coordinator will also be the primary point of contact between the contract analytical laboratory project manager and the EAA sampling team(s). The hydrologic data coordinator will report sampling deviations to the CTO and hydrogeology supervisor. Sample-collection staff (generally, environmental science technicians) are responsible for being familiar with the instructions provided in this SOP and for collection of samples in accordance with this SOP. For most sample-collection events, a sample team of two people will be utilized. Teams will have a lead sampler (according to experience level) who is directly responsible for adherence to directives of the SOP.

5.2 EQUIPMENT DECONTAMINATION

In order to obtain samples that are reliable and defensible, all (nondisposable) sample-collection equipment must be decontaminated prior to use. When possible, sample collection from a wellhead valve directly to a sample container is best. When this kind of collection is not possible, disposable equipment is preferable.

If neither option is plausible, then nondisposable sample-collection devices (constructed of Teflon® when possible) must be used. Sampling equipment that is exposed directly to sample media (pumps, peristaltic or submersible pump tubing, reusable bailers, or other devices) will be washed in a nonphosphate, laboratory-grade detergent such as Alconox®, followed by a double rinse in potable water. A final rinse of deionized or distilled water will be applied after completion of the initial decontamination process.

Equipment that will not be used immediately must be kept clean by wrapping in aluminum foil or placed inside clean plastic bags. Such storage will prevent contamination of the equipment prior to use. See Appendix G for additional detail regarding equipment-decontamination procedures.

5.3 SOURCES OF SAMPLE CONTAMINATION

Samples can easily become contaminated during the sample-collection process. It is the responsibility of the sampler to prevent contamination from occurring. A multitude of potential cross-contamination sources are present in the field environment. Because many of the analytical methods used can quantify various analytes in parts per billion or less, even minute sources can potentially contaminate a sample. For example, Table 5-1 summarizes some of the potential sources that can cause a false-positive reading in a sample. These should be considered when samples are collected in the field. Also note that water has a strong affinity for many anthropogenic compounds. Use of good judgment is another aspect of collecting defensible data. Steps should be taken to avoid cross-contamination of samples. If the sampler suspects the possibility of cross-contamination, he/she should note it in the field log for the sample set in question, or the site should be sampled again if necessary.

Table 5-1. Potential Sources of Cross-Contamination

Source	Possible Contaminant
Fuels—generators, work vehicles	BTEX/TPH/VOC/SVOC
Exhaust fumes—generators, vehicles, heavy roadway traffic, overhead air traffic	BTEX/TPH/VOC/SVOC
Oil/grease residue on tools, gloves, etc.	TPH/SVOC
Tape	VOC
Insect spray	VOC/SVOC/pesticides
Insect repellent	SVOC/VOC/pesticides
Sunscreen	VOC/SVOC/ PPCP
Soil/debris	Bacteriological/metals/SVOCs
Foods/drinks/medications and other personal care products such as soap, makeup, deodorant, etcetera.	PPCPs

5.4 FIELD NOTEBOOKS

The field notebook is a legal document and should be treated as such. All pertinent site information should be in the notebook, including site name, weather information, site conditions, well condition (if applicable), equipment problems, sample-collection notes such as approximate sample times, and any other information that may be deemed valuable. The names of individuals on the sample team, as well as visitors to the site, should also be recorded in the notebook. All information recorded in the field notebook should follow the format described herein. No blank spaces are to be left on pages. All blank areas should be marked through with a single line and initialed by the author. The top of each page should have the date and sample site. The base of each page should contain the initials of the author. Mistakes are to be crossed out with a single line and initialed. Field notebooks are to be recorded in black ink only.

5.5 SAMPLE COLLECTION

Field personnel must wear clean (disposable) nitrile gloves during the sample-collection process. Generally samples for field water quality parameters are to be collected first, followed by VOC, SVOC, and metals samples. Any required information is to be recorded in the field notebook before, during, and after sampling.

5.5.1 Well Samples

Each well must be gauged and sounded (if possible). The general condition of the well will be noted in the field notebook. After the water level is gauged, the purge volume for the well will be calculated by the following equation,

$$V = H \times F,$$

where V is one well volume, H is the difference between depth of the well and depth to water in feet (i.e., length of water column in well), and F is the number of gallons per foot of water for the well size (Table 5-2).

Table 5-2. Well-Casing Volume in Gallons per Foot

Casing Diameter (in inches)	F (gallons per foot of water in well)
2	0.16
4	0.65
6	1.47
8	2.6
10	4.1
12	5.9
16	10.4

The relationship $F = \pi (D/2)^2 \times 7.48$ gallons/ft^3 can be used to calculate pipe volumes not listed in the table. Note that D = pipe diameter in feet and F = volume per foot.

A well may be sampled upon achieving *one* of the following: a minimum of three well volumes are purged from the well or field-parameter readings are stabilized for a minimum of three parameter measurements. Wells that go dry prior to purging the three well volumes, or the field-parameter readings have not stabilized, shall be purged to dryness (except for drinking-water supply or irrigation wells). During purging, water will be monitored for the following field parameters: *temperature, pH, DO, conductivity, and turbidity.*

Stabilization is defined as

- Temperature fluctuations limited to ±1° C,
- pH fluctuations ±0.1 unit,
- DO fluctuations ± 0.3 milligrams per liter (mg/L),
- Conductivity fluctuations ±5%, and
- Turbidity ±10 NTU.

In the event that these parameters do not stabilize (after purging of three well volumes), a maximum of six well volumes will be purged prior to sample collection (if the field parameters stabilize at any point, the well is considered ready to sample, and purging may cease). Once the well has stabilized or the maximum purge volume is reached, and the well has recovered to at least 80% of its initial level, it is ready to sample.

5.5.2 Spring Samples

Springwater samples should be as representative of the actual water issuing forth from the spring as possible and not be “contaminated” by surrounding surface waters. As such, various sample-collection techniques may be necessary. For spring orifices located below surface water, samplers should use a peristaltic pump to collect the springwater sample by placing the intake part of the pump tubing in the spring orifice. This placement allows for filling of sample bottles without introducing surface waters or overflowing the bottles and losing any preservatives inside. This technique is not feasible or necessary for all spring sites but should be utilized as appropriate. When a spring that can be sampled without a pump is being sampled, then a typical grab sample may be collected. In some cases (high flow volume) it may be necessary to collect samples in a clean bottle (such as a clean 1,000-mL amber glass bottle, clean Teflon beaker, or something similar) and the container used to transfer water into subsequent containers. Doing so will prevent the loss of any preservatives that may be in sample bottles. However, the action should be performed with as little agitation to the sample as possible to preserve potential VOCs in the parent sample.

Note: If preservatives in the sample container are diluted or lost because of the collection technique, a new bottle should be used. If a new bottle is unavailable, the lack of preservatives must be communicated to the laboratory to ensure that the sample remains valid by being analyzed within the appropriate hold time.

Current information and observations concerning springflow at the time of sample collection should be entered in the field notebook. For example, approximate springflow volume (can be listed as low, medium, high) is the flow representative of an extreme volume (high or low); observed water quality should be noted (clear, cloudy, or murky), along with other observations deemed appropriate by the lead sampler.

5.5.3 Surface Water Samples

Surface water samples should be collected without disturbing the sediment, if at all possible. The presence of sediment in the sample may bias the results. Samples should be collected from the flowing parts of the stream on the upstream side of the sample collector. Samples are not to be collected from stagnant areas, and they should also be taken from approximately the same location for each sample event. Sample bottles should be filled by collecting the water sample in a clean bottle or by using a peristaltic pump and transferred into the final sample bottle. Caution should be used to prevent overfilling of the sample bottle and diluting any preservatives that may be in the bottle.

Note: If preservatives in the sample container are diluted or lost because of the collection technique, a new bottle should be used. If a new bottle is unavailable, the lack of preservatives must be communicated to the laboratory to ensure that the sample remains valid by being analyzed within the appropriate hold time.

Information regarding the sample point in the stream, streamflow, and water conditions, as well as other information deemed appropriate by the sampler, should be entered into the field notebook at the time of sample collection.

5.5.4 Sediment Samples

Sediment samples are scheduled for collection by the EAHCP sampling program. Furthermore, the possibility exists that EAA staff may be required to collect samples of this type on occasion for other programs. As such, a brief discussion of this type of sample is included herein. Sediment samples may be collected from below the water line, from a dry stream bed, or from any other source in which sediments or soils may collect. The collection technique will depend on conditions. For example, a push tube for collection of sediments below the water surface is generally needed. However, if sediments are being collected from a dry area, then they may be collected using a trowel, hand auger, or push tube of some type. As with all sediment/soil-related samples, VOC samples must be collected in a manner that will minimize the loss of in situ volatiles. As such, sediment samples for VOC analysis will not be composited or homogenized in the field. Samples for VOC analysis are to be collected first.

In the event that the discreet-interval sediment sampler is used for collection of sediments, the procedure for device operation is as follows:

1. Insert the lower-half of the lead internal rod using a ⅜-inch coupler (first stage) into the internal drive tip. Pull down on the brass ring, push the grooved end of the lead internal rod into the recess, and gently release the brass ring.
2. Insert the internal drive tip and lead internal-rod assembly into the external drive tip.
3. Connect the upper lead internal rod using the ⅜-inch coupler (second stage) to the lower lead internal rod (first stage).
4. Insert a four-ft liner, with the hole in the liner oriented to the top, into the sample tube (the sample tube has a two-inch outside diameter and consists of two parts, a double female lead section and a male × female extension). If the EAA staff chooses to use a two-ft liner instead of a four-ft liner, the process is the same, except that the male × female upper extension is not used.
5. Insert a plastic core catcher (white) in the bottom of the sample tube, with the dome pointing toward the top.
6. Insert the internal drive tip/external drive tip assembly into the sampler tube.
7. Insert the metal core catcher into the top of the main sampler tube, with the dome pointing upward.
8. Install the internal tip chamber to the top of the main sampler tube.
9. Install the top drive head adapter to the top of the internal tip chamber.
10. Install the thread protector cap or internal rod with external drive extensions (if using 1⅛ × 3 ft external extensions with ⅜-inch internal rods, place a ⅜-inch coupler on the top of the internal rods prior to installing the top drive head adapter). Install the thread protector cap at the top of the internal rod prior to connecting the vented drive head (install the correct number of internal/external extensions necessary to lower the sampler to the surface and arrive at the desired sampling point).
11. Install the vented hammer adapter, already attached to the slide hammer.

The field notebook will note details related to the sediment samples; for example, was the sediment dry or below water, how was it collected, was it discolored, at what depth (from the surface) was the sample collected? If sediments are field screened with a photoionization detector (PID), readings from the various intervals will be recorded. Other details will be recorded as deemed appropriate by the sampler.

Also, if a hand trowel is used, it must be constructed of stainless steel, and it must be decontaminated prior to each use. For sites at which multiple samples will be collected, multiple hand trowels may be used, or a single trowel may be used if it is decontaminated in the field (Alconox wash, double rinse in potable water, followed by a DI water rinse).

5.5.5 Stormwater Samples

Stormwater samples are scheduled for collection under the EAHCP program at each spring group, twice annually. Stormwater sample collection offers additional challenges and safety issues, as compared with that of other samples collected under EAA programs. This section provides a general summary of stormwater sampling, additional detail regarding this sample type being provided in Appendix F.

Stormwater samples are scheduled for collection across three points on the storm hydrograph. One sample collected from the initial rise on the hydrograph, a second sample from the peak area of the hydrograph, and a final sample along the recession limb of the graph. In addition, water quality parameters obtained from EAA-installed real-time water quality monitors, flow data from the U.S.G.S. springs gauges, and local weather radar maps will be used to define the behavior of the systems and help guide sample-collection timing. The real-time monitors collect data at 15-minute intervals for conductivity, DO, pH, temperature, and turbidity.

A stormwater event will be dictated by a rainfall event sufficient to cause a significant rise in springflow at either Comal or San Marcos springs. The significant rise in springflow is to be further defined in conjunction with real-time data systems. See Appendix F for details on stormwater sampling procedures.

SECTION 6

ANNUAL REVIEW OF PLAN

6.1 ANNUAL REVIEW OF GROUNDWATER QUALITY PLAN

Data collection described in this plan will be reviewed by May 31 each year. The review will be directed at ensuring that all data collection herein is necessary, properly performed, and properly staffed. Furthermore, the review will ascertain whether the methodologies in use remain appropriate for their intended purpose. The review process will include all sample types and programs, as well as methods used to collect and analyze these samples.

Postreview, modifications will be made, if needed, to accommodate changes to EAA sampling. Changes will be imitated by the management and staff of the EAA Aquifer Science Team.

SECTION 7

CONTINUING EDUCATION CREDITS FOR SAMPLE-COLLECTION PERSONNEL

7.1 CONTINUING EDUCATION

Staff members assigned to sample-collection teams must attain a minimum of 12 hours of continuing education each year. Opportunities for continuing education will be provided either in-house by the EAA, or, in some cases, staff may be sent to an offsite facility to attend a class. One hour of credit is considered to be one classroom or contact hour. Staff may also carry credits over into the following year if more than 12 hours of credit are obtained in a calendar year. It is the responsibility of each staff member to document his/her credit hours annually and submit them to the hydrogeology supervisor by December 1 of each year.

SECTION 8

REFERENCES CITED

AFCEE, 2001, Quality Assurance Project Plan, Version 3.1: Air Force Center for Environmental Excellence, Brooks AFB, Texas.

EAA, 2012, Water Quality Monitoring Program Strategy for Comal Springs and San Marcos Springs in Support of the Edwards Aquifer Habitat Conservation Plan.

SARA, 2013, Watershed Monitoring, San Antonio River Authority.

U.S. EPA, 2000, EPA QA/G-4, Guidance for the Data Quality Objectives Process.

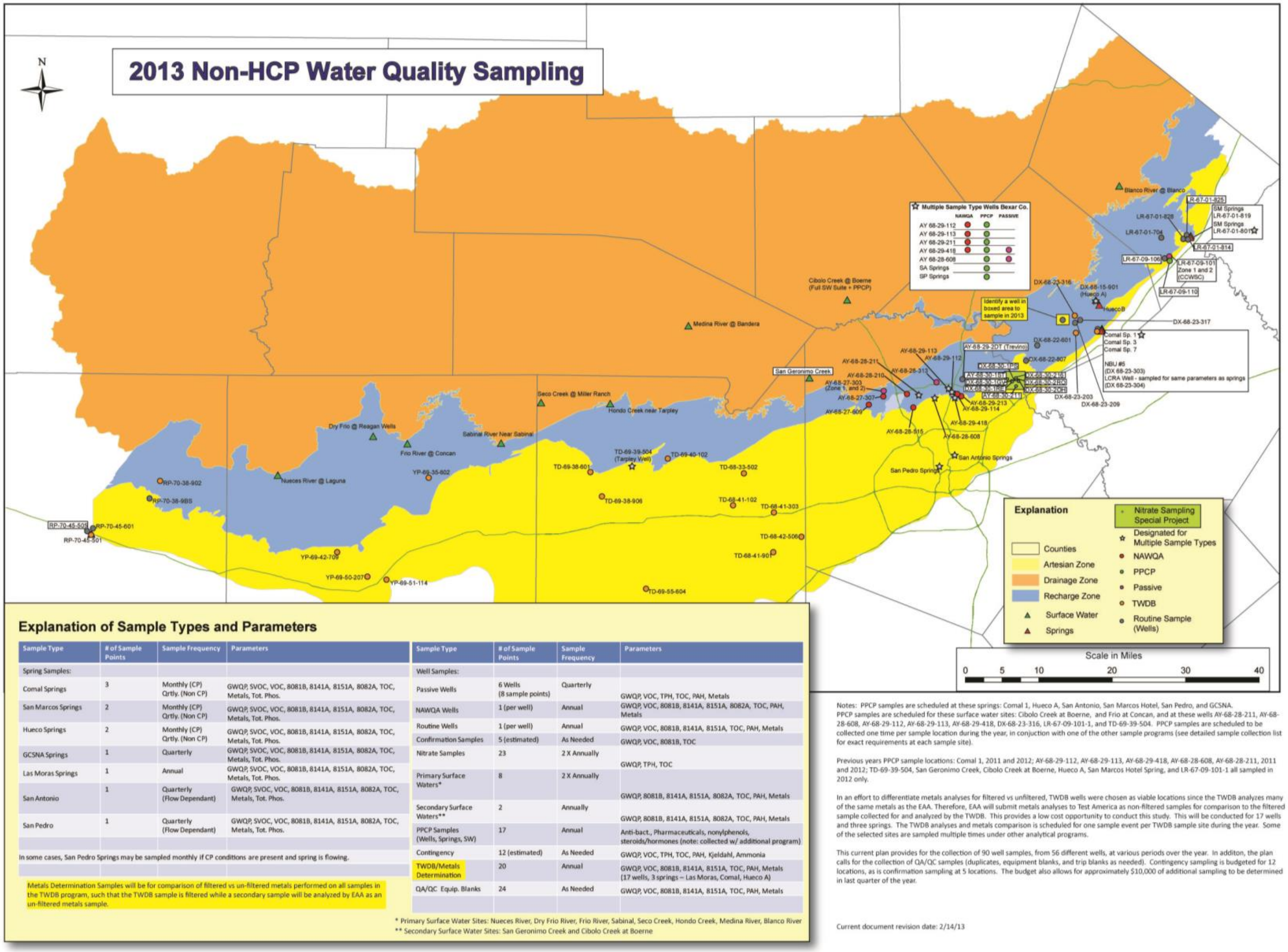
SECTION 9

REFERENCES NOT CITED

Driscoll, F.G., 1995, Groundwater and Wells: St. Paul, Johnson Screens, 1089 p.

Nielsen, D.M., 2006, Environmental Site Characterization and Ground-Water Monitoring: New York, Taylor and Francis, 1318 p.

APPENDIX A—Sample Locations (2013)



2013 Non-HCP Water Quality Sampling

Explanation of Sample Types and Parameters

Sample Type	# of Sample Points	Sample Frequency	Parameters
Spring Samples:			
Comal Springs	3	Monthly (CP) Qrtly. (Non CP)	GWQP, SVOC, VOC, 8081B, 8141A, 8151A, 8082A, TOC, Metals, Tot. Phos.
San Marcos Springs	2	Monthly (CP) Qrtly. (Non CP)	GWQP, SVOC, VOC, 8081B, 8141A, 8151A, 8082A, TOC, Metals, Tot. Phos.
Hueco Springs	2	Monthly (CP) Qrtly. (Non CP)	GWQP, SVOC, VOC, 8081B, 8141A, 8151A, 8082A, TOC, Metals, Tot. Phos.
GCSNA Springs	1	Quarterly	GWQP, SVOC, VOC, 8081B, 8141A, 8151A, 8082A, TOC, Metals, Tot. Phos.
Las Moras Springs	1	Annual	GWQP, SVOC, VOC, 8081B, 8141A, 8151A, 8082A, TOC, Metals, Tot. Phos.
San Antonio	1	Quarterly (Flow Dependant)	GWQP, SVOC, VOC, 8081B, 8141A, 8151A, 8082A, TOC, Metals, Tot. Phos.
San Pedro	1	Quarterly (Flow Dependant)	GWQP, SVOC, VOC, 8081B, 8141A, 8151A, 8082A, TOC, Metals, Tot. Phos.

In some cases, San Pedro Springs may be sampled monthly if CP conditions are present and spring is flowing.

Metals Determination Samples will be for comparison of filtered vs un-filtered metals performed on all samples in the TWDB program, such that the TWDB sample is filtered while a secondary sample will be analyzed by EAA as an un-filtered metals sample.

Sample Type	# of Sample Points	Sample Frequency	Parameters
Well Samples:			
Passive Wells	6 Wells (8 sample points)	Quarterly	GWQP, VOC, TPH, TOC, PAH, Metals
NAWQA Wells	1 (per well)	Annual	GWQP, VOC, 8081B, 8141A, 8151A, 8082A, TOC, PAH, Metals
Routine Wells	1 (per well)	Annual	GWQP, VOC, 8081B, 8141A, 8151A, TOC, PAH, Metals
Confirmation Samples	5 (estimated)	As Needed	GWQP, VOC, 8081B, TOC
Nitrate Samples	23	2 X Annually	GWQP, TPH, TOC
Primary Surface Waters*	8	2 X Annually	GWQP, 8081B, 8141A, 8151A, 8082A, TOC, PAH, Metals
Secondary Surface Waters**	2	Annually	GWQP, 8081B, 8141A, 8151A, 8082A, TOC, PAH, Metals
PPCP Samples (Wells, Springs, SW)	17	Annual	Anti-bact., Pharmaceuticals, nonylphenols, steroids/hormones (note: collected w/ additional program)
Contingency	12 (estimated)	As Needed	GWQP, VOC, TPH, TOC, PAH, Kjeldahl, Ammonia
TWDB/Metals Determination	20	Annual	GWQP, VOC, 8081B, 8141A, 8151A, TOC, PAH, Metals (17 wells, 3 springs – Las Moras, Comal, Hueco A)
QA/QC Equip. Blanks	24	As Needed	GWQP, VOC, 8081B, 8141A, 8151A, TOC, PAH, Metals

* Primary Surface Water Sites: Nueces River, Dry Frio River, Frio River, Sabinal, Seco Creek, Hondo Creek, Medina River, Blanco River
** Secondary Surface Water Sites: San Geronimo Creek and Cibolo Creek at Boerne

Notes: PPCP samples are scheduled at these springs: Comal 1, Hueco A, San Antonio, San Marcos Hotel, San Pedro, and GCSNA. PPCP samples are scheduled for these surface water sites: Cibolo Creek at Boerne, and Frio at Concan, and at these wells AY-68-28-211, AY-68-28-608, AY-68-29-112, AY-68-29-113, AY-68-29-418, DX-68-23-316, LR-67-09-101-1, and TD-69-39-504. PPCP samples are scheduled to be collected one time per sample location during the year, in conjuction with one of the other sample programs (see detailed sample collection list for exact requirements at each sample site).

Previous years PPCP sample locations: Comal 1, 2011 and 2012; AY-68-29-112, AY-68-29-113, AY-68-29-418, AY-68-28-608, AY-68-28-211, 2011 and 2012; TD-69-39-504, San Geronimo Creek, Cibolo Creek at Boerne, Hueco A, San Marcos Hotel Spring, and LR-67-09-101-1 all sampled in 2012 only.

In an effort to differentiate metals analyses for filtered vs unfiltered, TWDB wells were chosen as viable locations since the TWDB analyzes many of the same metals as the EAA. Therefore, EAA will submit metals analyses to Test America as non-filtered samples for comparison to the filtered sample collected for and analyzed by the TWDB. This provides a low cost opportunity to conduct this study. This will be conducted for 17 wells and three springs. The TWDB analyses and metals comparison is scheduled for one sample event per TWDB sample site during the year. Some of the selected sites are sampled multiple times under other analytical programs.

This current plan provides for the collection of 90 well samples, from 56 different wells, at various periods over the year. In additon, the plan calls for the collection of QA/QC samples (duplicates, equipment blanks, and trip blanks as needed). Contingency sampling is budgeted for 12 locations, as is confirmation sampling at 5 locations. The budget also allows for approximately $10,000 of additional sampling to be determined in last quarter of the year.

Current document revision date: 2/14/13

Comal Springs HCP Related Sample Points

Analytical Parameter List (HCP)

Surface Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals
Storm Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals
Sediment = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Metals

Notes:
Pesticides = Organochlorine and Organophosphorus;

GWQP = Alkalinity, Bicrbonate, Carbonate, Ca, Mg, Na, K, Chloride, Sulfate,
F, Si, Sr, Bromide, Nitrate (as N), pH, TDS, and TSS; as applicable.

Surface water samples collected twice annually.
Storm water samples collected twice annually.
Sediment samples at designated locations in first sample year.

Explanation

★ Surface Water and Sediment Sample Location
● Storm Water Sample Location
● Potential Well Sample Location for Extreme Low Flow Scenarios
★ Surface Water, Storm Water and Sediment Sample Location
▭ Real Time (Continuous) Water Quality Station Location

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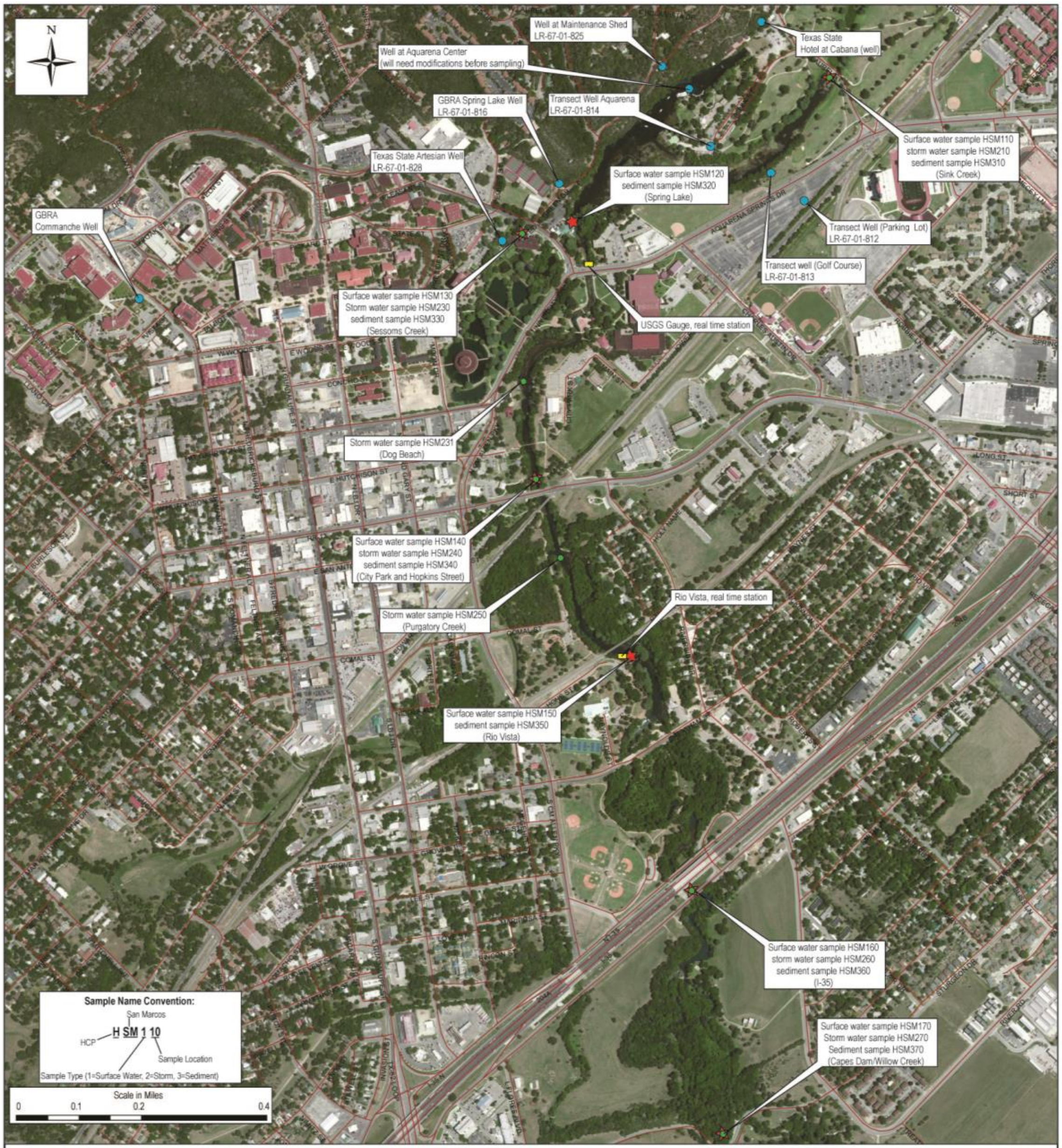

San Marcos Springs HCP Related Sample Points

Analytical Parameter List (HCP)

Surface Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals
Storm Water = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Kjeldahl, Metals
Sediment = GWQP, VOC, SVOC, Pesticides, Herbicides, PCBs, Tot. Phos., TOC, DOC, Metals

Notes:
Pesticides = Organochlorine and Organophosphorus;

GWQP = Alkalinity, Bicrbonate, Carbonate, Ca, Mg, Na, K, Chloride, Sulfate, F, Si, Sr, Bromide, Nitrate (as N), pH, TDS, and TSS; as applicable.

Surface water samples collected twice annually.
Storm water samples collected twice annually.
Sediment samples at designated locations in first sample year.

Explanation

★	Surface Water and Sediment Sample Location
●	Storm Water Sample Location
●	Potential Well Sample Location for Extreme Low Flow Scenarios
★	Surface Water, Storm Water and Sediment Sample Location
▬	Real Time (Continuous) Water Quality Station Location

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APPENDIX B—Glossary of Terms

Ambient blank	Sample known not to contain target analytes, which are used to assess airborne contaminants at the site. The ambient blank [AB] is

	opened at the site and exposed to site (ambient) conditions and subsequently treated as an environmental sample thereafter. AB samples are applicable to VOC analysis only.
Anion	Negatively charged ion.
Aquifer	Underground geological formation or group of formations containing water; source of groundwater for wells and springs.
Cation	Positively charged ion.
DOC	Abbreviation for dissolved organic carbon, a broad classification of organic molecules of varied origin and composition within aquatic systems. Organic carbon compounds are a result of decomposition processes from dead organic matter, such as plants.
DQO	Abbreviation for data quality objectives, a process used to develop performance and acceptance criteria or data quality objectives that clarify study objectives, define the appropriate type of data, and specify tolerable levels of data needed to support decisions.
Equipment blank	Sample used to assess the effectiveness of the decontamination process on sampling equipment. The equipment blank is prepared by pouring reagent-grade water over/through sampling equipment and analyzing for parameters of concern (to match the sampling routine applicable to the site).
Field duplicate	Second sample collected simultaneously from the same source as the parent sample, but which is submitted and analyzed as a separate sample. This sample should generally be identified such that the laboratory is unaware that it is a field duplicate.
Field replicate	Sometimes referred to as a *split sample*, a single sample divided into two (or more) samples.
Groundwater	Water found beneath Earth's surface that fills pores between materials, such as sand, soil, or gravel.
Initial rise	Initial surface runoff of a rainstorm. During this phase, water pollution entering storm drains in areas with high proportions of impervious surfaces is typically more concentrated during first flush than it is during the remainder of the storm.

Matrix spike	Sample used to determine the effect of the matrix on a method’s recovery efficiency. A known amount of the target analyte is added to a specified amount of matrix sample for which an independent estimate of the target analyte concentration is available. Duplicate samples must be available as well (matrix spike duplicate, or MSD).
MDL	Abbreviation for method detection limit, minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero, as determined from analysis of a sample containing the analyte in a given matrix.
Peak	Maximum instantaneous flow at a specific location resulting from a given storm condition.
PQL	Abbreviation for practical quantitation limit, which is the smallest concentration of the analyte that can be reported with a specific degree of confidence.
Precision	State or quality of being precise; exactness. The ability of a measurement to be consistently reproduced.
Purge	To remove standing water in a well.
Recession	End of runoff event, which is defined as the point in time when the recession limb of the hydrograph is <two% of the peak or is within ten % of the prestorm base flow, whichever is greater.
Recharge zone	Where an aquifer is replenished with water by the downward percolation of precipitation through soil and rock.
Representative	Said of samples collected that are similar to those of groundwater in its in situ condition.
RL	Abbreviation for reporting limit [RL], the smallest concentration of an analyte reported by the laboratory to a customer. The RL is never less than the PQL and is generally twice the MDL.
Spike sample	One of any known concentrations of specific analytes that have been added to minimize change in the matrix of the original

	sample. Every spike sample analyzed should have an associated reference to the spike solution and the volume added.
Spring	Water coming naturally out of the ground.
Surface water	That which forms and remains above ground, such as lakes, ponds, rivers, streams, bays, and oceans.
SVOC	Abbreviation for semivolatile organic compounds, which is a group of chemicals composed primarily of carbon and hydrogen that have a tendency to evaporate (volatilize) into the air from water or soil. Some of the compounds that make up asphalt are examples of SVOCs.
TDS	Abbreviation for total dissolved solids, or the total amount of all inorganic and organic substances, including minerals, salts, metal, cations, or anions that are dispersed within a volume of water.
Temporal	Over a period of time.
TKN	Abbreviation for total kjeldahl nitrogen, which is the total concentration of organic and ammonia nitrogen in wastewater.
TOC	Abbreviation for total organic carbon, which is the gross amount of organic matter found in natural water. Suspended-particulate, colloidal, and dissolved organic matter are part of the TOC measurement. Settable solids consisting of inorganic sediments and some organic particulate are not transferred from the sample by the lab analyst and are not part of the TOC measurement.
Trip blank	Sample known to be free of contamination (for target analytes) that is prepared in the laboratory and treated as an environmental sample after receipt by the sampler. Trip blank [TB] samples are applicable to VOC analysis only.
TSS	Abbreviation for total suspended solids, which are the nonfilterable residue retained on a glass-fiber disk filter mesh measuring 1.2 micrometers after filtration of a sample of water or wastewater.
VOC	Abbreviation for volatile organic compounds, which are often used as solvents in industrial processes and are either known or suspected carcinogens or mutagens. The five most toxic are vinyl

	chloride, tetrachloroethylene, trichloroethylene, 1,2-dichloroethane, and carbon tetrachloride.
Well	Bored, drilled, or driven shaft whose purpose is to reach underground water supplies.

APPENDIX C—Equipment Use and Calibration

DOCUMENTATION PROCEDURES

All equipment maintenance and calibration must be documented in the laboratory notebook kept at the EAA Camden Building. This documentation is an important part of ensuring that data-collection results are “defensible.” Calibration details, equipment type, date, calibration statement, and sampler’s signature must appear in the book for each day that the equipment is used.

EAA currently uses the YSI 556 MPS field instrument to collect pH, DO, conductivity, and temperature at each sample point. Calibration procedures for this instrument are detailed next.

CALIBRATION PROCEDURES

Calibration Procedures for YSI 556 MPS

Accessing the Calibrate Screen

1. Press the **On/Off** key to display the run screen.
2. Press the **Escape** key to display the main menu screen.
3. Use the arrow keys to highlight the **Calibrate** selection

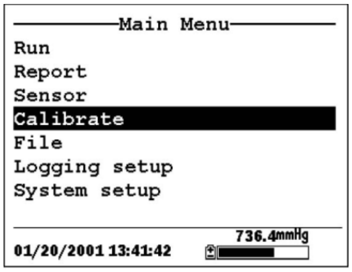


Figure 6.1 Main Menu

4. Press the **Enter** key. The Calibrate screen will be displayed.

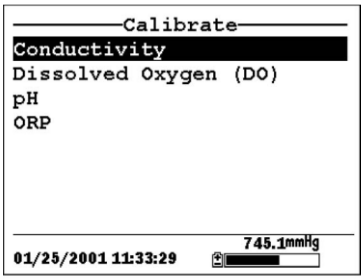


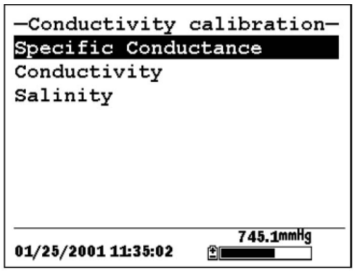
Figure 6.2 Calibrate Screen

Conductivity Calibration

This procedure calibrates specific conductance (recommended), conductivity, and salinity.

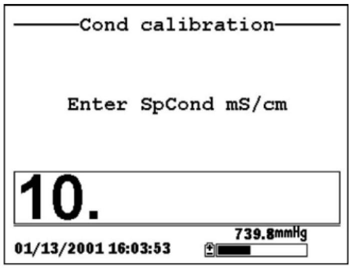
Calibrating any one option automatically calibrates the other two.

1. Go to the Calibrate screen
2. Use the arrow keys to highlight the **Conductivity** selection.
3. Press **Enter**. The Conductivity Calibration Screen is displayed.



Conductivity Calibration Selection Screen

4. Use the arrow keys to highlight the Specific Conductance selection.
5. Press **Enter**. The Conductivity Calibration Entry Screen is displayed.



Enter SpCond mS/cm

10.

Conductivity Calibration Selection Screen

6. Place the correct amount of conductivity standard into a clean, dry or pre-rinsed transport/calibration cup.

WARNING: Calibration reagents may be hazardous to health. See information on label.

NOTE: For maximum accuracy, the conductivity standard you choose should be within the same conductivity range as the samples you are preparing to measure. However, we do not recommend using standards less than one mS/cm. For example:

- For freshwater use a one-mS/cm conductivity standard.
- For brackish water use a ten-mS/cm conductivity standard.
- For seawater use a 50-mS/cm conductivity standard.

NOTE: Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the conductivity sensor with a small amount of standard that can be discarded. Be certain that cross-contamination of solutions be avoided. Make certain that no salt deposits are around the oxygen pr pH/ORP sensors, particularly if standards of low conductivity are being employed.

7. Carefully immerse the sensor end of the probe module into the solution.

8. Gently rotate and/or move the probe module up and down to remove any bubbles from the conductivity cell.

   NOTE: The sensor must be completely immersed past its vent hole. Using the recommended volumes and ensure that the vent hole is covered.

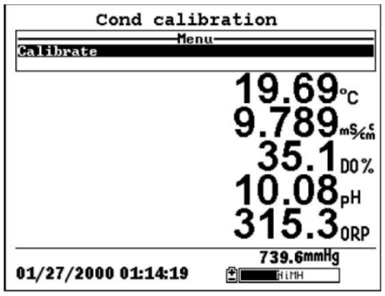
9. Screw the transport/calibration cup onto the threaded end of the probe module and securely tighten.

   NOTE: Do not over tighten because doing so could damage the threaded parts.

10. Use the keypad to enter the calibration value of the standard being used.

    NOTE: Be sure to enter the value in **mS/cm at 25°C**.

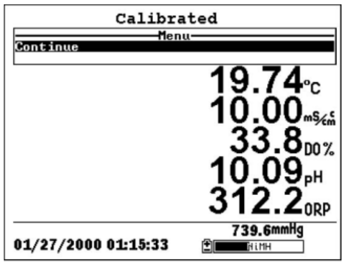
11. Press **Enter**. The Conductivity Calibration Screen is displayed.



```
19.69°C
9.789mS/cm
35.1DO%
10.08pH
315.3ORP
739.6mmHg
01/27/2000 01:14:19
```

Conductivity Calibration Screen

12. Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.
13. Observe the reading under Specific Conductance. When the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt pressing of **Enter** again to Continue.



```
19.74°C
10.00mS/cm
33.8DO%
10.09pH
312.2ORP
739.6mmHg
01/27/2000 01:15:33
```

Calibrated

14. Press **Enter** to return to the Conductivity Calibrate Selection Screen
15. Press **Escape** to return to the Calibrate menu. See Figure 6.2 Calibrate Screen.
16. Rinse the probe module and sensors in tap or purified water and dry.

Dissolved Oxygen Calibration

This procedure calibrates dissolved oxygen. Calibrating any one option (% or mg/L) automatically calibrates the other.

1. Go to the calibrate screen as described in Section *6.2.1 Accessing the Calibrate Screen*.

   NOTE: The instrument must be on for at least 10 to 15 minutes to polarize the DO sensor before calibrating.

2. Use the arrow keys to highlight the **Dissolved Oxygen** selection. See Figure 6.2 Calibrate Screen.
3. Press **Enter**. The Dissolved Oxygen Calibration Screen is displayed.

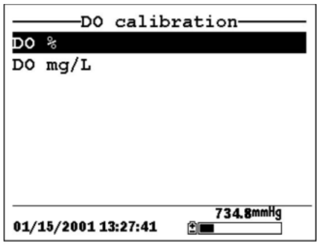
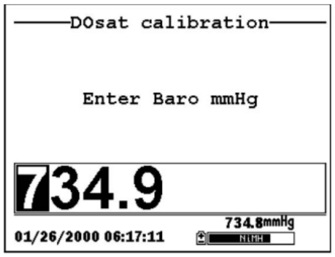


Figure 6.7 DO Calibration Screen

DO Calibration in Percent Saturation

1. Use the arrow keys to highlight the DO% selection.

2. Press **Enter**. The DO Barometric Pressure Entry Screen is displayed.


DOsat calibration

Enter Baro mmHg

734.9

Figure 6.8 DO Barometric Pressure Entry Screen

3. Place approximately 3 mm (⅛ inch) of water in the bottom of the transport/calibration cup.

4. Place the probe module into the transport/calibration cup.

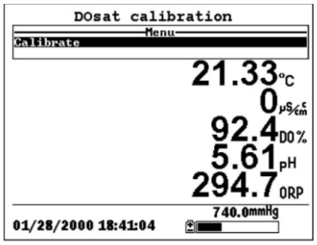
   NOTE: Ensure that the DO and temperature sensors are **not** immersed in the water.

5. Engage only one or two threads of the transport/calibration cup to ensure that the DO sensor is vented to the atmosphere.
6. Use the keypad to enter the current local barometric pressure.

   NOTE: If the unit has the optional barometer, no entry is required.

   NOTE: Barometer readings that appear in meteorological reports are generally corrected to sea level and must be uncorrected before use

7. Press **Enter**. The DO% Saturation Calibration screen is displayed.



```
DOsat calibration
Menu
Calibrate
21.33°C
0µS/cm c
92.4DO%
5.61pH
294.7ORP
740.0mmHg
01/28/2000 18:41:04
```

Figure 6.9 DO Sat Calibration Screen

8. Allow approximately ten minutes for the air in the transport/calibration cup to become water saturated and for the temperature to equilibrate before proceeding.

9. Observe the reading under DO %. When the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt pressing of **Enter** again to Continue. See Figure 6.6 Calibrated.

10. Press **Enter** to return to the DO Calibration Screen, See Figure 6.7 DO Calibration Screen.

11. Press **Escape** to return to the calibrate menu. See Figure 6.2 Calibrate Screen.

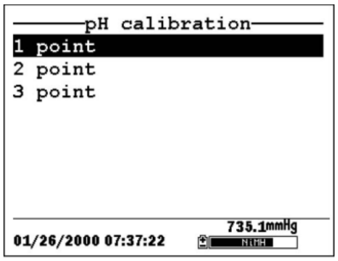
12. Rinse the probe module and sensors in tap or purified water and dry.

pH Calibration

1. Go to the Calibrate Screen as described in *Section 6.2.1 Accessing the Calibrate Screen*.

2. Use the arrow keys to highlight the **pH** selection. See Figure 6.2 Calibrate Screen.

3. Press **Enter**. The pH Calibration screen is displayed.



pH calibration
1 point
2 point
3 point

735.1mmHg
01/26/2000 07:37:22

Figure 6.12 pH Calibration Screen

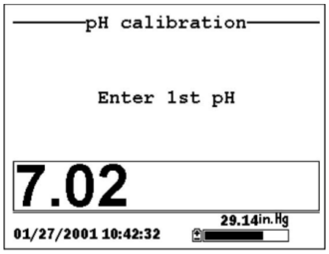
4. Select the **one-point** option only if adjusting a previous calibration. If a two-point or three-point calibration has been performed previously, the calibration can be adjusted by carrying out a one-point calibration. The procedure for this calibration is the same as for a two-point calibration, but the software will prompt a selection of only one pH buffer.

5. Select the **two-point** option to calibrate the pH sensor using only two calibration standards. Use this option if the media being monitored is known to be either basic or acidic. For example, if the pH of a pond is known to vary between 5.5 and seven, a two-point calibration with pH seven and pH four buffers is sufficient. A three-point calibration with an additional pH ten buffer will not increase the accuracy of this measurement because the pH is not within this higher range.

6. Select the **three-point** option to calibrate the pH sensor using three calibration solutions. In this procedure, the pH sensor is calibrated with a pH seven buffer and two additional buffers. The three-point calibration method assures maximum accuracy when the pH of the media to be monitored cannot be anticipated. The procedure for this calibration is the same as for a two-point calibration, but the software will prompt a selection of a third pH buffer.

7. Use the arrow keys to highlight the **two-point** selection.

8. Press **Enter**. The pH Entry Screen is displayed.



pH calibration

Enter 1st pH

7.02

29.14in.Hg
01/27/2001 10:42:32

Figure 6.13 pH Entry Screen

9. Place the correct amount (see Table 6.1 Calibration Volumes) of pH buffer into a clean, dry, or prerinsed transport/calibration cup.

NOTE: Always calibrate with buffer seven first, regardless of whether performing a one-, two-, or three-point calibration.

WARNING: Calibration reagents may be hazardous to health. See reagent label for more information.

NOTE: For maximum accuracy, the pH buffers chosen should be within the same pH range as the water being prepared for sampling.

NOTE: Before proceeding, ensure that the sensor is as dry as possible. Ideally, rinse the pH sensor with a small amount of buffer that can be discarded. Be certain to avoid cross-contamination of buffers with other solutions.

10. Carefully immerse the sensor end of the probe module into the solution.
11. Gently rotate and/or move the probe module up and down to remove any bubbles from the pH sensor.

    NOTE: The sensor must be completely immersed. Using the recommended volumes from Table 6.1 Calibration Volumes should ensure that the sensor is covered.

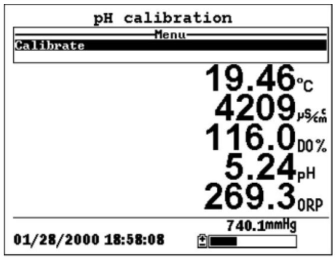
12. Screw the transport/calibration cup onto the threaded end of the probe module and securely tighten.

    NOTE: Do not overtighten because doing so could damage the threaded parts.

13. Use the keypad to enter the calibration value of the buffer being used **at the current temperature**.

    NOTE: pH vs. temperature values are printed on the labels of all YSI pH buffers.

14. Press **Enter**. The pH Calibration Screen is displayed.



19.46°C
4209μS/cm
116.0DO%
5.24pH
269.3ORP
740.1mmHg
01/28/2000 18:58:08

Figure 6.14 pH Calibration Screen

15. Allow at least one minute for temperature equilibration before proceeding. The current values of all enabled sensors will appear on the screen and will change with time as they stabilize.

16. Observe the reading under pH. When the reading shows no significant change for approximately 30 seconds, press **Enter**. The screen will indicate that the calibration has been accepted and prompt **Enter** to be pressed again to continue.
17. Press **Enter** to return to the specified pH Calibration Screen, See Figure 6.13 pH Entry Screen.
18. Rinse the probe module, transport/calibration cup, and sensors in tap or purified water and dry.
19. Repeat steps 6 through 13 using a second pH buffer.
20. Press **Enter** to return to the pH Calibration Screen. See Figure 6.12 pH Calibration Screen.
21. Press **Escape** to return to the Calibrate menu. See Figure 6.2 Calibrate Screen.
22. Rinse the probe module and sensors in tap or purified water and dry.

Return to Factory Settings.

1. Go to the Calibrate screen as described in Section *6.2.1 Accessing the Calibrate Screen*.
2. Use the arrow keys to highlight the **Conductivity** selection. See Figure 6.2 Calibrate Screen.

   NOTE: We will use the Conductivity sensor as an example; however, this process will work for any sensor.

3. Press **Enter.** The Conductivity Calibration Selection Screen is displayed. See Figure 6.3 Conductivity Calibration Selection Screen.
4. Use the arrow keys to highlight the **Specific Conductance** selection.
5. Press **Enter.** The Conductivity Calibration Entry Screen is displayed. See Figure 6.4 Conductivity Calibration Entry Screen.
6. Press and hold the **Enter** key down, and press the **Escape** key.

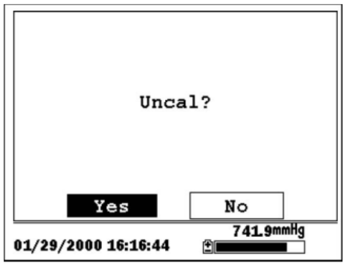


Figure 6.17 ORP Calibration Screen

7. Use the arrow keys to highlight the **YES** selection.

   CAUTION: Pressing **YES** returns a sensor to the factory settings. For example, in the selection to return specific conductance to the factory setting, salinity and conductivity will automatically return to their factory settings.

8. Press **Enter** to return you to the Conductivity Calibrate Selection Screen. See Figure 6.3 Conductivity Calibration Selection Screen. .
9. Press **Escape** to return to the Calibrate menu. See Figure 6.2 Calibrate Screen.

HACH Digital Titrator (for Alkalinity) Primary Method

Titrations are performed using the HACH digital titrator. This instrument provides precise results when properly operated.

Basic Operation

1. Select a sample volume and titration cartridge corresponding to the expected sample concentration.
2. Insert the cartridge into the titrator slide and lock it into place with the plunger. Remove the polyethylene cap from the cartridge and insert a clean delivery tube into the end of the cartridge. (Note: use a straight tube with a hook on the end for hand-held titrations and a 90° tube with a hook at the end for stationary setups.
3. To start the titrant flow, hold the tip of the cartridge upward while turning the delivery knob until the air is expelled and several drops of solution flow from the tip of the delivery tube.
4. Use the counter reset knob (the smaller of the two knobs) to set the digital counter back to zero, then blot any titrant from the delivery tube.
5. Proceed with titration by submerging the tip of the delivery tube into the sample and turning the delivery knob to dispense the titrant. (Note: during the titration process, samples must be continuously stirred either manually or with the magnetic stirrer)

Calculations

HACH titration cartridge solutions are designed to give those numbers used in the titrations (reading from the digital meter) to be actual sample concentration in mg/L, or they are marked with conversion factors. If in the process of sample preparation, the amount of SAMPLE becomes less than 100 mL, the titration number must be multiplied by the divisional factor. For example, if the intended 100-mL sample is reduced to 25 mL (¼ of 100 mL) during the sample-preparation process, then the final result must be multiplied by 4 (25 mL × 4 = 100 mL) to obtain the result.

General Maintenance

1. For long-term storage the delivery tube should be removed, the polyethylene cap reattached, and the cartridge removed from the titrator body. DO NOT attempt to remove the cartridge from the titrator without recapping.
2. After use and removal from the cartridges, rinse the delivery tubes with deionized water to prevent clogging.

The titration process should be checked monthly by titration of a standard solution and recorded in the laboratory notebook. Acceptable results are obtained if the titration is within ±3% of the standard solution.

Alkalinity Determination Using the HACH Digital Titrator

Alkalinity of water is defined by its acid-neutralizing capacity. Once a sample has been collected, geochemical changes can alter the sample's alkalinity. Therefore, alkalinity samples are to be analyzed in the field or immediately upon returning to the EAA laboratory.

Procedure

Sample alkalinity is determined by titration with sulfuric acid to a pH of 4.5 and includes all carbonate, bicarbonate, and hydroxide present within the sample. Values are recorded as mg/L calcium carbonate.

1. Follow the steps outlined in HACH digital titrator usage, with the sulfuric acid cartridge as the active titrant and the 90° delivery tube as a stationary setup.
2. Set up the HACH titrator unit and attach the digital titrator to the rotational holder and clamp securely.
3. The pH and temperature probes should also be connected to the titrastir at the end of the rotational holder. For best results, attempt to have the ends of the delivery tube, pH probe, and temperature probe at the same level.
4. Rinse a 25-mL pipette three times with deionized water and then three times with the sample water to be tested. Pipette 25 mL of this sample into a clean 50-mL beaker. Record this amount on the corresponding field sheet.
5. Place the beaker on the stir plate, put a stir bar in the beaker, and turn on the stirring function.
6. Rotate the titrastir arm toward the sample beaker, submerging the probes and delivery tube. Note: ensure that the titrator counter is reset to zero and the outside of the delivery tube is free of sulfuric acid before submerging.
7. Turn on the pH meter and record the stabilized pH reading of the sample. Record this value on the corresponding field data sheet.
8. Titrate by turning the delivery knob until the pH is reduced to 4.5, which is the endpoint, and the amount of titrant used should be recorded.
9. Calculate the alkalinity by multiplying the amount of titrant used by the dilution factor, and record on the appropriate field data sheet.

Collect a second alkalinity sample every ten samples as a field duplicate, and analyze as outlined above. The field duplicate percent difference should not exceed ±5%, where %D is defined as

$$[(X1 - X2) / X1] \times 100 = \%D \text{ (X1 = original sample, X2 = duplicate sample)}$$

(see next page for additional alkalinity procedures)

Additional Procedures for Alkalinity Analyses, University of Minnesota Methodology (to be incorporated into the EAA methodology)

Good Titration Practices

Aliquot Measurement

- Sample aliquots should be measured with the most accurate method available.
- Rinse the volumetric flask with sample water.
- Never rinse the titration flask with sample water.
- Rinse the titration flask with De-Ionized water between samples and air dry (glass) or shake dry (PMP plastic).
- An electronic balance is preferred over a volumetric flask is preferred over a graduated cylinder.
- A 0.1g scale is comparable to a volumetric flask.
- An electronic balance allows the size of sample aliquots to be varied.
- An electronic balance allows aliquot size to be reduced in high alkalinity samples which reduces titration time.

Titration Equipment

- Digital titrator should be periodically lubricated.
- Titrant cartridges must be kept tightly capped to prevent evaporation.
- Old, partially used titrant cartridges should be replaced.
- Don't try to use every drop of acid in the titrant cartridge - when it gets low start a new cartridge.
- Delivery tubes should be flushed with fresh titrant before use and rinsed after use.
- A magnetic stirrer (battery powered for field use) helps ensure thorough mixing.

Titration Procedures

- All chemical analyses should be replicated.
- Titrations are done in triplicate to allow comparison of results ensuring that reproducible results are obtained.
- Replicates that vary by more than two percent indicate interference or analytic error.
- Real time analysis of the results allows additional titrations and/or a change in procedure to identify the sources of the interference or error.
- Work consistently and quickly to limit degassing and precipitation in your sample bottle.
- Add acid uniformly to each aliquot as if performing the first titration.

Colorimetric

- Bromcresol Green / Methyl Red indicator dyes.
- pH 4.8 to 4.5 buffer solutions.
- Adding acid too quickly and incomplete equilibration will produce irregular results.
- Use buffered indicator solutions to define endpoint.
- Relies on human color interpretation.

Potentiometric

pH Endpoint

- Meter calibration is critical.
- Adding acid too quickly and incomplete equilibration will produce irregular results.
- Must allow for solution equilibration and meter stabilization.
- Uses one data point to determine endpoint.

ΔpH/Δv acid

- Must be done in uniform steps through the endpoint.
- Adding acid too quickly and incomplete equilibration will produce irregular results.
- Organics may shift endpoint.
- Uses two data points to determine endpoint.

Figure 1 shows a typical “S” shaped titration curve. The inflection point represents the true alkalinity of the sample and may not occur at exactly pH 4.5.

Gran Titration

- Uses many data points.
- Must be carried well past the endpoint.
- Requires graphical interpretation or linear regression.
- Adding acid too quickly and incomplete equilibration will produce non-linear trend.
- Presence of organics will produce non-linear trends.
- Least susceptible to operator error or chemical interference but should still be backed up by replicate measurements - replicate may be by colorimetric or potentiometric methods.

To calculate the alkalinity, use the formula ($V_{aliquot} + V_{titrant}$) x $10^{(4.65-pH)}$ to plot an ascending line after the endpoint with apparent alkalinity on the x-axis; $V_{aliquot}$ in ml, $V_{titrant}$ = titrator digits/800 and 4.65 is the assumed endpoint. A linear regression can then be used to calculate an x-intercept. Use only the points well after the endpoint to get the best regression as shown in Figure 2.

Common Interferences

- Highly colored waters
  Organic-rich waters with humic and fulvic acids.
  Often have low pH and correspondingly low alkalinity.

Solutions

Perform Gran Titration - by extrapolating from points below pH 4.5 a fairly precise determination of alkalinity can be made.

Add a second packet of indicator dye to intensify green and red colors.

- Chlorinated waters
  Color change at endpoint goes form green to yellow.

Solution: Add 5 drops and 2N Sodium Thiosulfate to scavenge any free chlorine before titrating.

- Clay-rich waters
  Colors of indicators are "off" often tending towards an orange endpoint.
  Commonly associated with poorly developed monitoring wells.

Solution: Filter the sample before titrating.

- Muddy waters
  Suspended sediment may contain carbonates or clays that could react with the acid titrant.
  Thick sediment may mask the color changes.

Solution: Filter the sample, preferably after allowing sediment to settle.

References

Determination of the Equivalent Point in Potentiometric Titrations, 1950, Gunnar Gran, Acta Chemica Scandinavica, pp 559-577.

Determination of the Equivalence Point in Potentionmetric Titrations - Part II, 1952, Gunnar Gran, The Analyst, International Congress on Analytical Chemistry, V. 77, pp 661-671.

Field Guide for Collecting and Processing Stream-Water Samples for the National Water-Quality Assessment Program, Larry R. Shelton, 1994, U.S. Geological Survey Open-File Report 94-455, 42 pp.

Field and Laboratory Methods, 1998, Scott C. Alexander and E.C. Alexander Jr., Hydrogeochemistry Lab, Dept. of Geology & Geophysics, Univ. of Minnesota, 21 pp.

EPA Method 310.1: Alkalinity determination to a colorimetric end-point.

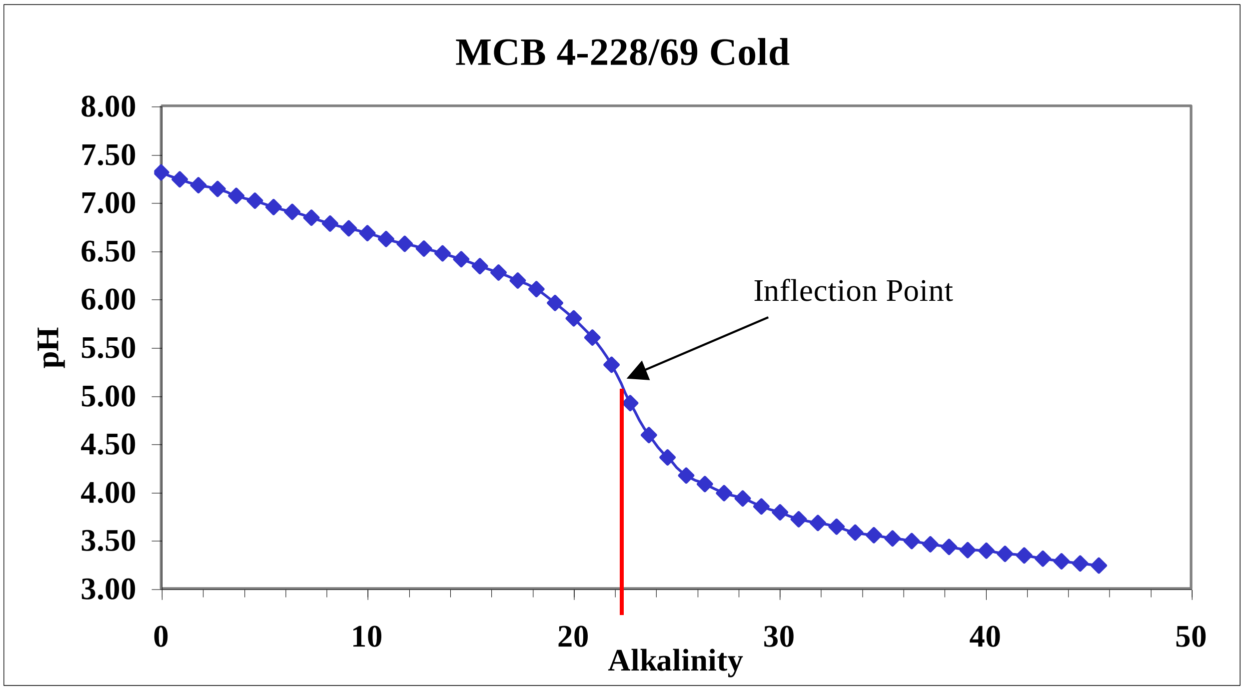


Figure 1. Example of pH titration

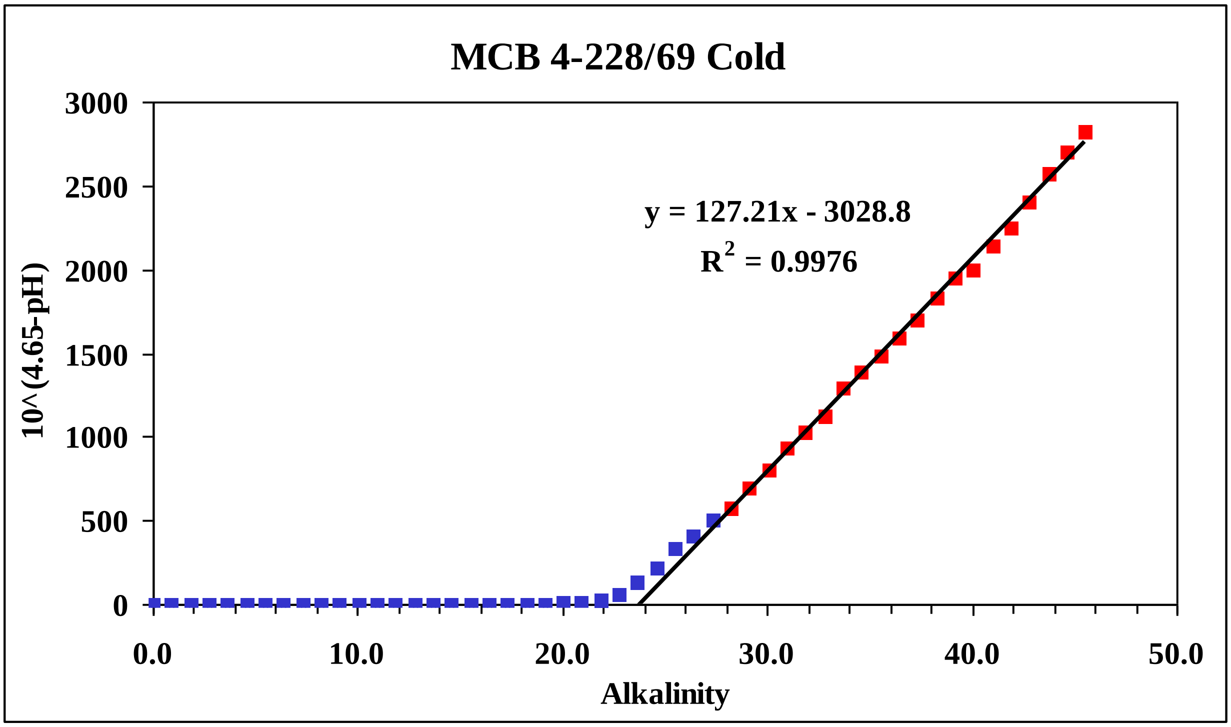


Figure 2. Example of Gran Titration

Use of the DR2800 Portable Spectrophotometer for Alkalinity Measurements (Secondary Method for Alkalinity Determination)

EAA currently uses the DR2800 Portable Spectrophotometer for measuring alkalinity values of samples in the event the Hach Digital Titrator is not available. Measurements are made at the EAA Camden building following the field sample-collection event. All measurements are to be recorded in the alkalinity notebook and on the field sheet. Operation procedures for this instrument are detailed next.

Alkalinity, Total

DOC316.53.01257

Colorimetric Method

Method 10239

25 to 400 mg/L $CaCO_3$

TNTplus™ 870

Scope and Application: For drinking water, wastewater and boiler water.

Test preparation

Before the test:

DR 2800 only: Install the light shield in Cell Compartment #2 before performing this test.

Read the safety advice and expiration date on the package.

The recommended sample and reagent temperature is 15–25 °C (59–77 °F).

The recommended reagent storage temperature is 15–25 °C (59–77 °F).

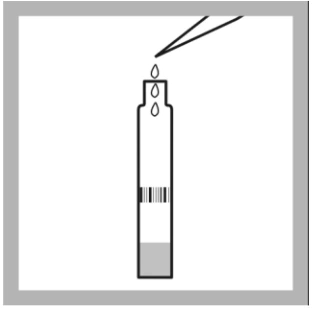
TNTplus™ methods are activated from the Main Menu when the sample vial is inserted into the sample cell holder.

Collect the following items:

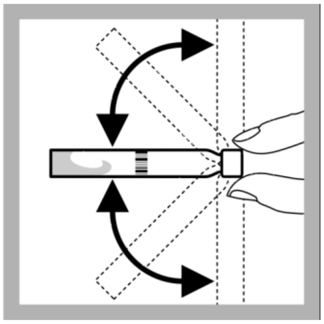
Description	**Quantity**
Total alkalinity TNT870 vials	variable
Light shield (DR 2800 only)	1
Pipette for 2.0-mL sample	1
Pipette for 0.5-mL sample	1
Pipette tips	variable

TNTplus™ method

1. Pipette 2.0 mL of **Solution A** into test vial.



2. Pipette 0.5 mL of sample into vial.



3. Cap and invert vial until contents are well mixed.

4. Wait 5 minutes.

5. After timer expires, wipe vial and insert it into cell holder. Instrument reads barcode, selects method, and make measurement. No instrument zero required.
Results are in mg/L $CaCO_3$.

Interferences

If samples contain particles, remove the particles by filtration through a 0.45-µm filter.

Sample collection, preservation, and storage

- Collect samples in clean plastic or glass bottles. Fill completely and cap tightly.
- Prevent excessive agitation or prolonged exposure to air. Complete the test procedure as soon as possible after collection for best accuracy.
- The sample can be stored for 24 h if cooled to 4 °C (39 °F) or below. Warm to room temperature before the test begins.

Accuracy check

Standard solution method
required for accuracy check:

- Alkalinity Voluette® Ampule Standard Solution, 25,000 mg/L $CaCO_3$ (0.500 N)
- Ampule breaker
- Variable-volume pipette
- Pipette tips
- 100-mL volumetric flask, Class A
- Deionized water

1. Prepare a 250-mg/L $CaCO_3$ standard solution as follows:

a. Pipette 1.0 mL of alkalinity standard solution, 25,000 mg/L as $CaCO_3$, into a clean 1.0-mL volumetric flask.

b. Dilute to the mark with deionized water. Mix well. Prepare this solution daily.

2. Use this solution in place of the sample. Follow the TNTplus™ method test procedure. The result should be within 10% of the expected value.

Summary of method

Carbonates and other buffers react with the reagent in the vial to change the pH. The pH affects the color of the indicator, which is measured photometrically at 615 nm.

Calibration Procedures for Backup Instruments

The following pages contain a discussion of proper use of "backup" instrumentation owned by the EAA, but not in regular use. These instruments may be utilized during a contingency sampling event, or in the case where newer instrumentation is not available due to damage or other issues.

Calibration Procedures for Luminescent Dissolved Oxygen Probe Model LDO10101 with HQ30d Meter

Before calibration:

The probe must have the correct service-life time stamp. Set the date and time in the meter before the probe is attached.

It is not necessary to recalibrate when moving a calibrated probe from one HQd meter to another if the additional meter is configured for the same calibration options.

To view the current calibration, push Select View Probe Data, then select View Current Calibration.

If any two probes are connected, push the **UP** or **DOWN** arrow to change to the single display mode in order to show the Calibrate option.

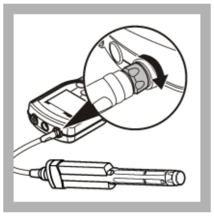
Calibration notes:

- % saturation or mg/L calibration methods are available in the Modify Current Settings menu.
- Slope value is the comparison between the latest calibration and the factory calibration shown as a percentage.
- Calibration is recorded in the probe and the data log. Calibration is also sent to a PC, printer, or flash memory stick if connected.

- Air bubbles under the sensor tip when submerged can cause slow response or error in measurement. If bubbles are present, gently shake the probe until bubbles are removed.

Water-saturated air (100%) calibration procedure:

1. Connect the probe to the meter. Ensure that the cable locking nut is securely connected to the meter. Turn on the meter.

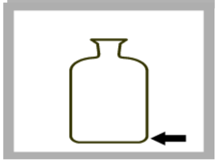


2. Push **Calibrate**.

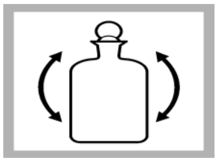
3. Push **Methods**. Select User Cal-100%. Push **OK**.

4. Rinse the probe cap with deionized water. Blot dry with a lint-free cloth.

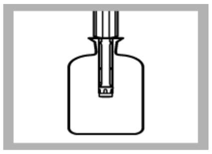
5. Add approximately ¼ inch (6.4 mm) of reagent water to a narrow-neck bottle, such as a BOD bottle.



6. Put a stopper in the bottle and shake the bottle vigorously for approximately 30 seconds to saturate the entrapped air with water. Allow up to 30 minutes for contents to equilibrate to room temperature.



7. Remove the stopper. Carefully dry the probe cap using a nonabrasive cloth. Put the probe in the bottle.



8. Push **Read**. The display shows “Stabilizing” as the probe stabilizes. The display shows the standard value when the reading is stable.

9. Push **Done** to view the calibration summary.

10. Push **Store** to accept the calibration and return the measurement mode. If a rugged probe, install the shroud on the probe.

Calibration Procedures for Conductivity Model 5197500 or 5197503 with sensION ™ 5 (Backup Instrumentation)

Before the test:

Collect samples in clean plastic or glass bottles.

Analyze samples as soon as possible after collection. However, samples may be stored at least 24 h by cooling to 4 °C (39 °F) or below (all storage temperatures have changed to 0 to 6 °C as per the EPA MUR, March 2007). When solutions are measured that are not at reference temperature, the meter automatically adjusts the conductivity value to reference temperature from 20 or 25 °C.

Water samples containing oils, grease, or fats will coat the electrode and affect the accuracy of the readings. If this coating occurs, clean the probe with a strong detergent solution, then thoroughly rinse with deionized water.

Mineral buildup on the probe can be removed with a diluted 1:1 hydrochloric acid solution. Refer to the meter user’s manual.

Calibration instructions are given in the operation section of the meter manual. For most accurate results, calibrate before use or check the accuracy of the meter using a known conductivity standard.

Calibrating with a Known Standard

1. Place the probe in a conductivity standard that is in the expected range of the samples. On the meter, choose one of four ranges that corresponds to the sample range. Agitate the probe to dislodge bubbles in the cell. Avoid resting the probe on the bottom or sides of the container.

2. Press **CAL**. Functional keys will appear in the lower-left part of the display. **CAL?** and **1.000 1/cm** will appear in the upper display. If the meter has been calibrated, the last calibration value will appear. The numeric keypad will become active.

3. Press the arrow keys to scroll to the factory-calibration options (1000 µS/cm or 18 mS/cm). To calibrate using one of these standards, press **ENTER**.

4. If using a standard with a different value, use the number keys to enter the standard conductivity at 25 °C, then press **ENTER**. The meter will automatically correct the calibration measurement to 25 °C using the NaCl-based, non-linear temperature coefficient.

   If the standard has a value of 25 °C in the µS/cm range, enter the value when 1000 µS/cm is displayed. If the standard has a value of 25 °C in the mS/cm range, enter the value when 18 mS/cm is displayed. All four places have a number entered in them. If a number entry error occurs, start over by pressing **SETUP/CE.**

5. When the reading is stable, the calibration is automatically stored, and the instrument returns to reading mode.

Calibration Procedures for Turbidimeter

Note: *for best accuracy, use the same sample cell of four matched sample cells for all measurements during calibration. Always insert the cell so that the orientation mark placed on the cell during the matching procedure is correctly aligned.*

Calibration

1. Rinse a clean sample cell with dilution water several times. Then fill the cell to the line (~15 mL) with dilution water or use StablCal <0.1 NTU standard. *Note: the same dilution water used for preparing the standards must be used in this step.*

2. Insert the sample cell in the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid, and press **I/O**. *Note: choose signal average mode option (on or off) before pressing CAL— the SIGNAL AVERAGE key in calibration mode.*

3. Press **CAL.** The CAL and S0 icons will be displayed and will flash. The four-digit display will show the value of the S0 standard for the previous calibration. If the blank value were forced to 0.0, the display would be blank (as shown.) Press → for a numerical display.

Hach Company recommends the use of StableCal ® Stabilized Formazin or formazin standards only for the calibration of Hach turbidimeters. **Hach Company cannot guarantee the performance of the turbidimeter if calibrated with co-polymer styrene divinlybenzene beads of other suspension. DO NOT calibrate with Gelex® Secondary Standards.**

4. Press **READ.** The instrument will count from 60 to 0 (67 to 0 if signal average is on), read the blank, and use it to calculate a correction factor for the 20 NTU standard measurement. If the dilution water is less than or equal to 0.5 NTU, E 1 will appear when the calibration is calculated. The display will automatically increment to the next standard. Remove the sample cell from the cell compartment. *Note: turbidity of the dilution water can be "forced" to zero by pressing → rather than reading the dilution water. The display will show S0 NTU, and the up arrow key must be pressed to continue with the next standard.*

5. The display will show the S1 (with the 1 flashing) and 20 NTU, or the value of the S1 standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key until the number that needs editing flashes. Use the up arrow key to scroll to the correct number. After editing, fill a clean sample cell to the line with well-mixed 20 NTU StablCal Standard of 20 NTU formazin standard. Insert the sample cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.

6. Press **READ.** The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity, and store the value. The display will automatically increment to the next standard. Remove the sample cell from the cell compartment. *Note: for potable water applications with low turbidity values, instrument calibration may be stopped after the 20 NTU StablCal Standard has been read. Pres* ***CAL*** *after reading the 20-NTU standard. Instrument calibration is now complete for the range of 0–20 NTU only. The instrument will continue to read turbidity values above 20 NTU. These values were not updated during the 0–20 NTU calibration.*

7. The display will show the S2 (with the 2 flashing) and 100 NTU of the value of the S2 standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key until the number that needs editing flashes. Use the up arrow key to scroll to the correct number. After

editing, fill a clean sample cell to the line with well-mixed 100 NTU StableCal Standard or 100 NTU formazin standard. Insert the sample cell into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.

8. Press **READ.** The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity and store the value. Then the display will automatically increment to the next standard. Remove the sample cell from the cell compartment.

9. The display will show the S3 (with 3 flashing) and 800 NTU, or the value of the S3 standard for the previous calibration. If the value is incorrect, edit the value by pressing the → key until the number that needs editing flashes. Use the up arrow key to scroll to the correct number. After editing, fill a clean sample cell to the line with well-mixed 800 NTU formazin standard. Insert the sample cell into the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment. Close the lid.

10. Press **READ**. The instrument will count from 60 to 0 (67 to 0 if signal average is on), measure the turbidity, and store the value. Then the display will increment back to the S0 display. Remove the sample cell from the cell compartment.

11. Press **CAL** to accept the calibration. The instrument will return to measurement mode automatically. *Note: pressing CAL completes the calculation of the calibration coefficients. If calibration errors occurred during calibration, error messages will appear after CAL is pressed. If E1 or E2 appear, check the standard preparation and review the calibration; repeat the calibration if necessary. If CAL? appears, an error may have occurred during calibration. If CAL? is flashing, the instrument is using the default calibration.*

Notes

- If the **I/O** key is pressed during calibration, the new calibration data are lost, and the old calibration will be used for measurements. Once in calibration mode, only the **READ, I/O,** ↑, and → keys function. Signal averaging and range mode must be selected before the calibration mode can be entered.

- If **E 1** or **E 2** is displayed, an error occurred during calibration. Check the standard preparation and review the calibration; repeat the calibration if necessary. Press **DIAG** to cancel the error message (**E 1** or **E 2)**. To continue without repeating the calibration, press **I/O** twice to restore the previous calibration. If **CAL?** is displayed, an error may have occurred during calibration. The previous calibration may not be restored. Either recalibrate or use the calibration as is.

- To review a calibration, press **CAL** and then ↑ to view the calibration standard values. As long as **READ** is never pressed and **CAL** is not flashing, the calibration will not be updated. Press **CAL** again to return to the measurement mode.

pH Meter Calibration

The pH meter must be calibrated before daily use. The calibration may be accomplished in the laboratory or in the field. In addition to a “preuse” calibration, it is strongly recommended that the meter be checked with a standard buffer solution at least once during the day in order to observe any instrument drift that may have occurred.

Manual Calibration (with two reference solutions)

1. Attach or verify that the pH-indicating electrode and the automatic temperature compensator (ATC) are on the display unit.
2. Remove the rubber filling solution plug (if so equipped) to allow equilibration of the internal solution to the ambient air. Allow approximately five minutes for the equilibration process, and replace the plug.
3. Turn on the unit and select the calibration mode.
4. Rinse both electrodes with deionized water and dry (carefully) any excess water.
5. Rinse the pH electrode in the first pH buffer (reference) solution. After rinsing, immerse the electrode in a container of the first reference solution, and stir to remove bubbles on the electrode.
6. Allow the display to read **READY** and begin flashing. If the pH reading is within the manufacturer’s specifications (see equipment manual), press **YES**. If not, press **NO** and repeat the procedure. The first standard will subsequently be locked into the unit’s memory.
7. To calibrate the meter to the second pH reference solution, repeat steps 4, 5, and 6 USING the second solution.
8. Remove and rinse probes IN deionized water, and begin sample analysis. Otherwise the meter may be turned off; it will keep calibrating as long as the power source remains intact.

Electrode Care and Maintenance for pH Meters

The pH electrodes discussed above are of the temperature-compensating triode design. These probes are delicate and require careful handling. The probes should not be allowed to freeze and MUST be stored in a vial of the storage solution.

1. Inspect the probe for damage before each use. Verify that probes contain the appropriate levels of filling solution.
2. If filling-solution levels are low, more solution should be added. Use the Hach solution for Hach probes and the Orion solution for Orion probes.
3. If the probe appears sluggish when readings are taken, the filling solution should be drained and refilled with fresh solution.
4. During normal operations, the probe will become fouled with scale deposits and oils. Clean with laboratory-grade soap by soaking the probe in the soap solution and rinsing in deionized water. If fouling is not removed by this procedure, then a 0.1-N solution of HCL or HNO_3 can be used as a soaking media.
5. Probes must be stored in the electrode storage solution or in a 4.0-pH buffer solution. If probes are allowed to dry out, irreversible damage to the probe may occur.

Conductivity Probes

Orion Conductivity/Temperature Meters, Models 122, 126, 128, and 1230
Conductance, refers to the ability of a substance to carry an electrical current. These probes are used to define the physical parameters of conductivity. Conductivity is the algebraic reciprocal of electrical resistance and is expressed in SI units of microSeimens per centimeter. Specific conductance is electrical conductance measured across a one-cm cube of liquid (sample) between opposing faces of two platinum electrodes at 25°C. Conductivity is the same parameter measured at ambient temperature that has not been temperature compensated to 25°C.

Calibration

The conductivity meter must be calibrated in the laboratory or in the field daily. Conductance standards should be chosen to closely reflect the values expected in the sample groups. For example, if historical conductivity values for an area to be sampled range below 1000 µS/cm, the 500-µS/cm solution should be chosen. The meters are designed to provide a nonlinear-function temperature coefficient to correct calculations; however, best results may be obtained when samples are 25°C.

Calibration Steps

1 Select conductivity measurement by turning the meter's conductivity/temperature selector knob from **OFF** to **CONDUCTIVITY** (labeled Δ).

2 Submerge the probe into THE selected conductivity standard (past the open area within the probe), and stir briefly to eliminate any air bubbles.

3 Maintain the probe in solution, wait for the reading to stabilize, and record the final value.

4 No manual adjustment for the meter exists; therefore, the process described herein provides a reference check. If the conductivity reading obtained from steps 1 through 3 is within ±3% of the given standard value, the meter is deemed to be within tolerance limits. If repeated attempts fail to obtain readings within the acceptable range, the meter will require factory service.

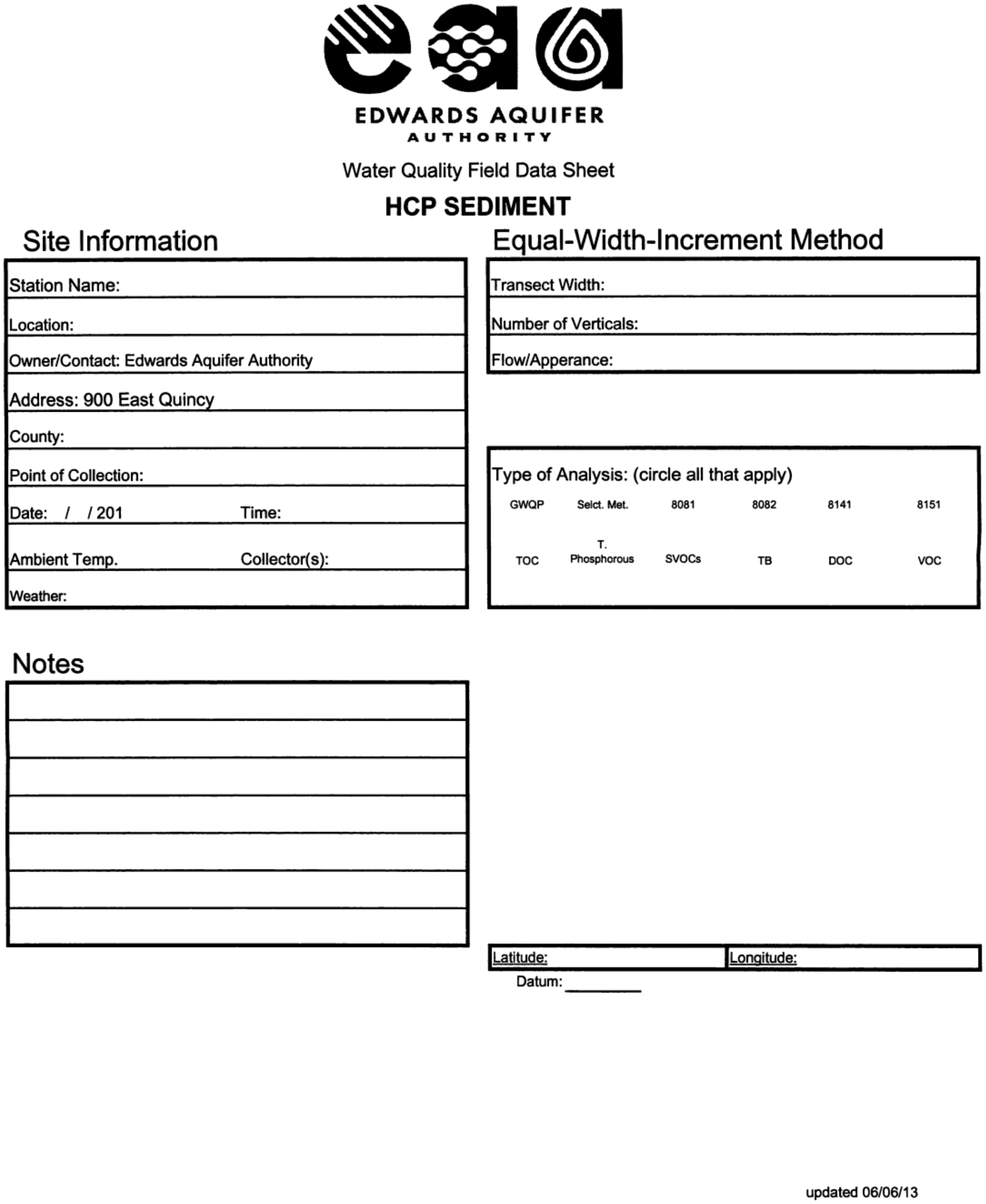
Maintenance

1 The meter electrode must be clean for readings to be accurate. Laboratory-grade soap may be used to clean dirt and oil deposits from the meter. For mineral deposits, a 1-M-HCl solution may be used in ten parts deionized water, and ten parts isopropyl alcohol as a soaking agent for their removal.

2 The conductivity probe may be stored dry. After each use, however, the probe should be rinsed in deionized water and blotted dry.

3 The unit will indicate a low battery by flashing **LOBAT** in the upper-left-hand corner of the LCD display. The nine-volt disposable battery should be changed out with the unit **OFF**, to prevent damage.

APPENDIX D—Forms



EDWARDS AQUIFER
AUTHORITY

Water Quality Field Data Sheet

HCP SEDIMENT

Site Information

Station Name:
Location:
Owner/Contact: Edwards Aquifer Authority
Address: 900 East Quincy
County:
Point of Collection:
Date: / / 201 Time:
Ambient Temp. Collector(s):
Weather:

Equal-Width-Increment Method

Transect Width:
Number of Verticals:
Flow/Apperance:

Type of Analysis: (circle all that apply)

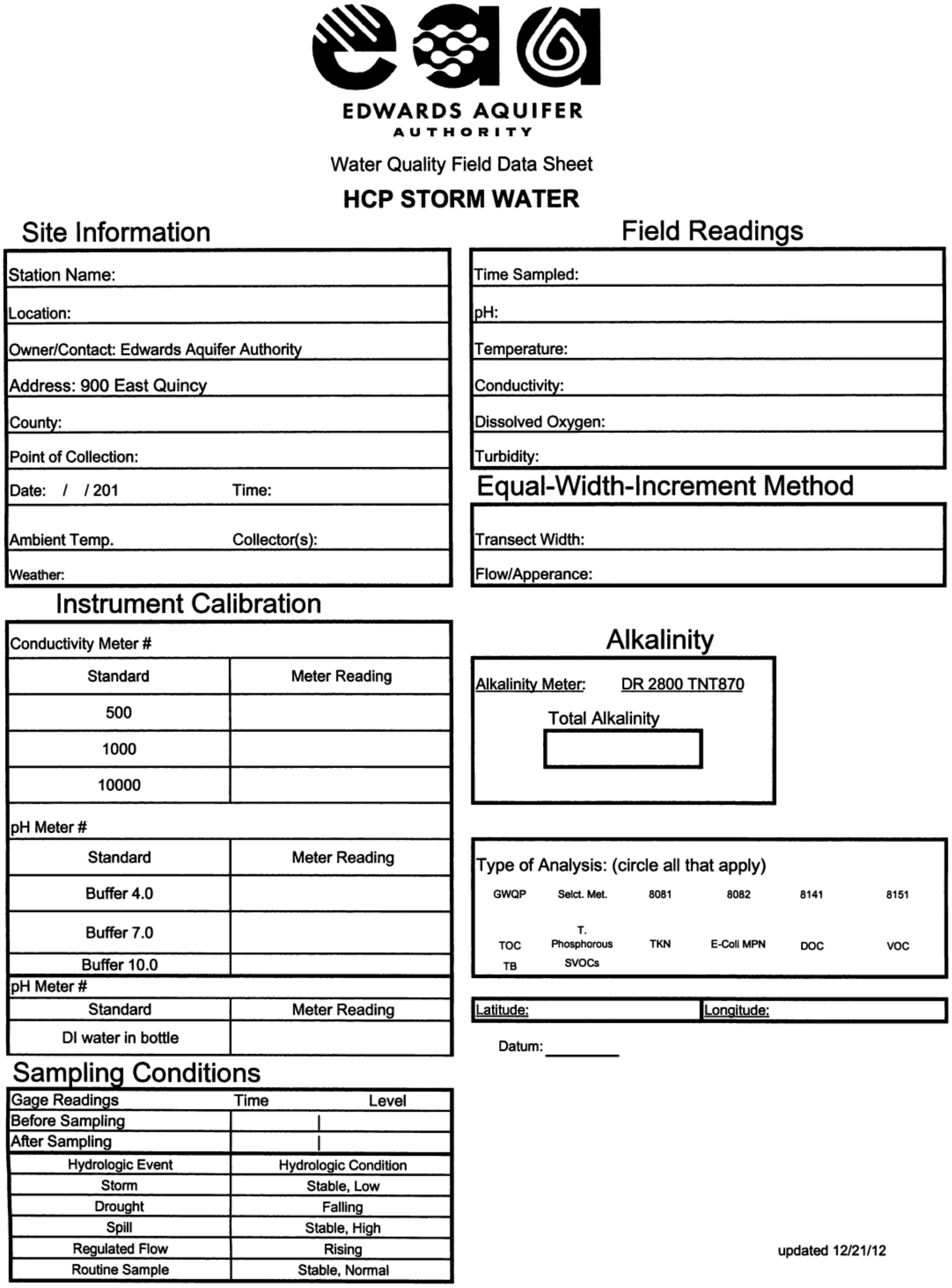
GWQP	Selct. Met.	8081	8082	8141	8151
TOC	T. Phosphorous	SVOCs	TB	DOC	VOC

Notes

Latitude:	Longitude:

Datum: ________

updated 06/06/13



EDWARDS AQUIFER AUTHORITY

Water Quality Field Data Sheet

HCP STORM WATER

Site Information

Station Name:
Location:
Owner/Contact: Edwards Aquifer Authority
Address: 900 East Quincy
County:
Point of Collection:
Date: / / 201 Time:
Ambient Temp. Collector(s):
Weather:

Field Readings

Time Sampled:
pH:
Temperature:
Conductivity:
Dissolved Oxygen:
Turbidity:

Equal-Width-Increment Method

Transect Width:
Flow/Apperance:

Instrument Calibration

Conductivity Meter #

Standard	Meter Reading
500	
1000	
10000	

pH Meter #

Standard	Meter Reading
Buffer 4.0	
Buffer 7.0	
Buffer 10.0	

pH Meter #

Standard	Meter Reading
DI water in bottle	

Alkalinity

Alkalinity Meter: DR 2800 TNT870

Total Alkalinity ☐

Type of Analysis: (circle all that apply)

GWQP	Selct. Met.	8081	8082	8141	8151
TOC TB	T. Phosphorous SVOCs	TKN	E-Coli MPN	DOC	VOC

Latitude: Longitude:

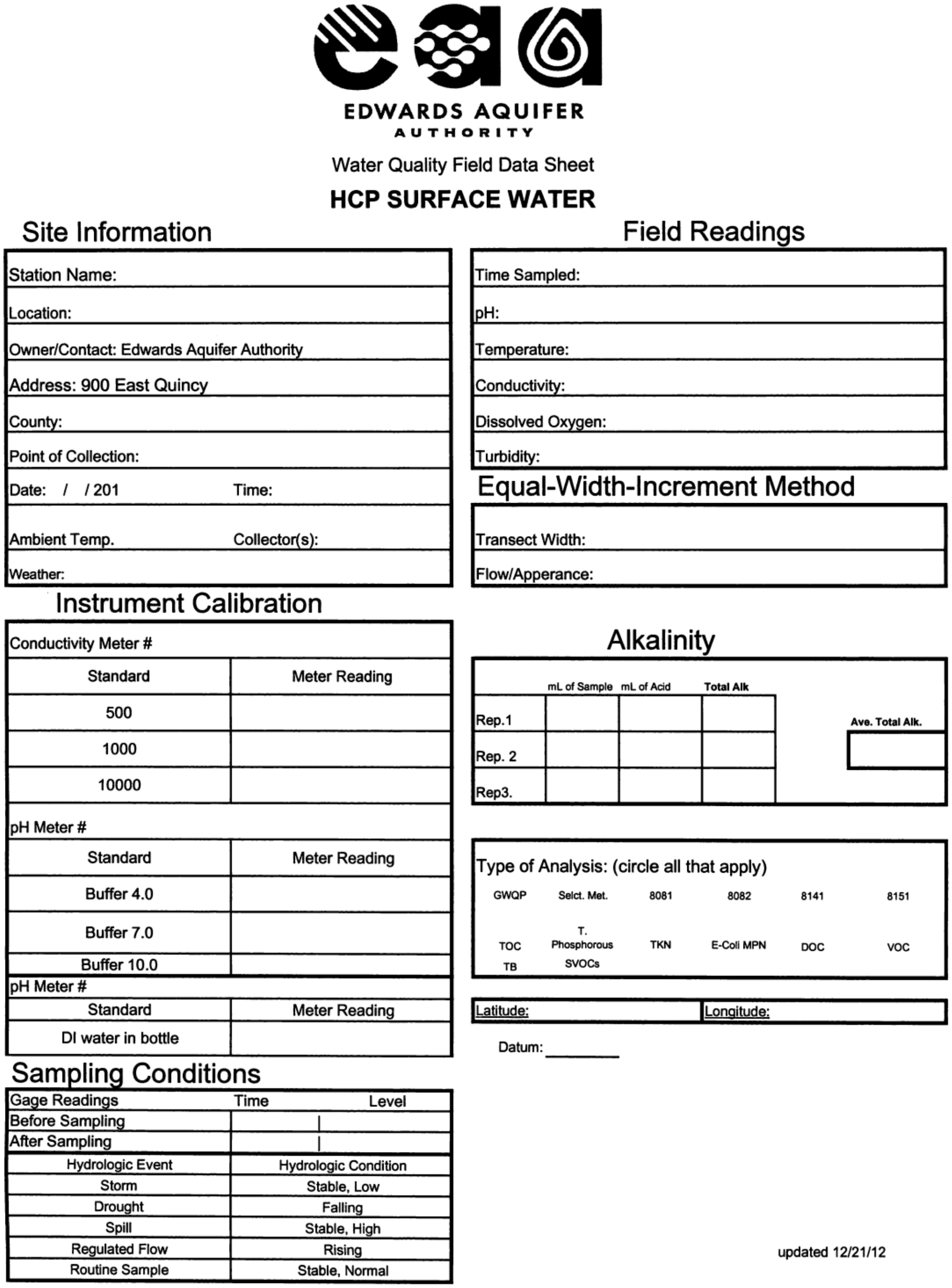
Datum: ________

Sampling Conditions

Gage Readings	Time	Level
Before Sampling		
After Sampling		

Hydrologic Event	Hydrologic Condition
Storm	Stable, Low
Drought	Falling
Spill	Stable, High
Regulated Flow	Rising
Routine Sample	Stable, Normal

updated 12/21/12



EDWARDS AQUIFER
AUTHORITY

Water Quality Field Data Sheet

HCP SURFACE WATER

Site Information

Station Name:
Location:
Owner/Contact: Edwards Aquifer Authority
Address: 900 East Quincy
County:
Point of Collection:
Date: / / 201 Time:
Ambient Temp. Collector(s):
Weather:

Field Readings

Time Sampled:
pH:
Temperature:
Conductivity:
Dissolved Oxygen:
Turbidity:

Equal-Width-Increment Method

Transect Width:
Flow/Apperance:

Instrument Calibration

Conductivity Meter #

Standard	Meter Reading
500	
1000	
10000	

pH Meter #

Standard	Meter Reading
Buffer 4.0	
Buffer 7.0	
Buffer 10.0	

pH Meter #

Standard	Meter Reading
DI water in bottle	

Alkalinity

	mL of Sample	mL of Acid	**Total Alk**
Rep.1			
Rep. 2			
Rep3.			

Ave. Total Alk.

Type of Analysis: (circle all that apply)

GWQP	Selct. Met.	8081	8082	8141	8151
TOC	T. Phosphorous	TKN	E-Coli MPN	DOC	VOC
TB	SVOCs				

Latitude: Longitude:

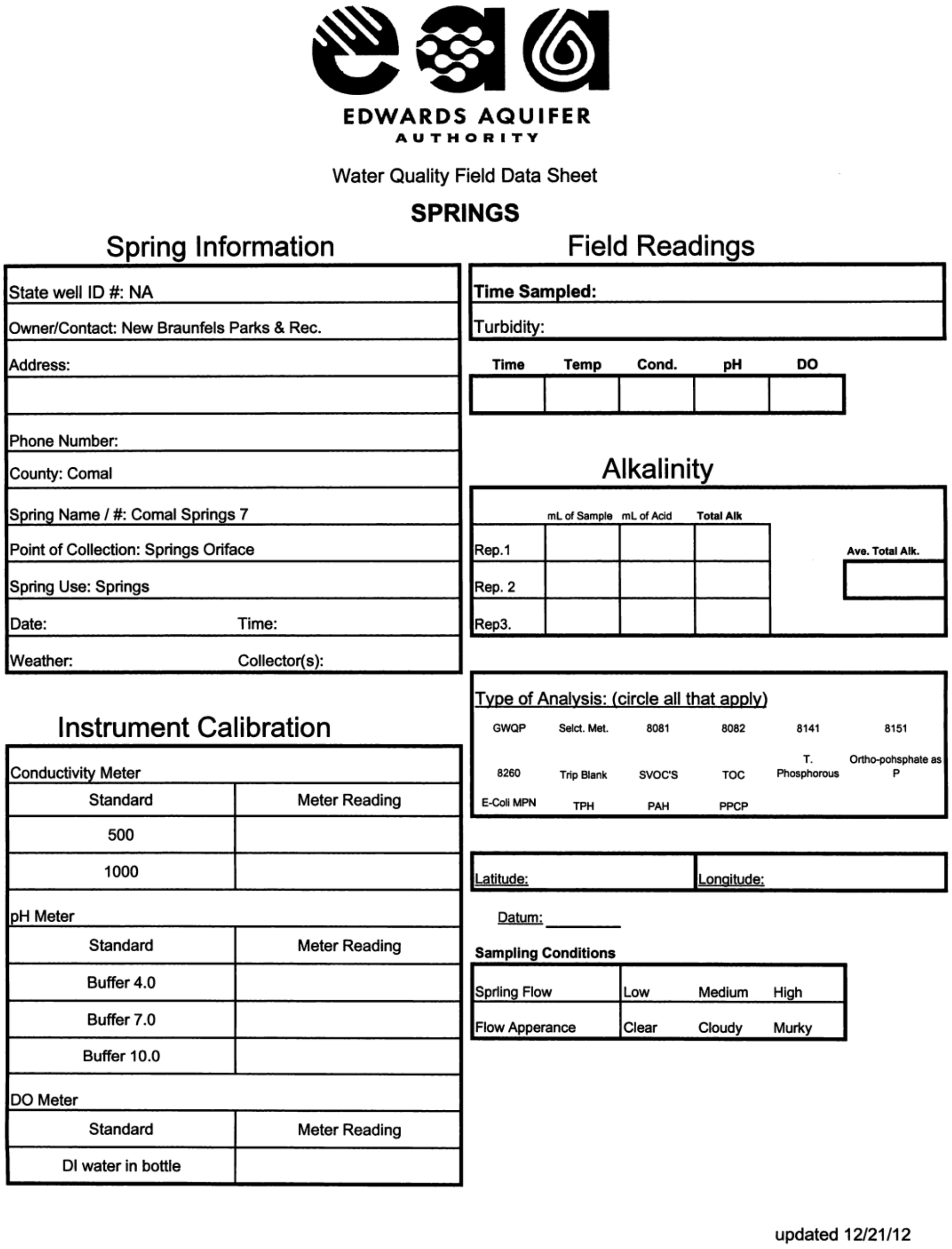
Datum: ________

Sampling Conditions

Gage Readings	Time	Level
Before Sampling		
After Sampling		

Hydrologic Event	Hydrologic Condition
Storm	Stable, Low
Drought	Falling
Spill	Stable, High
Regulated Flow	Rising
Routine Sample	Stable, Normal

updated 12/21/12



EDWARDS AQUIFER
AUTHORITY

Water Quality Field Data Sheet

SPRINGS

Spring Information

State well ID #: NA	
Owner/Contact: New Braunfels Parks & Rec.	
Address:	
Phone Number:	
County: Comal	
Spring Name / #: Comal Springs 7	
Point of Collection: Springs Oriface	
Spring Use: Springs	
Date:	Time:
Weather:	Collector(s):

Field Readings

Time Sampled:

Turbidity:

Time	Temp	Cond.	pH	DO

Alkalinity

	mL of Sample	mL of Acid	Total Alk
Rep.1			
Rep. 2			
Rep3.			

Ave. Total Alk.

Type of Analysis: (circle all that apply)

GWQP	Selct. Met.	8081	8082	8141	8151
8260	Trip Blank	SVOC'S	TOC	T. Phosphorous	Ortho-pohsphate as P
E-Coli MPN	TPH	PAH	PPCP		

Latitude: Longitude:

Datum: ________

Sampling Conditions

Spriing Flow	Low	Medium	High
Flow Apperance	Clear	Cloudy	Murky

Instrument Calibration

Conductivity Meter

Standard	Meter Reading
500	
1000	

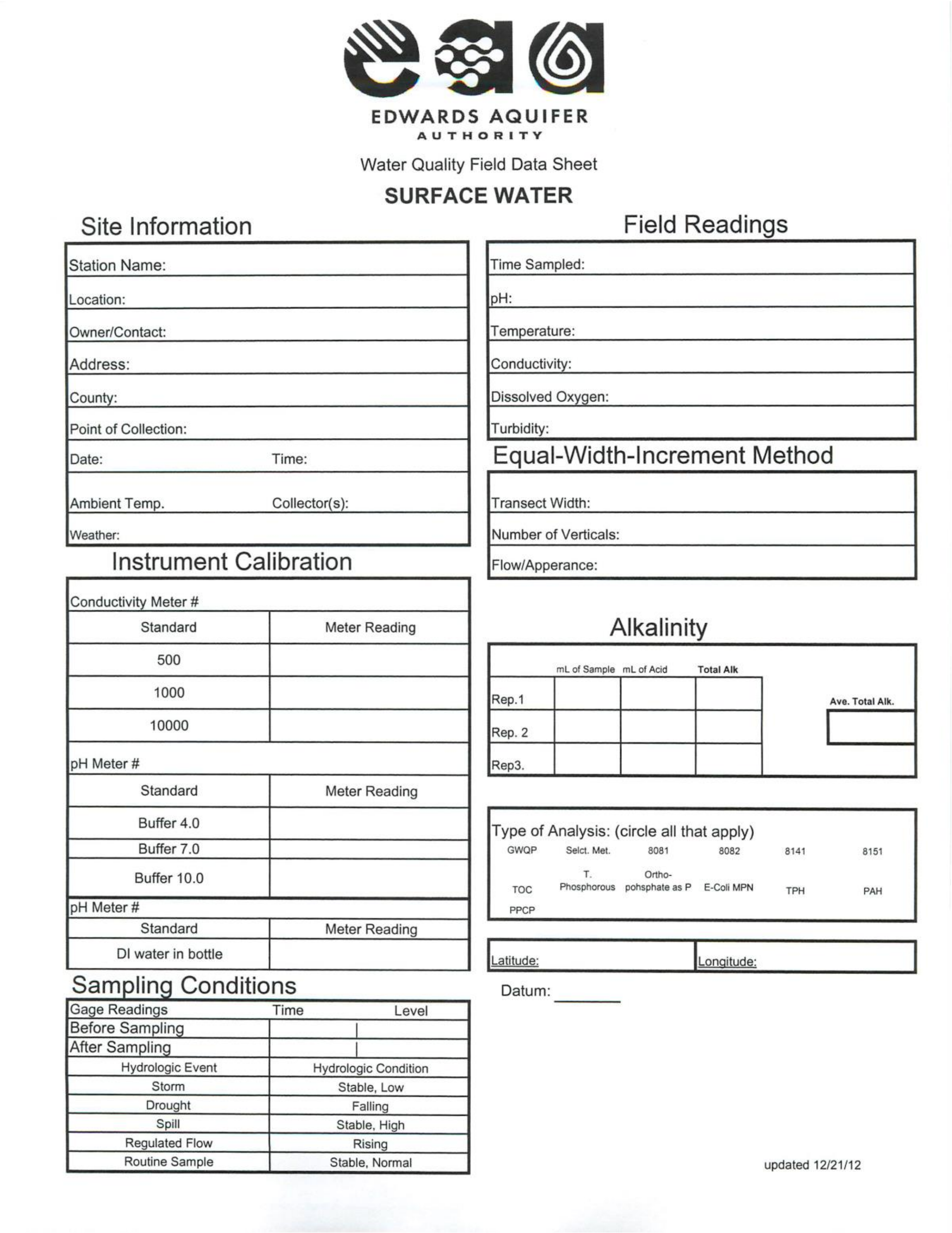
pH Meter

Standard	Meter Reading
Buffer 4.0	
Buffer 7.0	
Buffer 10.0	

DO Meter

Standard	Meter Reading
DI water in bottle	

updated 12/21/12



EDWARDS AQUIFER
AUTHORITY

Water Quality Field Data Sheet

SURFACE WATER

Site Information

Station Name:	
Location:	
Owner/Contact:	
Address:	
County:	
Point of Collection:	
Date:	Time:
Ambient Temp.	Collector(s):
Weather:	

Instrument Calibration

Conductivity Meter #

Standard	Meter Reading
500	
1000	
10000	

pH Meter #

Standard	Meter Reading
Buffer 4.0	
Buffer 7.0	
Buffer 10.0	

pH Meter #

Standard	Meter Reading
DI water in bottle	

Sampling Conditions

Gage Readings	Time	Level
Before Sampling		
After Sampling		

Hydrologic Event	Hydrologic Condition
Storm	Stable, Low
Drought	Falling
Spill	Stable, High
Regulated Flow	Rising
Routine Sample	Stable, Normal

Field Readings

Time Sampled:
pH:
Temperature:
Conductivity:
Dissolved Oxygen:
Turbidity:

Equal-Width-Increment Method

Transect Width:
Number of Verticals:
Flow/Apperance:

Alkalinity

	mL of Sample	mL of Acid	Total Alk
Rep.1			
Rep. 2			
Rep3.			

Ave. Total Alk.

Type of Analysis: (circle all that apply)

GWQP	Selct. Met.	8081	8082	8141	8151
TOC	T. Phosphorous	Ortho-pohsphate as P	E-Coli MPN	TPH	PAH
PPCP					

Latitude:	Longitude:

Datum: _______

updated 12/21/12

EDWARDS AQUIFER
AUTHORITY

Water Quality Field Data Sheet
GROUNDWATER

Well Information

State well ID #:
Owner/Contact:
Address:
Phone Number:
County:
Well Name / #:
Point of Collection:
Well Use:
Weather:
Date: Time:
Flow Rate: gpm Collector(s):
Water Level: Well Depth:
Casing Dia.: 3 x well volume=

Instrument Calibration

Conductivity Meter #

Standard	Meter Reading
500	
1000	
10000	

pH Meter #

Standard	Meter Reading
Buffer 4.0	
Buffer 7.0	
Buffer 10.0	

DO Meter

Standard	Meter Reading
DI water in bottle	

Field Readings

Started Pumping:
Time Sampled:
Turbidity:

Time	Temp	Cond.	pH	Do

Alkalinity

	mL of Sample	mL of Acid	Total Alk
Rep.1			
Rep. 2			
Rep3.			

Ave. Total Alk.

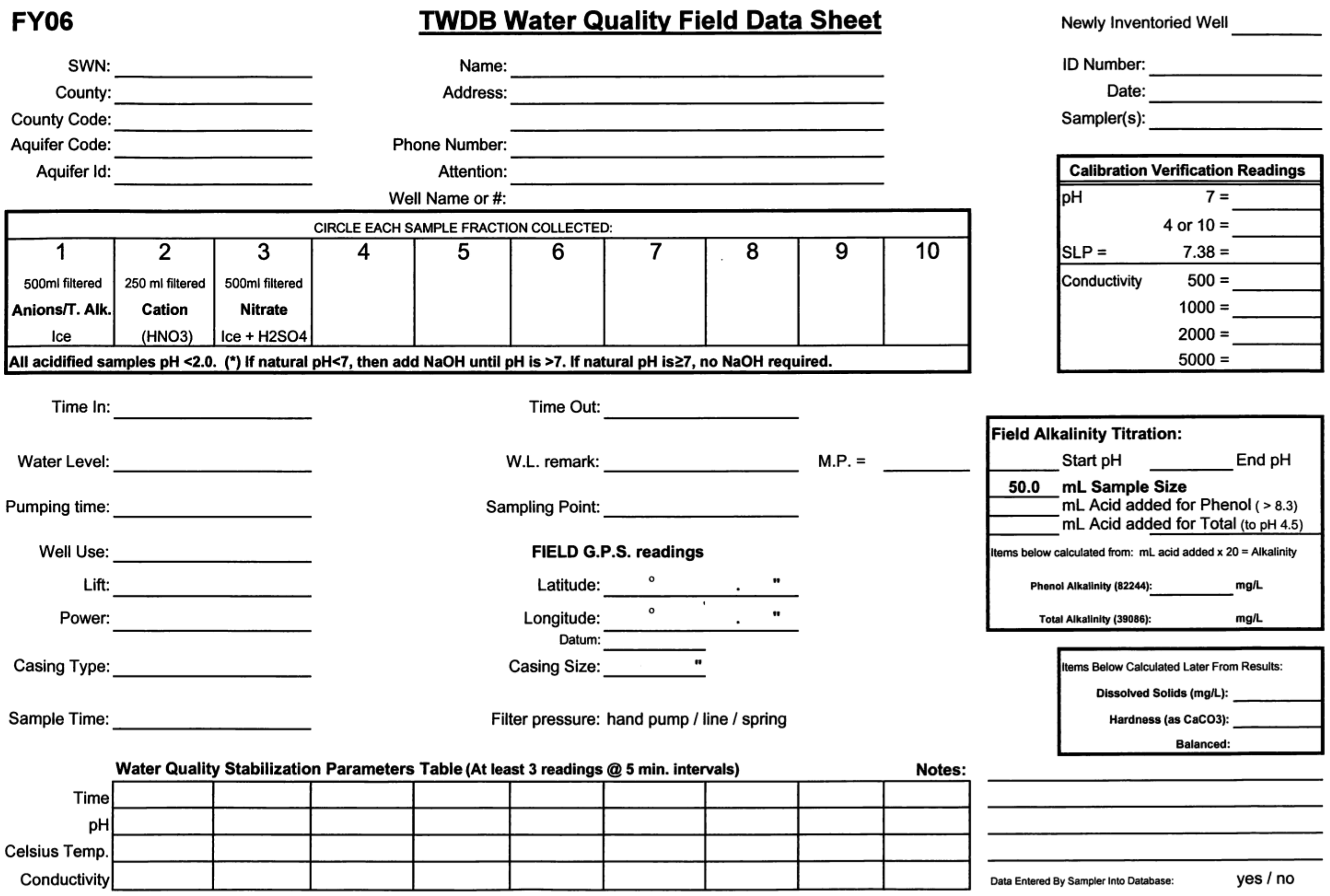
Latitude:	Longitude:

Datum:

Type of Analysis: (circle all that apply)

GWQP	Selct. Met.	8081	8082	8141	8151
8260	Trip Blank	SVOC'S	TOC	T. Phosphorous	Ortho-pohsphate as P
E-Coli MPN	TPH	PAH	PPCP		

Updated on 12/21/12



FY06

TWDB Water Quality Field Data Sheet

Newly Inventoried Well ________

SWN: ____________
County: ____________
County Code: ____________
Aquifer Code: ____________
Aquifer Id: ____________

Name: ____________
Address: ____________
____
Phone Number: ____________
Attention: ____________
Well Name or #:

ID Number: ____________
Date: ____________
Sampler(s): ____________

Calibration Verification Readings		
pH	7 =	
	4 or 10 =	
SLP =	7.38 =	
Conductivity	500 =	
	1000 =	
	2000 =	
	5000 =	

CIRCLE EACH SAMPLE FRACTION COLLECTED:

1	2	3	4	5	6	7	8	9	10
500ml filtered **Anions/T. Alk.** Ice	250 ml filtered **Cation** (HNO3)	500ml filtered **Nitrate** Ice + H2SO4							

All acidified samples pH <2.0. (*) If natural pH<7, then add NaOH until pH is >7. If natural pH is≥7, no NaOH required.

Time In: ____________
Water Level: ____________
Pumping time: ____________
Well Use: ____________
Lift: ____________
Power: ____________
Casing Type: ____________
Sample Time: ____________

Time Out: ____________
W.L. remark: ____________ M.P. = ________
Sampling Point: ____________

FIELD G.P.S. readings

Latitude: ____° ____' ____. ____"
Longitude: ____° ____' ____. ____"
Datum: ____________
Casing Size: ________"

Filter pressure: hand pump / line / spring

Field Alkalinity Titration:

________ Start pH ________ End pH
50.0 **mL Sample Size**
________ mL Acid added for Phenol (> 8.3)
________ mL Acid added for Total (to pH 4.5)

Items below calculated from: mL acid added x 20 = Alkalinity

Phenol Alkalinity (82244): ________ mg/L
Total Alkalinity (39086): ________ mg/L

Items Below Calculated Later From Results:

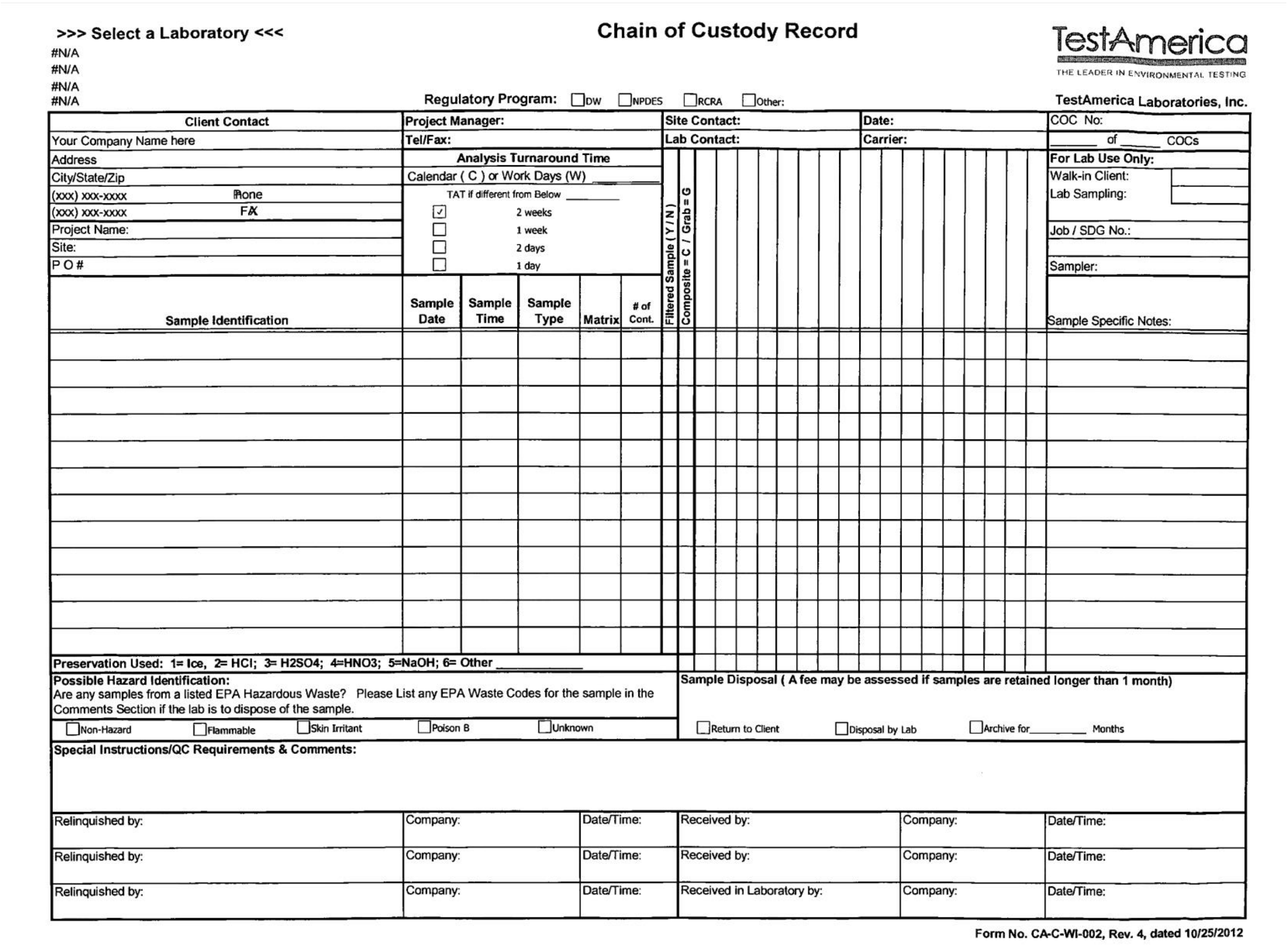
Dissolved Solids (mg/L): ________
Hardness (as CaCO3): ________
Balanced:

Water Quality Stabilization Parameters Table (At least 3 readings @ 5 min. intervals)

Time									
pH									
Celsius Temp.									
Conductivity									

Notes:
____
____
____
____

Data Entered By Sampler Into Database: yes / no



>>> Select a Laboratory <<<

#N/A
#N/A
#N/A
#N/A

Chain of Custody Record

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

TestAmerica Laboratories, Inc.

Regulatory Program: ☐ DW ☐ NPDES ☐ RCRA ☐ Other:

Client Contact	**Project Manager:**	**Site Contact:**	**Date:**	COC No:
Your Company Name here	**Tel/Fax:**	**Lab Contact:**	**Carrier:**	______ of ______ COCs
Address	**Analysis Turnaround Time**			**For Lab Use Only:**
City/State/Zip	Calendar (C) or Work Days (W) ______			Walk-in Client:
(xxx) xxx-xxxx Phone	TAT if different from Below ________			Lab Sampling:
(xxx) xxx-xxxx FAX	☑ 2 weeks			
Project Name:	☐ 1 week			Job / SDG No.:
Site:	☐ 2 days			
P O #	☐ 1 day			Sampler:

Sample Identification	Sample Date	Sample Time	Sample Type	Matrix	# of Cont.	Filtered Sample (Y / N)	Composite = C / Grab = G																		Sample Specific Notes:

Preservation Used: 1= Ice, 2= HCl; 3= H2SO4; 4=HNO3; 5=NaOH; 6= Other ____________

Possible Hazard Identification:
Are any samples from a listed EPA Hazardous Waste? Please List any EPA Waste Codes for the sample in the Comments Section if the lab is to dispose of the sample.

☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☐ Unknown

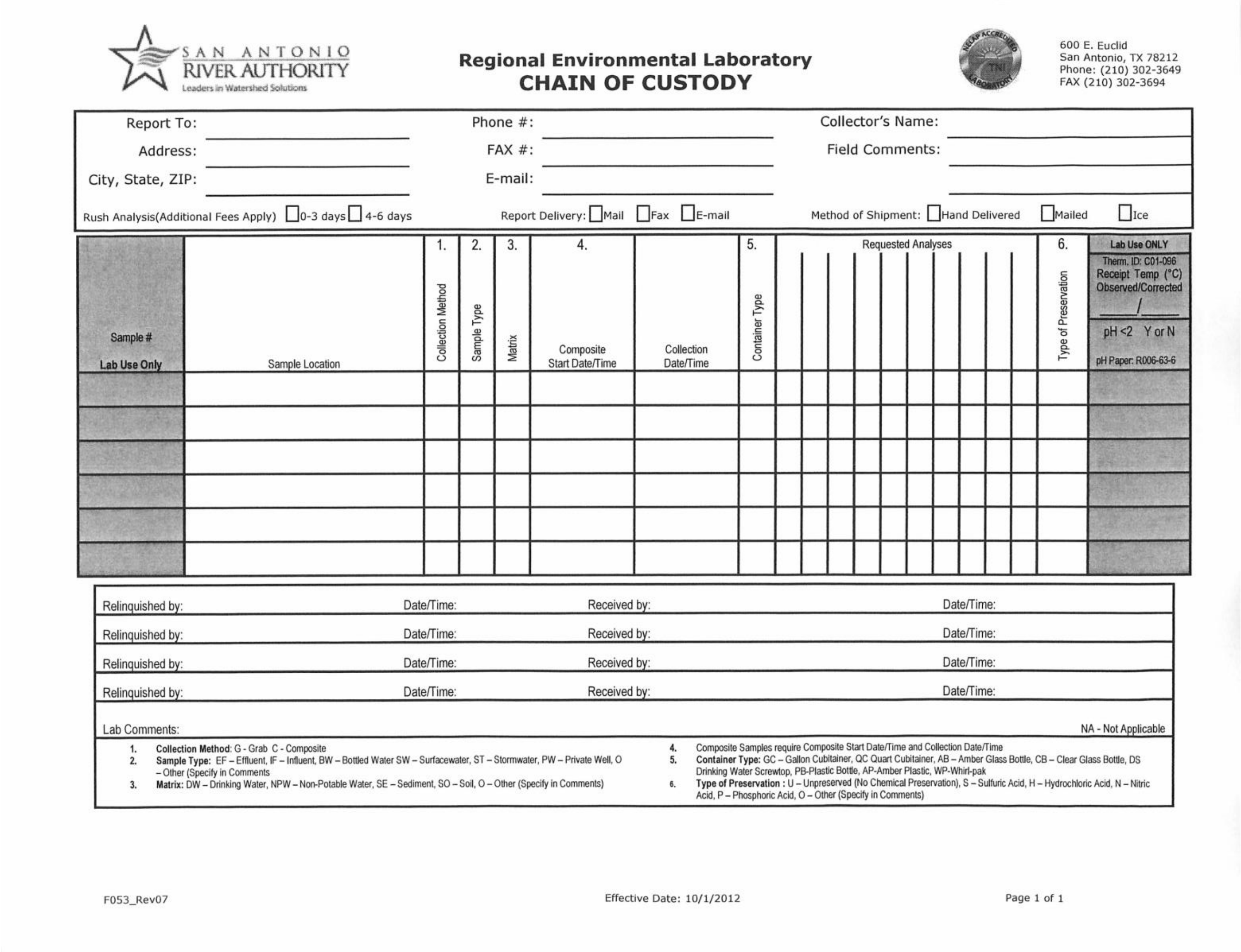
Sample Disposal (A fee may be assessed if samples are retained longer than 1 month)

☐ Return to Client ☐ Disposal by Lab ☐ Archive for________ Months

Special Instructions/QC Requirements & Comments:

Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received by:	Company:	Date/Time:
Relinquished by:	Company:	Date/Time:	Received in Laboratory by:	Company:	Date/Time:

Form No. CA-C-WI-002, Rev. 4, dated 10/25/2012



SAN ANTONIO RIVER AUTHORITY
Leaders in Watershed Solutions

Regional Environmental Laboratory
CHAIN OF CUSTODY

600 E. Euclid
San Antonio, TX 78212
Phone: (210) 302-3649
FAX (210) 302-3694

Report To: ______
Address: ______
City, State, ZIP: ______
Phone #: ______
FAX #: ______
E-mail: ______
Collector's Name: ______
Field Comments: ______

Rush Analysis(Additional Fees Apply) ☐0-3 days ☐ 4-6 days
Report Delivery: ☐Mail ☐Fax ☐E-mail
Method of Shipment: ☐Hand Delivered ☐Mailed ☐Ice

		1.	2.	3.	4.		5.	Requested Analyses										6.	Lab Use ONLY
Sample # Lab Use Only	Sample Location	Collection Method	Sample Type	Matrix	Composite Start Date/Time	Collection Date/Time	Container Type											Type of Preservation	Therm. ID: C01-096 Receipt Temp (°C) Observed/Corrected ____/____ pH <2 Y or N pH Paper: R006-63-6

Relinquished by: Date/Time: Received by: Date/Time:
Relinquished by: Date/Time: Received by: Date/Time:
Relinquished by: Date/Time: Received by: Date/Time:
Relinquished by: Date/Time: Received by: Date/Time:

Lab Comments:

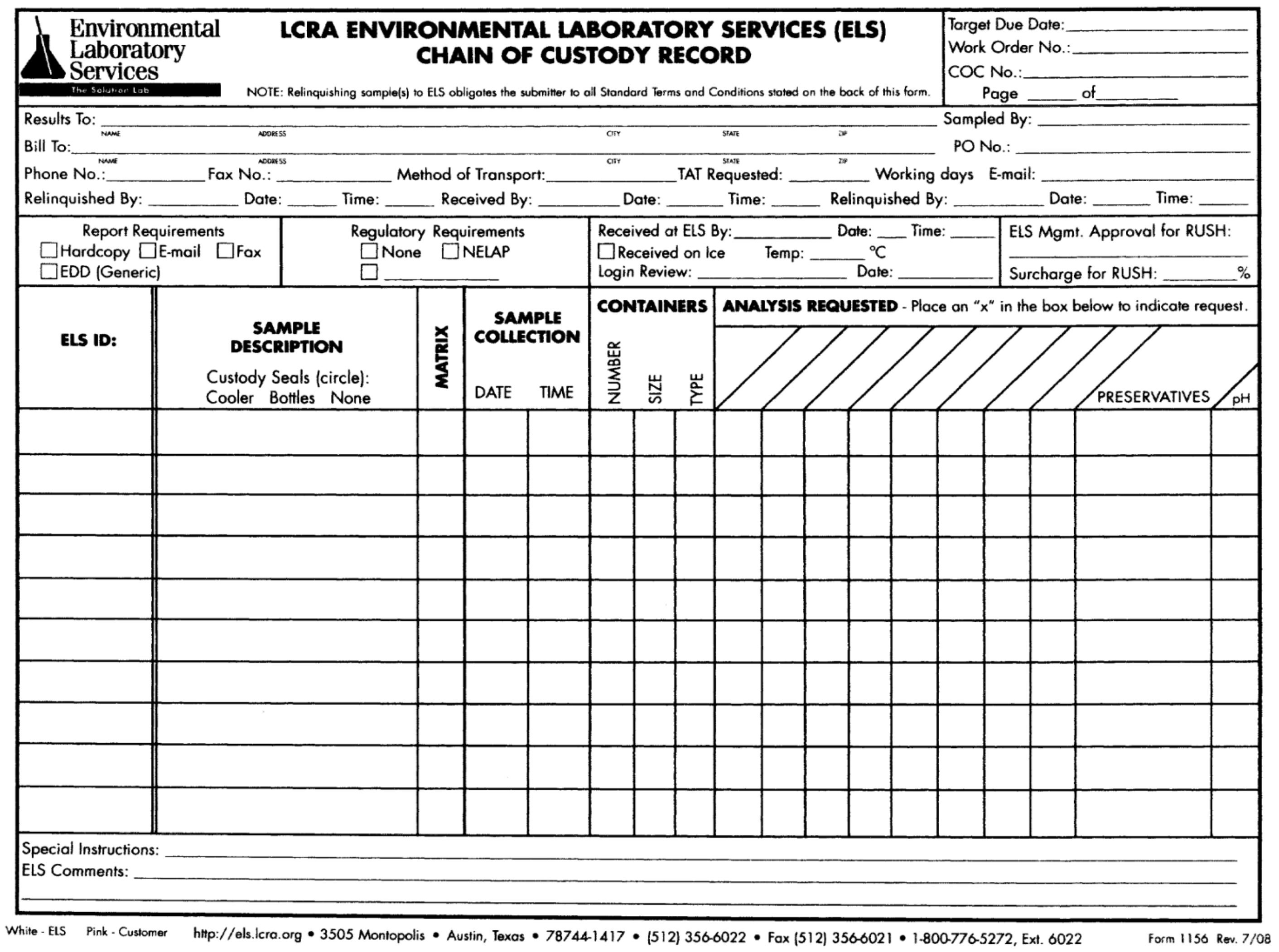
NA - Not Applicable

1. **Collection Method**: G - Grab C - Composite
2. **Sample Type:** EF – Effluent, IF – Influent, BW – Bottled Water SW – Surfacewater, ST – Stormwater, PW – Private Well, O – Other (Specify in Comments
3. **Matrix:** DW – Drinking Water, NPW – Non-Potable Water, SE – Sediment, SO – Soil, O – Other (Specify in Comments)
4. Composite Samples require Composite Start Date/Time and Collection Date/Time
5. **Container Type:** GC – Gallon Cubitainer, QC Quart Cubitainer, AB – Amber Glass Bottle, CB – Clear Glass Bottle, DS Drinking Water Screwtop, PB-Plastic Bottle, AP-Amber Plastic, WP-Whirl-pak
6. **Type of Preservation :** U – Unpreserved (No Chemical Preservation), S – Sulfuric Acid, H – Hydrochloric Acid, N – Nitric Acid, P – Phosphoric Acid, O – Other (Specify in Comments)

F053_Rev07

Effective Date: 10/1/2012

Page 1 of 1



Environmental Laboratory Services
The Solution Lab

LCRA ENVIRONMENTAL LABORATORY SERVICES (ELS)
CHAIN OF CUSTODY RECORD

NOTE: Relinquishing sample(s) to ELS obligates the submitter to all Standard Terms and Conditions stated on the back of this form.

Target Due Date: ____________
Work Order No.: ____________
COC No.: ____________
Page ______ of ________

Results To: ____________ NAME ADDRESS CITY STATE ZIP Sampled By: ____________
Bill To: ____________ NAME ADDRESS CITY STATE ZIP PO No.: ____________
Phone No.: __________ Fax No.: __________ Method of Transport: __________ TAT Requested: ________ Working days E-mail: ____________
Relinquished By: __________ Date: ______ Time: ______ Received By: __________ Date: ______ Time: ______ Relinquished By: __________ Date: ______ Time: ______

Report Requirements
☐ Hardcopy ☐ E-mail ☐ Fax
☐ EDD (Generic)

Regulatory Requirements
☐ None ☐ NELAP
☐ ____________

Received at ELS By: __________ Date: ___ Time: _____
☐ Received on Ice Temp: ______ °C
Login Review: ______________ Date: __________

ELS Mgmt. Approval for RUSH: ____________
Surcharge for RUSH: ________ %

ELS ID:	SAMPLE DESCRIPTION Custody Seals (circle): Cooler Bottles None	MATRIX	SAMPLE COLLECTION DATE	SAMPLE COLLECTION TIME	CONTAINERS NUMBER	CONTAINERS SIZE	CONTAINERS TYPE	ANALYSIS REQUESTED - Place an "x" in the box below to indicate request.								PRESERVATIVES	pH

Special Instructions: ____________
ELS Comments: ____________

White - ELS Pink - Customer http://els.lcra.org • 3505 Montopolis • Austin, Texas • 78744-1417 • (512) 356-6022 • Fax (512) 356-6021 • 1-800-776-5272, Ext. 6022 Form 1156 Rev. 7/08

APPENDIX E—Drinking-Water Standards and Chemical Health Effects, from 30 TAC 290, RG-346, and U.S. EPA, July 2002

(Note, regulatory limits change frequently for certain compounds, the data herein are for general comparisons. The reader should utilized the most recent data available online from TCEQ and EPA if sample results exceed regulatory limits)

Parameter, Method, and Units	Maximum Contaminant Levels or Secondary Standards	Potential Health Effects from Ingestion of Water^	Sources of Contaminant in Drinking Water^
Temperature (˚C) EPA 170.1	**NE**	**NA**	**NA**
pH measured at 25°C EPA 150.1	**>7.0***	**NA**	**NA**
Turbidity (NTU)	**NE**	**NA**	**NA**
Dissolved oxygen (DO) (mg/L)	**NE**	**NA**	**NA**
Alkalinity total as $CACO_3$ SM 2320 B (mg/L)	**NE**	**NA**	**NA**
Specific conductance µS/cm	**NE**	**NA**	**NA**
Laboratory		**NA**	**NA**
Alkalinity total as $CACO_3$ SM 2320 B	**NE**	**NA**	**NA**
Bicarbonate (HCO_3) SM 2320 B	**NE**	**NA**	**NA**
Fecal coliform (CFU/100 mL)	**0 MCLG[1]**	**NA**	**NA**
Fecal strep (CFU/100 mL)	**0 MCLG[1]**	**NA**	**NA**
E. coli (CFU/100 mL)	**0 MCLG[1]**	**NA**	**NA**
pH measured at 25°C EPA 150.1	**>7.0***	**NA**	**NA**
Specific conductance µS/cm	**NE**	**NA**	**NA**
Nutrients (mg/L)			
Nitrate-nitrite as N EPA354.1/300.0	**10**	**Infants below the age of six months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.**	**Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits**

Parameter, Method, and Units	Maximum Contaminant Levels or Secondary Standards	Potential Health Effects from Ingestion of Water^	Sources of Contaminant in Drinking Water^
Nitrate as N E300	**10**	**Infants below the age of six months who drink water containing nitrate in excess of the MCL could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.**	**Runoff from fertilizer use; leaching from septic tanks, sewage; erosion of natural deposits**
Orthophosphate EPA 365.3	**NE**	**NA**	**NA**
Ammonia as N SM 4500	**NE**	**NA**	**NA**
Phosphorus	**NE**	**NA**	**NA**
Major Ions (mg/L)		**NA**	**NA**
Sulfate (SO_4) EPA 300.0	**300***	**NA**	**NA**
Solids total dissolved (TDS) EPA 160.1	**1,000***	**NA**	**NA**
Solids total suspended (TSS) EPA 160.2	**NE**	**NA**	**NA**
Bromide (Br) EPA 300.0	**NE**	**NA**	**NA**
Chloride (CI) EPA 300.0	**300***	**NA**	**NA**
Fluoride (F) EPA 340.2	**2.0***	**Bone disease (pain and tenderness of the bones); children may get mottled teeth**	**Water additive that promotes strong teeth, erosion of natural deposits, discharge from fertilizer and aluminum factories**
Metals by EPA 200.7 and 200.8 (µg/L)		**NA**	**NA**
Aluminum	**24,000****	**NA**	**NA**
		NA	**NA**
Antimony	**6**	**Increase in blood cholesterol; decrease in blood sugar**	**Discharge from petroleum refineries, fire retardants, ceramics, electronics, solder**
Arsenic	**5**	**Skin damage or problems with circulatory systems and increased risk of cancer**	**Erosion of natural deposits; runoff from orchards and glass and electronics production wastes**

Parameter, Method, and Units	Maximum Contaminant Levels or Secondary Standards	Potential Health Effects from Ingestion of Water^	Sources of Contaminant in Drinking Water^
Barium	**2,000**	**Increase in blood pressure**	**Discharge of drilling wastes, discharge from metal refineries, erosion of natural deposits**
Beryllium	**4**	**Intestinal lesions**	**Discharge from metal refineries and coal-burning factories. erosion of natural deposits**
Boron	**4,900****		
Cadmium	**5**	**Kidney damage**	**Corrosion of galvanized pipe, erosion of natural deposits, discharge from metal refineries, runoff from waste batteries and paints**
Chromium	**100**	**Allergic dermatitis**	**Discharge from steel and pulp mills, erosion of natural deposits**
Cobalt	**1,500****	**NA**	**NA**
Copper	**1,300***	**Short-term exposure, gastrointestinal distress; long-term exposure, liver or kidney damage. People with Wilson's disease should consult their personal doctor if the amount of copper in their water exceeds the action level.**	**Corrosion of household plumbing systems, erosion of natural deposits**
Iron	**300***	**NA**	**NA**
Lead	**15**	**Infants and children: delays in physical or mental development; children could show slight deficits in attention span and learning abilities. Adults: Kidney problems, high blood pressure**	**Corrosion of household plumbing systems, erosion of natural deposits**
Lithium	**490****	**NA**	**NA**
Manganese	**1,100***	**NA**	**NA**
Molybdenum	**120****	**NA**	**NA**
Nickel	**490****	**NA**	**NA**

Parameter, Method, and Units	Maximum Contaminant Levels or Secondary Standards	Potential Health Effects from Ingestion of Water^	Sources of Contaminant in Drinking Water^
Selenium	**50**	**Hair or fingernail loss, numbness in fingers or toes, circulatory problems**	**Discharge from petroleum refineries, erosion of natural deposits, discharge from mines**
Silver	**120***	**NA**	**NA**
Strontium	**15,000****	**NA**	**NA**
Thallium	**2**	**Hair loss; changes in blood; kidney, intestine, or liver problems**	**Leaching from ore processing sites; discharge from electronics, glass, and drug factories**
Uranium	**30**	**NA**	**NA**
Vanadium	**1.7****	**NA**	**NA**
Zinc	**7,300***	**NA**	**NA**
		NA	**NA**
Metals by E200.8 (mg/L)			
Calcium	**NE**	**NA**	**NA**
Magnesium	**NE**	**NA**	**NA**
Potassium	**NE**	**NA**	**NA**
Sodium	**NE**	**NA**	**NA**
Metals by SW-7470A (mg/L)			
Mercury	**0.002**	**Kidney damage**	**Erosion of natural deposits, discharge from refineries and factories, runoff from landfills and croplands**
Total Organic Carbon by E415.1 (mg/L)			
TOC	**NE**	**NA**	**NA**
Herbicides by SW-8141 (µg/L)			
Azinphosmethyl	**37****	**NA**	**NA**
Bolstar (Sulprofos)	**73****	**NA**	**NA**
Chlorpyrifos	**73****	**NA**	**NA**
Coumaphos	**170****	**NA**	**NA**

Parameter, Method, and Units	**Maximum Contaminant Levels or Secondary Standards**	**Potential Health Effects from Ingestion of Water^**	**Sources of Contaminant in Drinking Water^**
Demeton-O	**1.0****	**NA**	**NA**
Demeton-S	**0.98****	**NA**	**NA**
Diazinon	**22****	**NA**	**NA**
Dichlorvos	**3.1****	**NA**	**NA**
Dimethoate	**4.9****	**NA**	**NA**
Disulfoton	**0.98****	**NA**	**NA**
EPN	**0.24****	**NA**	**NA**
Ethoprop	**2.4****	**NA**	**NA**
Famphur	**0.73****	**NA**	**NA**
Fensulfothion	**24****	**NA**	**NA**
Fenthion	**1.7****	**NA**	**NA**
Malathion	**490****	**NA**	**NA**
Merphos	**7.3****	**NA**	**NA**
Methyl parathion	**6.1****	**NA**	**NA**
Mevinphos (Phosdrin)	**0.61****	**NA**	**NA**
Mononcrotophos	**15****	**NA**	**NA**
Naled	**49****	**NA**	**NA**
Parathion	**150****	**NA**	**NA**
Phorate	**4.9****	**NA**	**NA**
Ronnel	**1,200****	**NA**	**NA**
Stirophos (Tetrachlorvinphos)	**1,000****	**NA**	**NA**
Sulfotepp (Tetraethyl dithiopyrophosphate)	**12****	**NA**	**NA**
Tokuthion (Prothiofos)	**2.4****	**NA**	**NA**
Trichloronate	**73****	**NA**	**NA**
Thionazin	**1.7****	**NA**	**NA**
Herbicides by SW-8151 (µg/L)			
2,4,5-T	**240**	**NA**	**NA**
2,4,5-TP (Silvex)	**50**	**Liver problems**	**Residue of banned herbicide**

Parameter, Method, and Units	Maximum Contaminant Levels or Secondary Standards	Potential Health Effects from Ingestion of Water^	Sources of Contaminant in Drinking Water^
2,4- D	**70**	**Kidney, liver, or adrenal gland problems**	**Runoff from herbicide used on row crops**
2,4-DB	**200**	**NA**	**NA**
Dalapon	**200**	**Minor kidney changes**	**Runoff from herbicide used on rights of way**
Dicamba	**730**	**NA**	**NA**
Dichoroprop	**240**	**NA**	**NA**
Dinoseb	**7**	**Reproductive difficulties**	**Runoff from herbicide used on soybeans and vegetables**
MCPA	**12**	**NA**	**NA**
MCPP (mecoprop)	**24**	**NA**	**NA**
Pentachlorophenol	**1**	**Liver or kidney problems, increased cancer risk**	**Discharge from wood-preserving factories**
Pesticides by SW-8081 (µg/L)			
4, 4'-DDD	**3.8****	**NA**	**NA**
4, 4'-DDE	**2.7****	**NA**	**NA**
4, 4'-DDT	**2.7****	**NA**	**NA**
Aldrin	**0.05****	**NA**	**NA**
Alpha-bhc (Alpha-hexachlorocyclohexane)	**0.1****	**NA**	**NA**
Alpha-chlordane	**2.6****	**NA**	**NA**
Beta-bhc (Beta-hexachlorocyclohexane)	**0.5****	**NA**	**NA**
Chlordane	**2.0****	**Liver or nervous system problems, increased risk of cancer**	**Residue of banned termiticide**
Delta-bhc (Delta-hexachlorocyclohexane)	**0.5****	**NA**	**NA**
Dieldrin	**0.57****	**NA**	**NA**
Endosulfan I	**49****	**NA**	**NA**
Endosulfan II	**150****	**NA**	**NA**
Endosulfan sulfate	**150****	**NA**	**NA**
Endrin	**2.0****	**Liver problems**	**Residue of banned insecticide**

Parameter, Method, and Units	**Maximum Contaminant Levels or Secondary Standards**	**Potential Health Effects from Ingestion of Water^**	**Sources of Contaminant in Drinking Water^**
Endrin aldehyde	**7.3****	**NA**	**NA**
Endrin ketone	**==**		
Gamma-bhc (Lindane)	**7.3****	**NA**	**NA**
Gamma-chlordane	**0.2**	**Liver or kidney problems**	**Runoff/leaching from insecticide used on cattle, lumber, gardens**
	2.6**	**NA**	**NA**
Heptachlor epoxide	**0.4**	**Liver damage, increased risk of cancer**	**Residue of banned termiticide**
Methoxychlor	**0.2**	**Liver damage, increased risk of cancer**	**Breakdown of heptachlor**
Toxaphene	**40**	**Reproductive difficulties**	**Runoff/leaching from insecticide used on fruits, vegetables, alfalfa, livestock**
PCBs by SW-8082 (µg/L)	**3**	**Kidney, liver, or thyroid problems; increased risk of cancer**	**Runoff/leaching from insecticide used on cotton and cattle**
Aroclor 1016			
Aroclor 1221	**0.5**	**Skin changes, thymus gland problems, immune deficiencies, reproductive or nervous system difficulties, increased risk of cancer**	**Runoff from landfills, discharge of waste chemicals**
Aroclor 1232	**0.5**	**Skin changes, thymus gland problems, immune deficiencies, reproductive or nervous system difficulties, increased risk of cancer**	**Runoff from landfills, discharge of waste chemicals**
Aroclor 1242	**0.5**	**Skin changes, thymus gland problems, immune deficiencies, reproductive or nervous system difficulties, increased risk of cancer**	**Runoff from landfills, discharge of waste chemicals**
Aroclor 1248	**0.5**	**Skin changes, thymus gland problems, immune deficiencies, reproductive or nervous system difficulties, increased risk of cancer**	**Runoff from landfills, discharge of waste chemicals**

Parameter, Method, and Units	Maximum Contaminant Levels or Secondary Standards	Potential Health Effects from Ingestion of Water^	Sources of Contaminant in Drinking Water^
Aroclor 1254	**0.5**	**Skin changes, thymus gland problems, immune deficiencies, reproductive or nervous system difficulties, increased risk of cancer**	**Runoff from landfills, discharge of waste chemicals**
Aroclor 1260	**0.5**	**Skin changes, thymus gland problems, immune deficiencies, reproductive or nervous system difficulties, increased risk of cancer**	**Runoff from landfills, discharge of waste chemicals**
Aroclor 1262	**0.5**	**Skin changes, thymus gland problems, immune deficiencies, reproductive or nervous system difficulties, increased risk of cancer**	**Runoff from landfills, discharge of waste chemicals**
Aroclor 1268	**0.5**	**Skin changes, thymus gland problems, immune deficiencies, reproductive or nervous system difficulties, increased risk of cancer**	**Runoff from landfills, discharge of waste chemicals**
	0.5	**Skin changes, thymus gland problems, immune deficiencies, reproductive or nervous system difficulties, increased risk of cancer**	**Runoff from landfills, discharge of waste chemicals**
SVOCs by SW-8270C (µg/L)			
1,2- dichlorobenzene			
	600**	**NA**	**NA**
1,2,4- trichlorobenzene			
2, 4, 5-trichlorophenol	**70****	**Changes in adrenal glands**	**Discharge from textile finishing factories**
2, 4, 6-trichlorophenol	**2,400****	**NA**	**NA**
2, 4-dichlorophenol	**24****	**NA**	**NA**
2, 4-dimethylphenol	**73****	**NA**	**NA**

Parameter, Method, and Units	**Maximum Contaminant Levels or Secondary Standards**	**Potential Health Effects from Ingestion of Water^**	**Sources of Contaminant in Drinking Water^**
2, 4-dinitrophenol	**490****	**NA**	**NA**
2-chlorophenol	**49****	**NA**	**NA**
2-methylnaphthalene	**120****	**NA**	**NA**
2-methylphenol (o-cresol)	**98****	**NA**	**NA**
2-nitroaniline	**1,200****	**NA**	**NA**
2-nitrophenol	**7.3****	**NA**	**NA**
3 & 4 methylphenol (m&p cresol)	**49****	**NA**	**NA**
3-nitroaniline	**1,200****	**NA**	**NA**
4, 6-dinitro-2-methylphenol	**7.3****	**NA**	**NA**
4-chloro-3-methylphenol	**2.4****	**NA**	**NA**
4- chloroaniline	**120****	**NA**	**NA**
4-nitroaniline	**4.6****	**NA**	**NA**
4-nitrophenol	**46****	**NA**	**NA**
Naphthalene	**49****	**NA**	**NA**
Nitrobenzene	**490****	**NA**	**NA**
Pentachlorophenol	**49****	**NA**	**NA**
Phenanthrene	**1**	**NA**	**NA**
Phenol	**730****	**NA**	**NA**
Pyrene	**7,300****	**NA**	**NA**
N-nitrosodi-n-propylamine	**730****	**NA**	**NA**
N-nitrosodiphenylamine	**0.13****	**NA**	**NA**
Acenaphthene	**190****	**NA**	**NA**
Acenaphthylene	**1,500****	**NA**	**NA**
Anthracene	**1,500****	**NA**	**NA**
Benzo(a)anthracene (1 2-benzanthracene)	**7,300****	**NA**	**NA**
Benzo(b)fluoranthene	**1.3****	**NA**	**NA**
Benzo(k)fluoranthene	**1.3****	**NA**	**NA**
Benzo(ghi)perylene	**13****	**NA**	**NA**
Benzo(a)pyrene	**730****	**NA**	**NA**

Parameter, Method, and Units	Maximum Contaminant Levels or Secondary Standards	Potential Health Effects from Ingestion of Water^	Sources of Contaminant in Drinking Water^
Benzyl Alcohol	**0.2**	**Reproductive difficulties, increased risk of cancer**	**Leaching from linings of water storage tanks and distribution lines**
Butyl benzyl phthalate	**2,400****	**NA**	**NA**
Bis(2-chloroethoxy)methane	**480****	**NA**	**NA**
Bis(2-chloroethyl)ether	**0.83****	**NA**	**NA**
Bis(2-ethylhexyl)phthalate	**0.83****	**NA**	**NA**
4-bromophenyl phenyl ether	**6**	**NA**	**NA**
4-chloroaniline	**0.061****	**NA**	**NA**
2-chloronaphthalene	**4.6****	**NA**	**NA**
4-chlorophenyl phenyl ether	**2,000****	**NA**	**NA**
Chrysene	**0.061****	**NA**	**NA**
Dibenz(a,h)anthracene	**130****	**NA**	**NA**
Dibenzofuran	**0.2****	**NA**	**NA**
3 3-dichlorobenzidine	**98****	**NA**	**NA**
Diethyl phthalate	**2****	**NA**	**NA**
Dimethyl phthalate	**20,000****	**NA**	**NA**
Di-n-butyl phthalate	**20,000****	**NA**	**NA**
Di-n-octyl phthalate	**2,400****	**NA**	**NA**
2 4-dinitrotoluene	**980****	**NA**	**NA**
2 6-dinitrotoluene	**1.3****	**NA**	**NA**
Fluoranthene	**1.3****	**NA**	**NA**
Fluorene	**980****	**NA**	**NA**
Hexachlorobenzene	**980****	**NA**	**NA**
Hexachlorobutadiene	**1****	**Liver or kidney problems, reproductive difficulties, increased risk of cancer**	**Discharge from metal refineries and agricultural chemical factories**
Hexachlorocyclopentadiene	**12****	**NA**	**NA**
Hexachloroethane	**50**	**Kidney or stomach problems**	**Discharge from chemical factories**
Indeno(1,2,3-cd)pyrene	**24****	**NA**	**NA**

Parameter, Method, and Units	Maximum Contaminant Levels or Secondary Standards	Potential Health Effects from Ingestion of Water^	Sources of Contaminant in Drinking Water^
Isophorone	**1.3****	**NA**	**NA**
VOCs SW-8260b (µg/L)	**960****	**NA**	**NA**
1, 1, 1, 2-tetrachloroethane			
1, 1, 1-trichloroethane	**35.0****	**NA**	**NA**
1, 1, 2, 2-tetrachloroethane	**200**	**Liver, nervous system, or circulatory problems**	**Discharge from metal degreasing sites and other factories**
1, 1, 2-trichloroethane	**4.6****		
1, 1-dichloroethane	**5**	**Liver, kidney, or immune system problems**	**Discharge from industrial chemical factories**
1, 1-dichloropropene	**4,900****	**NA**	**NA**
1, 1-dichloroethene (Vinylidene chloride)	**9.1****	**NA**	**NA**
1- chlorohexane	**7**	**NA**	**NA**
1-octene	**980****	**NA**	**NA**
1, 2, 3-trichlorobenzene	**NE**	**NA**	**NA**
1, 2, 3-trichloropropane	**73****	**NA**	**NA**
1, 2, 4-trichlorobenzene	**0.03****	**NA**	**NA**
1, 2, 4-trimethylbenzene	**72****	**NA**	**NA**
1, 2-dibromo-3-chloropropane	**1,200****	**NA**	**NA**
1, 2-dibromoethane (EDB)	**0.2**	**Reproductive difficulties, increased risk of cancer**	**Runoff/leaching from soil fumigant used on soybeans, cotton, pineapples, and orchards**
1, 2-dichlorobenzene	**NE**	**NA**	**NA**
1, 2-dichloroethane (EDC)	**600****	**NA**	**NA**
1, 2-dichloropropane	**5**	**Increased risk of cancer**	**Discharge from industrial chemical factories**
1, 3, 5-trimethylbenzene	**5**	**Increased risk of cancer**	**Discharge from industrial chemical factories**
1,3- butadiene	**1,200****	**NA**	**NA**
1, 3-dichlorobenzene	**NE**	**NA**	**NA**
1, 3-dichloropropane	**730****	**NA**	**NA**
1, 4-dichlorobenzene	**9.1****	**NA**	**NA**
1, 4-dioxane	**75****	**NA**	**NA**

Parameter, Method, and Units	Maximum Contaminant Levels or Secondary Standards	Potential Health Effects from Ingestion of Water^	Sources of Contaminant in Drinking Water^
2, 2-dichloropropane	**9.1****	**NA**	**NA**
2- chloro-1,3- butadiene	**13**	**NA**	**NA**
2-chlorotoluene	**NE**	**NA**	**NA**
2-hexanone	**490****	**NA**	**NA**
2-nitropropane	**120****	**NA**	**NA**
1,3,5- trichlorobenzene	**3.4****	**NA**	**NA**
3- chloro-1- propene	**73****	**NA**	**NA**
4-chlorotoluene	**NE**	**NA**	**NA**
4-isopropyltoluene	**490****	**NA**	**NA**
4-methyl-2-pentanone (MIBK)	**2,400****	**NA**	**NA**
Acetone	**1,950****	**NA**	**NA**
Acetonitrile	**22,000****	**NA**	**NA**
Benzene	**780****	**NA**	**NA**
Benzyl chloride	**5**	**Anemia, decrease in blood platelets, increased risk of cancer**	**Discharge from factories, leaching from gas storage tanks and landfills**
Bromobenzene	**5.4****	**NA**	**NA**
Bromochloromethane (chlorobromomethane)	**200****	**NA**	**NA**
Bromodichloromethane	**980****	**NA**	**NA**
Bromoform (Tribromomethane)	**15****	**NA**	**NA**
Bromomethane (methyl bromide)	**120****	**NA**	**NA**
Carbon disulfide	**34****	**NA**	**NA**
Carbon tetrachloride	**2,400****	**NA**	**NA**
Chlorobenzene	**5**	**Liver problems, increased risk of cancer**	**Discharge from chemical plants and other industrial activities**
Chloroethane (ethyl chloride)	**100**	**Liver or kidney problems**	**Discharge from chemical and agricultural chemical factories**
Chloroform	**9,800****	**NA**	**NA**
Chloromethane (methyl chloride)	**240****	**NA**	**NA**

Parameter, Method, and Units	**Maximum Contaminant Levels or Secondary Standards**	**Potential Health Effects from Ingestion of Water^**	**Sources of Contaminant in Drinking Water^**
Cis-1, 2-dichloroethene	**70****	**NA**	**NA**
Cis-1, 3-dichloropropene	**70**	**NA**	**NA**
Cis-1,4- dichloro-2- butene	**2.0****	**NA**	**NA**
Cyclohexane	**NE**	**NA**	**NA**
Cyclohexanone	**120,000****	**NA**	**NA**
Dibromochloromethane	**120,000****	**NA**	**NA**
Dibromomethane	**11****	**NA**	**NA**
Dichlorodifluoromethane	**NE**	**NA**	**NA**
Ethylbenzene	**4,900****	**NA**	**NA**
Ethyl acetate	**700****	**Liver or kidney problems**	**Discharge from petroleum refineries**
Ethyl ether	**22,000****	**NA**	**NA**
Ethylene oxide	**4900****	**NA**	**NA**
Ethyl methacrylate	**0.89****	**NA**	**NA**
Hexane	**2,200****	**NA**	**NA**
Hexachlorobutadiene	**1,500****	**NA**	**NA**
Iodomethane	**12****	**NA**	**NA**
Isobutyl alcohol	**34****	**NA**	**NA**
Isooctane	**7,300****	**NA**	**NA**
Isopropylbenzene (cumene)	**NE**	**NA**	**NA**
Methacrylonitrile	**700 / 2,400****	**NA**	**NA**
Methyl ethyl ketone (2-butanone)	**2.4****	**NA**	**NA**
Methyl methacrylate	**15,000****	**NA**	**NA**
Methylene chloride (dichloromethane)	**34,000****	**NA**	**NA**
Naphthalene	**5****	**NA**	**NA**
n-Butylbenzene	**490****	**NA**	**NA**
n-Heptane	**1,200****	**NA**	**NA**
n-Propylbenzene	**1,500****	**NA**	**NA**
Pentachloroethane	**980****	**NA**	**NA**

Parameter, Method, and Units	Maximum Contaminant Levels or Secondary Standards	Potential Health Effects from Ingestion of Water^	Sources of Contaminant in Drinking Water^
Propionitrile	**10****	**NA**	**NA**
sec-Butylbenzene	**9.8****	**NA**	**NA**
Styrene	**980****	**NA**	**NA**
tert-Butylbenzene	**100**	**NA**	**NA**
Tert-butyl methyl ether (mtbe)	**980****	**NA**	**NA**
Tetrachloroethene	**240****	**NA**	**NA**
Toluene	**5**	**NA**	**NA**
Trans-1, 2-dichloroethene	**1,000**	**Nervous system, kidney, or liver problems**	**Discharge from petroleum factories**
Trans-1, 3-dichloropropene	**100**	**NA**	**NA**
Trans-1,4- dicloro-2-butene	**9.1****	**NA**	**NA**
Trichloroethene	**NE**	**NA**	**NA**
Trichlorofluoromethane	**5**	**NA**	**NA**
Vinyl Acetate	**7,300****	**NA**	**NA**
Vinyl chloride (chloroethene)	**24,000****	**NA**	**NA**
m-p-xylene	**2**	**Increased risk of cancer**	**Leaching from PVC pipes, discharge from plastic factories**
o-xylene	**10,000****	**NA**	**NA**
Xylenes, Total	**10,000****	**NA**	**NA**
	10,000**	**Nervous system damage**	**Discharge from petroleum factories, discharge from chemical factories**
Total coliforms (including E. Coli MPN)			
1694 Pharmaceuticals (LCMS/MS)	**0**	**Not a health threat in itself; it is used to indicate whether other potentially harmful bacteria may be present.**	**Coli forms are naturally present in the environment, as well as feces; fecal coli forms and E. coli only come from human and animal fecal waste.**
1694 Pharmaceuticals (LCMS/MS)	**NA**	**NA**	**NA**
1694 Pharmaceuticals (LCMS/MS)	**NA**	**NA**	**NA**
1694 Pharmaceuticals (LCMS/MS)	**NA**	**NA**	**NA**

Parameter, Method, and Units	**Maximum Contaminant Levels or Secondary Standards**	**Potential Health Effects from Ingestion of Water^**	**Sources of Contaminant in Drinking Water^**
Turbidity	**NA**	**NA**	**NA**
	NA	**Turbidity is a measure of the cloudiness of water. It is used to indicate water quality and filtration effectiveness (e.g., whether disease-causing organisms are present). Higher turbidity levels are often associated with higher levels of disease-causing microorganisms such as viruses, parasites, and some bacteria. These organisms can cause symptoms such as nausea, cramps, diarrhea, and associated headaches.**	**Soil runoff**

Maximum contaminant level and secondary standards from 30 TAC 290 Subchapter F.

** Numerical value for risk reduction not an MCL, but provides a measure of desirable concentrations,from RG-346 (www.sos.state.tx.us).

^From EPA 816-F-02-013 July 2002.

APPENDIX F—Stormwater-Sampling Detail

Stormwater-Sampling Program for Comal and San Marcos Springs in Support of the Edwards Aquifer Habitat Conservation Plan

PURPOSE

The purpose of this technical procedure is to describe the methodology for collecting grab samples from stormwater runoff in surface waters at Comal and San Marcos springs. Sample frequency is twice annually, with samples collected across three points on the hydrograph. The EAA samples storm waters at Comal Springs at the following five locations (see Appendix A for map):

1. Upper Springs (near Blieders Creek),
2. New Channel—(below confluence with Dry Comal Creek),
3. Upper Old Channel—(at Elizabeth Street),
4. Lower Old Channel—(above Hinman Island), and
5. Comal River—(above confluence with Guadalupe River).

The EAA samples stormwaters at San Marcos Springs at the following seven locations (see Appendix A for map):

1. Sink Creek, upstream of Spring Lake,
2. Sessoms Creek,
3. Dog Beach Outflow,
4. Hopkins Street Outflow,
5. Purgatory Creek (above San Marcos River),
6. I-35 Reach, and
7. Willow Creek (above San Marcos River).

SCOPE

This procedure applies to all EAA personnel and subcontractors who sample storm water.

DEFINITIONS

1. Stormwater runoff as stated by the US EPA, “is generated when precipitation from rain and snowmelt events flows over land or impervious surfaces and does not percolate into the ground” (US EPA Stormwater Program, epa.gov).
2. Rivers are sources of water that flow on top of the ground in volume.
3. Sample intervals (for the EAHCP stormwater sampling program) are defined as:
    a. Initial rise, or rising limb of the hydrograph;
    b. Peak area of hydrograph; and
    c. Recession limb of the hydrograph.

GENERAL

Weather permitting, EAA will sample two stormwater events per year to evaluate stormwater quality from urban landscapes that discharge to Comal and San Marcos springs.

STORM-EVENT SELECTION CRITERIA

According to the *Water Quality Monitoring Program Strategy for Comal Springs and San Marcos Springs in Support of the Edwards Aquifer Habitat Conservation Plan***,** (EAHCP Workplan **"**a storm water sampling event will be triggered when a local rainfall event causes a significant increase in spring flow at the historic Comal Springs gauging station and the San Marcos Springs gauging station." Furthermore, data collected from real-time instrumentation for surface water quality will be used to further refine the type of stormwater event(s) to be sampled. Real-time data are collected for the following parameters at 15-minute intervals from the stations shown on Comal and San Marcos springs EAHCP maps (Appendix A):

- Conductivity,
- DO,
- pH,
- Temperature, and
- Turbidity.

EAA field staff will monitor incoming storms by radar to determine whether the storm will produce one-half inch or more of localized precipitation and determine whether the storm is safe for stormwater sampling. Because of the nature of storms, stormwater sampling may be canceled as a result of false starts, safety issues, or if a new storm interrupts the stormwater sampling. Aquifer Science Management will make the final determination regarding go/no go for stormwater sampling.

Minimum Antecedent Dry Period Requirements

The following is a guideline to determine whether watersheds have returned to "normal" flow conditions. Each watershed will be evaluated separately because one watershed may return to "normal" flow conditions faster and technically be ready for another stormwater sampling event before another watershed, as noted below:

- One day wait if the previous rain event was limited to light rain/drizzle, producing only a surface wetting and no runoff
- Three days wait if the previous rain event did not produce enough rainfall to result in a measurable increase in discharge at the sample location(s)

- Minimum of five days wait if preceded by a rainfall of at least one-half inch at a sample location. The antecedent dry period may be longer if the sample location(s) are still being impacted by runoff from a previous rain event (SARA, 2013).

Canceling a Stormwater-Sampling Event

- A stormwater-sampling event may be canceled because of excessive lightning, hail, high winds, or flooding. If a storm does become severe during a stormwater-sampling event, the event will be postponed, cancelled, or suspended under some circumstances.
- A stormwater sampling event may be suspended because of a new rain event. For example, if samples are collected during the 10% of baseline flow conditions and another storm event interrupts this sampling event, then sampling will be suspended. The second storm will represent a new stormwater event.

RESPONSIBILITIES

CTO and Hydrogeologist Supervisor—Aquifer Science

The CTO and hydrogeologist supervisor—aquifer science will determine which parameters need to be sampled and will ensure that the samples obtained represent the environment being investigated. Sampling parameters are listed in the EAHCP workplan.

Hydrologic Data Coordinator

The hydrologic data coordinator will schedule sampling events and ensure that all field crews are provided with the information and equipment necessary to successfully complete scheduled sampling (i.e., location ID and selected analyses). Furthermore, the coordinator will organize and interface with local entities as needed to ensure that all notifications are in place for each river/spring complex as needed.

Environmental Science Technicians

Environmental science technicians will generally be responsible for collection of samples. Other individuals may also be asked to participate in sample-collection activities. However, each sample team of two people will have a lead sampler who reports back to the hydrogeologist supervisor—aquifer science. Reports will include problems and issues in the field, inability to sample because of unforeseen or changing circumstances, and any deviations from the sample-collection plan and protocols.

PROCEDURE

Supplies and Equipment

Major Equipment Items

- Sample dipper
- Peristaltic pump with inert sample tubing
- 500- or 1,000-mL Teflon™ beakers affixed to telescoping rods
- Two gallon buckets for field-parameter readings

Equipment Support Items

- Trash bags
- Gloves (nitrile)
- Kim wipes/towels
- Rope
- Garden wagon

Sampling Supplies

- Sample bottles
- COC forms
- Sample labels
- Bailer (for filtration)
- 0.45-micron filter
- Ice chest
- Ice for sample preservation
- Ziplock bags
- Field sheet
- Pen and waterproof permanent marker

Monitoring Equipment

- pH and temperature meter
- Specific conductance meter
- Dissolved-oxygen meter
- Turbidity meter

Health and Safety Items

- First-aid kit and emergency eye-wash kit
- Fire extinguisher
- Mobile phone
- Helmet with head lamp
- Hand sanitizer
- Mud boots
- Raincoat
- Life vests with reflective markings
- Throw rope
- Computer access to real-time flow, water quality, and weather data

Field Equipment Decontamination

Proper decontamination between sites is essential to the avoidance of introducing contaminants from the sampling equipment. Before sampling, all hoses, buckets, water quality probes, and other sampling equipment should be decontaminated at EAA before fieldwork. Procedures specified in the EAA's *Field Sampling Plan* should be followed for decontamination of field equipment.

Instrument Usage and Measurement of Water Quality Parameters

Before going into the field, the environmental science technician should verify that all field instruments are operating properly. Calibration will be done on pH, specific conductivity, dissolved oxygen, and turbidity meters, and calibration information should be recorded in the calibration log book.

Purging

No purging is required for stormwater runoff to be sampled in the Comal and San Marcos rivers.

Sample Collection

According to the EAHCP work plan**, "**three water quality samples will be collected from each surface water sampling location during the sampling event. Sample times will be spaced to reflect changes in the stream hydrograph." The first sample will be during the initial rise in the hydrograph. The second sample will be collected near the peak of flow. The final sample will be collected along the recession limb of the storm hydrograph. In some circumstances, additional samples may be collected during the storm event such that sample groups may be subsequently compared to hydrograph data and the most representative samples groups sent for analyses. Following is the sampling procedure:

At EAA Offices

- EAA field staff will monitor local weather forecasts and Doppler radars to determine whether an incoming storm meets the criteria for a stormwater sampling event.
- If the incoming storm DOES NOT meet the criteria, no action will be taken.
- If the incoming storm DOES meet the criteria, EAA field staff will monitor weather conditions, estimate a time of arrival of the incoming storm, and determine whether weather conditions are safe for stormwater sampling (CTO or hydrogeologist supervisor will make the final go/no go decision).
- EAA field staff will notify the contracted laboratories for the possibility of samples.
- Labels for the sample bottles will be filled out.
- Aquifer Science CTO or Hydrogeologist supervisor will make the final determination regarding go/no-go with regard to the storm event.

In the Field

- Field personnel must wear clean (disposable) nitrile gloves during the sample-collection process.
- Sample water will be collected in a two-gallon bucket for parameter readings, and sample water will be collected in a 500- or 1000-mL Teflon™ beaker attached to telescoping rods, or, if needed, a peristaltic pump with inert tubing will be used.
- Meter(s) will be inserted into a two-gallon bucket and measurements recorded on a field sheet, or, if a peristaltic pump is being used, a flow chamber will be used.
- Samples will be collected using beakers or a peristaltic pump.
  - Herbicides and pesticides
  - General water quality parameters
  - Selected metals
  - Turbidity
  - Bacteria (E-coli most probable number)
  - Total phosphorous
  - Total organic carbon
  - Dissolved organic carbon
  - Total kjeldahl nitrogen
  - All containers will be filled almost full, except for alkalinity and VOCs
  - Alkalinity

        - A bailer attached with a filter will be used or a filter will be attached onto tubing from the peristaltic pump
        - Alkalinity must have no head space.
    - Selected metals
        - A bailer attached with a filter will be used or a filter will be attached onto tubing from the peristaltic pump
    - VOC
        - The VOC sample vial will be completely filled so that the water forms a convex meniscus at the top and then capped so that no air space exists in the vial. The vial must be turned over and tapped to check for bubbles in the vial, which indicate trapped air. If bubbles are observed, the vial should be discarded and another sample collected.
    - Any required information will be recorded on the field sheet before, during, and after sampling. Parameter readings will be measured in a two-gallon bucket and recorded on field sheets.
- Preservatives (if any) will be placed in the bottles by EAA-contracted laboratories.
- After the samples have been collected, they will be immediately placed in an ice-filled cooler.
- Prior to departure from the field, field documentation, including the COC form, will be completed, and all EAA field employees will clean their hands with hand sanitizer.
- Field notebooks will be used to record basic information for each event, such as magnitude of storm, issues related to sample collection, weather conditions, time of day samples were collected, and other information deemed pertinent by the lead sampler and/or coordinator.

The second sample will be collected near the peak of flow and will follow the same procedure as that of the initial rise on the hydrograph sample. The third sample will be collected along the recession limb of the hydrograph and will follow the same procedure as that of the other two sampling events. Again, the possibility exists that additional sample may be collected during the event with the most representative three sample groups being submitted for analyses (based on comparison with the appropriate stream hydrograph).

Contracted Laboratories

EAA field staff will drop off samples at EAA-contracted laboratories or have samples picked up at the EAA offices. Samples will be analyzed within proper holding times.

Equipment Blanks

Equipment blanks consist of ASTM II, reagent-grade water poured over/through any sampling equipment used for collection of definitive samples. Most sample-collection equipment is disposable; however, in some cases, an equipment blank may be required. Equipment blanks are used to assess the effectiveness of decontamination procedures (for new materials provided to the EAA or from EAA's decontamination processes) and are designated as *EB* on the COC. The frequency of collection of equipment blanks will depend on the sampling routine and sampling equipment in use. Collection of equipment blanks will be designated prior to sample-collection events.

Trip Blanks

Trip blanks are used to assess potential volatile organic contamination during sample custody in the field and shipment to the receiving laboratory. Trip blanks are submitted with characteristic samples to the laboratory to verify that volatile organic contamination has not occurred from outside influences during sample handling to transport (such as absorption through the septa.)

Trip blanks consist of two 40-mL vials filled with ASTM Type II reagent-grade water prepared by the contracted laboratory. Trip blanks will remain unopened until they are received at the contracted laboratory.

Sample Identification, Handling, and Documentation

Samples will be identified, handled, and recorded as described in the preceding sections of this document.

Records

Field sheets and COCs will be kept in a bound field log book. The following will be recorded using waterproof ink on these sheets and in the field notebook:

- Names of sampling personnel
- Weather conditions
- Project name
- Date and time of sampling
- Analyses to be performed by EAA-contracted laboratory
- Equipment-calibration information
- Field-parameter measurements
- Irregularities, problems, or delays

APPENDIX G—Equipment-Decontamination Procedures

Decontamination

Proper decontamination of all equipment used in the sample-collection process is essential to obtaining quality, representative samples. Improperly decontaminated equipment is capable of causing cross-contamination between sample sites, resulting in samples that are not representative of in situ site conditions. The objective of this appendix is to provide a set of decontamination procedures applicable to various EAA equipment and sampling programs.

Whereas many different protocols exist for decontamination, ASTM Standard D 5088 is perhaps the most commonly referenced protocol. The methods outlined here are tailored to EAA sampling environments and programs.

Basic Decontamination Procedure—Groundwater, Surface Water, and Spring Sampling Equipment

When possible, equipment that comes into contact with sample media will be single-use (disposable) equipment or dedicated equipment. Having such equipment helps reduce the possibility of cross-contamination of samples. However, for many sample types, such dedicated equipment may not be possible. As such, a listing of equipment that may be used to collect a water sample (groundwater, surface water, or spring) would include

- Grundfos submersible pump and associated pump tubing
- Peristaltic pump tubing
- Sample dippers
- Surface water churn

Other equipment that *may* come into direct contact with sample media of concern includes

- Water level measurement devices (steel tape and e-lines)
- Field-parameter probes
- Downhole geophysical equipment

Equipment that will have direct contact with any sample media will be decontaminated prior to use for sample collection or prior to introduction into the well, surface water site, or spring vent, as applicable.

Grundfos Submersible Pumps

Decontamination will be accomplished as follows for submersible well pumps. Sampler will wear new, disposable, nitrile (or equivalent) gloves to perform the decontamination.

Materials needed:

- Submersible pump, pump controller, and pump tubing
- 33-gallon trashcan (dedicated for decon use only)
- Alconox® or laboratory-grade soap
- DI water
- Large plastic bags or foil
- Plastic sheeting
- Clean scrub brush(es)

The designated trashcan will be rinsed with fresh, potable water and subsequently filled with potable water and laboratory-grade soap (per soap label directions).

When the container is approximately 80% full, the pump will be lowered, with heat shield attached, into the trashcan. The pump should be suspended at least six inches off the bottom of the trashcan. The pump will then be activated and allowed to discharge outside of the trashcan for at least 30 seconds. After the initial discharge, pump tubing will be directed into the trashcan such that the decontamination mixture is recirculated through the pump and tubing. The pump should run/recirculate a minimum of ten pump-tubing volumes (about 40 gallons) through the system. This process should take about 15 to 20 minutes.

Note: in the event that the pump or tubing has sediment or other foreign matter on it, a step will be added. A clean scrub brush will be used to remove any sediment or other foreign matter from the equipment manually prior to the circulation process.

Next, the decontamination mixture will be allowed to pump out of the trashcan into the sink (the pump should not be allowed to run dry or cavitate). The pump and tubing will be placed on a clean surface (plastic sheet) and the trashcan rinsed in clean water. The pump will be rinsed and placed back into the trashcan. The pump is to be allowed to discharge outside of the trashcan until the soapy water is evacuated from the tubing. The discharge tubing will then be placed back into the trashcan and more clean water added if needed. The freshwater will be recirculated through the pump and into the trashcan for a minimum of ten volumes (about 40 gallons). Once circulation is complete, the pump will be allowed to discharge outside the trashcan until nearly empty (again, the pump should not be allowed to run dry or cavitate). Next, a final rinse of DI water will be provided on the pump and tubing, an adequate volume being used to ensure that the pump and tubing are well rinsed.

Upon completion of the decontamination procedure, the pump will be sealed in a clean plastic bag, and the end of the pump tubing will be sealed in its own clean plastic bag. A rubber band can be used to affix the bags around the apparatus. Pump and hose assembly are to be stored indoors when not in use, away from any sources of cross-contamination.

Tubing Decontamination for Peristaltic Pumps:
Decontamination should be accomplished as follows for peristaltic pump tubing. Sampler will wear new, disposable, nitrile (or equivalent) gloves to perform the decontamination.

Materials needed:

- Four five- or seven-gallon plastic buckets (for decon use only)
- Alconox® or laboratory-grade soap
- DI water
- Large plastic bags that can be sealed (large zip-top bags)
- Plastic sheeting
- Clean scrub brush(s)

The designated buckets will be rinsed in fresh, potable water. The first bucket will be subsequently filled with potable water and laboratory-grade soap (per soap label directions). The next two buckets will be filled with clean tap water. All three decontamination buckets are to be placed on top of a clean sheet of plastic sufficiently long to provide a clean surface on which all decontamination can take place. Decon buckets are to be placed in order on the sheet, with the soap bucket first, followed by the two rinse buckets. Decontamination should proceed such that each step is always followed in order from most contaminated to least contaminated (i.e., from prewash if needed, to soap–water mixture, to first rinse bucket, to second rinse bucket, to final DI water rinse).

Any excess foreign material will be removed from the tubing, first by wiping or scrubbing with soap and water mixture (if needed). The suction side of the tubing will be lowered into the soap–water bucket. The pump will be activated and allowed to discharge outside of the bucket until the soap–water mixture has initially purged the tubing. After the initial discharge, the pump tubing will be directed into the bucket such that the decontamination mixture is recirculated through the tubing. The pump will be allowed to run a minimum of ten pump-tubing volumes through the system (or about eight to ten gallons).

Next, the suction end of the tubing will be placed into the first rinse bucket and the pump allowed to discharge into the soap bucket until the soapy water is evacuated from the tubing. The discharge side of the tubing will then be placed back into the first rinse bucket. The freshwater will be allowed to recirculate through the pump and into the first rinse bucket for a minimum of ten volumes (or about eight to ten gallons). Once circulation is complete, the process will be repeated using the second rinse bucket. Final rinse is to be accomplished by pumping/recirculating DI water through the tubing for a minimum of ten volumes, using the third rinse bucket filled with DI water. Next, a final rinse of DI water will be provided on the outside of the tubing using an adequate volume to ensure that the tubing is well rinsed. This final rinse will complete the decontamination process.

Upon completion of the decontamination procedure, the tubing will be allowed to dry and the tubing seal placed in a plastic bag to prevent exposure to cross-contamination. Bagged tubing is to be stored indoors when not in use away from any sources of cross-contamination.

Note: peristaltic tubing for EAHCP samples is dedicated tubing and is to be stored in *labeled* bags. The bag label will have the name of the sample point written on the outside of it. EAHCP-related tubing is not to be used for any other applications.

Decontamination of Other Equipment Used in Collection of Water or Soil Samples

Decontamination will be accomplished as follows for other equipment that will come into direct contact with sample media (dippers, churns, sample probes—if placed into sample media, water level measurement devices, soil sampling devices, or trowels). Sampler will wear new, disposable, nitrile (or equivalent) gloves to perform the decontamination.

Materials needed:

- Sample-collection device (dipper, churn, etc.) or field meter (applies only to that part of the probe exposed to sample media) or water level measurement device
- Three five- or seven-gallon plastic buckets (for decon use only)
- Alconox® or laboratory-grade soap
- DI water
- Large plastic bags or foil
- Plastic sheeting
- Clean scrub brush

Designated buckets will be rinsed in fresh, potable water. The first bucket will be subsequently filled with potable water and laboratory-grade soap (per soap label directions). The remaining two buckets will be filled with clean tap water. All three decontamination buckets are to be placed on top of a clean sheet of plastic sufficiently long to provide a clean surface on which all decontamination will take place. Decon buckets are to be placed in order on the sheet, with the soap bucket first, followed by the two rinse buckets. Decontamination will proceed such that each step is always followed in order from most contaminated to least contaminated (i.e., from prewash if needed, to soap–water mixture, to first rinse bucket, to second rinse bucket, to final DI water rinse).

Any excess sediment or foreign matter will be removed from the device by gentle scrubbing and rinsing with water prior to placement into the soap–water mixture. The sampling device will be placed into the soap–water mixture and gently scrubbed (all surfaces that will come into contact with sample media must be cleaned).

Note: the surface water churn may not fit in the bucket(s), as such the churn may be cleaned in the 33-gallon trashcan, or it may be cleaned by some of the soap–water mixture being poured into the churn. The churn will be cleaned with the soap–water mixture; double rinsed in clean, potable water; and provided a final rinse in DI water.

Upon completion of the soap–water wash, each device being decontaminated must be double rinsed (i.e., buckets two and three) in clean, potable water, followed by a final rinse in DI water. Upon completion of decontamination, equipment will be allowed to dry and stored such that it is not exposed to potential contaminants. Equipment should be stored in plastic bags or wrapped in foil to further insulate it from potential contamination.

Note: decontamination buckets are to be monitored when used for multiple items to ensure that the soap–water mixture does not become spent or ineffective. They are to be replaced as needed. Also, rinse water should be replaced regularly when it appears to have a significant accumulation of soap.

Special Decontamination Procedures

Downhole or soil-sampling equipment may be decontaminated generally by one of the applicable processes outlined above. However, in rare cases, a tool or device that is not disposable may be exposed to hydrocarbon residue or, in rarer cases, high concentrations of heavy metals may occur. In such a scenario, the tool may (at the discretion of management) require a more elaborate decontamination procedure.

Exposure to Hydrocarbons

In the event that a tool is exposed to free-product hydrocarbons, an additional step in the decontamination process may be required that will involve spraying the tool with pesticide-grade methanol or hexane prior to the final DI water rinse. Use of solvents in this case serves to remove any hydrocarbon residual from the tool.

Exposure to Heavy Metals

In the event that a tool or device is exposed to heavy metals, and the sample media are being analyzed for these same metals, another step in the decontamination process may be required. In this case, the tool may require a spray rinse with dilute (10%) hydrochloric or nitric acid prior to DI water rinse. Use of acid in this situation will act to remove residual metals from the tool.

Note: use of solvents or acids is only to be pursued if directed by management. Use of these products can be hazardous and can also present issues regarding disposal of the waste products themselves. Use of the products may also damage sampling equipment in some cases. In the vast majority of cases, the standard washing and rinsing procedures described herein are adequate for proper decontamination of sampling equipment. Analysis of equipment blanks will be pursued when needed so that the decontamination process might be assessed. It is the responsibility of the sampler to notify management if a tool is suspected of any unusual exposure

APPENDIX E

PHOTOGRAPHIC LOG

Photographic Log For Comal and San Marcos Springs

Photo 1. Installed PDS deployment device on February 1, 2018; Sample location HCS430.

Photo 2. Installing PDS Deployment device on August 1, 2018; Sample location HSM450.

Photo 3. Locking the POCIS stainless-stell encasement sampler onto the chain with buoys that spans the Comal River at HCS460.

Photo 4. In the process of installing PDS on October 1, 2018; Sample location HCS430.

Photo 5. Retrieving PDS Deployment Device on August 15, 2018; Sample location HCS410

Photo 6. Installed PDS deployment device at HSM430.

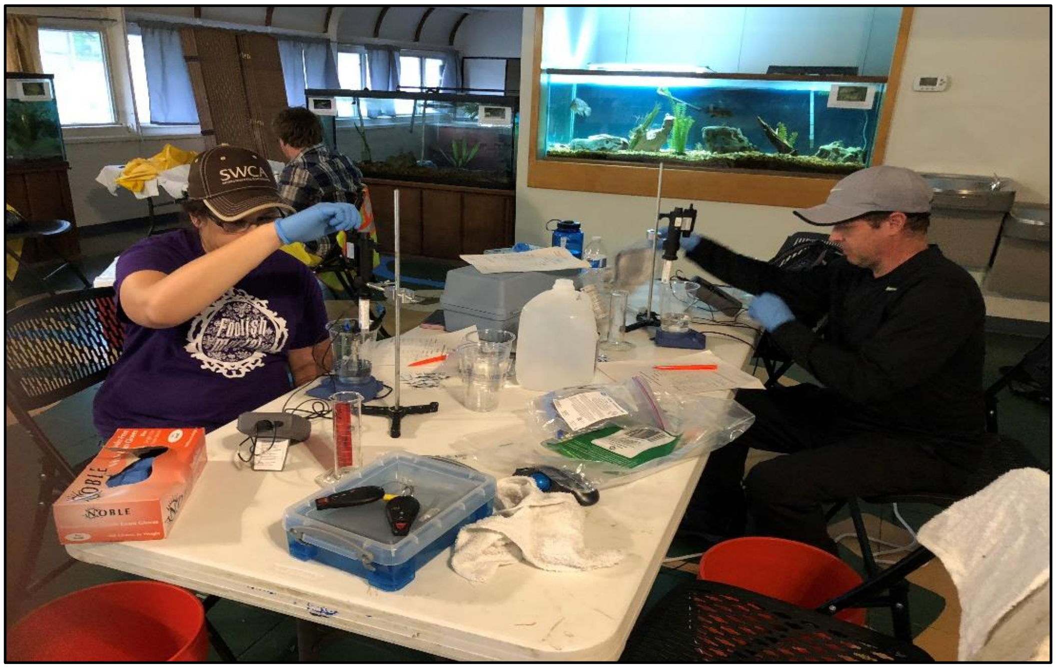


Photo 7. Alkalinity testing during San Marcos stormwater event on May 4, 2018.

Photo 8. Set of sample coolers during the San Marcos stormwater sampling event on May 4, 2018

APPENDIX F

RECORD OF STORMWATER SAMPLING

During the month of January 2018, SWCA staff restocked and assembled necessary supplies and equipment. All sample bottles were labeled with the exception of sample date, sample time, and sampler initials. Each sample kits was kept in separate ice chest that was labeled and color coded for sample location. All kits for both the Comal and San Marcos Springs complexes were prepared in January. Staff then went on standby for sampling events when all preparations were complete.

COMAL SPRINGS COMPLEX

March 28, 2018 – SWCA staff mobilized to New Braunfels in the evening of March 27, 2018. A base camp was established at the Schlitterbahn Resort, by 21:00. Rain began to fall at around 03:00 on March 28, 2018, and lead sampling was initiated at 3:30 after real-time instruments installed in Comal River indicated a change in water quality had occurred as a result of stormwater runoff entering the river. Peak sampling was initiated at approximately 06:30 on March 28, 2018, after the specific conductivity measurements from RTIs indicated a rise in readings had occurred. Trail sampling was initiated at approximately 09:30. A second wave of strong thunderstorms started to pass through the area before all of the trail samples were collected. Samples were brought back to the SWCA San Antonio office and were packaged for shipment. TestAmerica picked up the samples along with completed chain-of-custody forms. The samples were successfully delivered to Test America Laboratory the following morning, March 29, 2018.

SAN MARCOS RIVER COMPLEX

May 4, 2018 – SWCA staff mobilized to San Marcos in the early morning of May 4, 2018. A base camp was established at the San Marcos Discovery Center, by 07:00. Rain began to fall at around 10:30 on May 4, 2018, and lead sampling was initiated at 11:00 after real-time instruments installed in San Marcos River indicated a change in water quality had occurred as a result of stormwater runoff entering the river. Peak sampling was initiated at approximately 13:00 on May 4, 2018, after the specific conductivity measurements from RTIs indicated a rise in reading had occurred. Trail sampling was initiated at approximately 17:00. After the trail sample was collected, the sample teams returned to the SWCA San Antonio office with the samples in order to package them for shipment. Because the stormwater event occurred on Friday, May 4, 2018, the samples were picked up on Monday, May 7, 2018 by TestAmerica Laboratories personnel. SWCA iced samples throughout the weekend.

APPENDIX G

LABORATORY REPORTS

(Laboratory reports have been provided to the Edwards Aquifer Authority in a digital format.)

APPENDIX H

ANALYTICAL DATA VALIDATION DISCUSSION

Introduction

This appendix provides an overview of SWCA Environmental Consultants' (SWCA's) post-analyses review of the contract laboratories analytical data set. In general, the data are considered valid for the intended purpose of assessing the baseline of sediment quality, stormwater runoff quality, and baseline surface water quality through passive diffusion sampler (PDSs) and polar organic chemical integrated sampler (POCIS) screening for Comal and San Marcos Springs. Analyses with any associated laboratory issues are listed herein.

Worth noting in this assessment are the detection of plasticizer compounds such as bis(2-ethylhexyl) phthalate (DEHP) and other phthalate compounds. While it is possible these compounds were introduced post-sample collection from either sampling equipment or laboratory equipment, they should not be completely dismissed.

Based on analysis of 2013 laboratory data, the Edwards Aquifer Authority (EAA) concluded that three compounds detected in sediment samples may have been laboratory artifacts. The compounds were DEHP, di-n-octyl phthalate, and di-n-butyl phthalate. The EAA noted in the 2013 *Edwards Aquifer Habitat Conservation Plan Expanded Water Quality Report* that as the data set grows, additional conclusions could be drawn. The 2014 laboratory analyses of sediment samples did not detect di-n-octyl phthalate or di-n-butyl phthalate. However, DEHP was detected in three of the sediment samples in 2014 (HSM320, HSM330, and HSM350). DEHP was also detected in the three of the 2015 sediment samples (HSM330, HSM340, and HSM350). With the exception of sample location HCS340, only stainless-steel sample trowels were used during 2015 sediment sampling. In the 2015 annual report, SWCA concluded that continued detections of DEHP indicated that DEHP may be present in the middle reaches of the San Marcos Springs complex. In 2016, DEHP was again detected in many of the sediment samples (all samples except HSM310) from both the Comal and San Marcos Spring complexes. DEHP was also detected in multiple base flow and stormwater samples collected in September and November from both spring complexes. In 2018, DEHP was detected in multiple stormwater samples collected in March and May. However, DEHP was not detected in any sediment samples, but was detected in the sediment sample collection equipment blank samples.

Analytical results are discussed by analytical laboratory sample data group number, and by sample event type and date. Each event (sediment, stormwater, PDS, or POCIS) is discussed by sample data group with sample names and date outlined for each event in the beginning of the discussion.

A key to sample names is provided below:

Key to Sample Names

H CS 1 10

H=HCP
CS=Comal Springs (**SM**=San Marcos Springs)
1=Sample Type (1=Surface Water (Base Flow), 2=Storm, 3=Sediment, 4=PDS)
10=Sample Location

Field Duplicates are identified with the prefix “FD” followed by the sample identification described above. Trip Blank samples are denoted with the prefix “TB” followed by a sequential number. Equipment Blank samples are denoted with the prefix “EB” followed by a sequential number.

Analytical Data Review Summary for HCP Samples Collected in 2018

Data Group Numbers **(HCP stormwater samples collected March 28, 2018, at Comal Springs):**

560-72923-1 (HCS210 Lead 1)
560-72923-2 (HCS210 Lead 2)
560-72923-3 (HCS210 Lead 3)
560-72923-4 (HCS240 Lead)
560-72923-5 (HCS250 Lead)
560-72923-6 (HCS260 Lead 1)
560-72923-7 (HCS270 Lead 2)
560-72923-8 (HCS260 Lead 3)
560-72923-9 (HCS270 Lead)
560-72923-10 (HCS210 Peak)
560-72923-11 (HCS240 Peak)
560-72923-12 (HCS250 Peak)
560-72923-13 (HCS260 Peak)
560-72923-14 (HCS270 Peak)
560-72923-15 (HCS210 Trail)
560-72923-16 (HCS240 Trail)
560-72923-17 (FDHCS240 Trail)
560-72923-18 (HCS250 Trail)
560-72923-19 (HCS260 Trail)
560-72923-20 (FDHCS260 Trail)
560-72923-21 (HCS270 Trail)

General Comments

Although some analytical issues are noted for the data group, unless otherwise noted in the detailed discussion, the data are considered valid for the purposes of the investigation. pH values are collected in the field at the time of sample collection and are listed in the field parameters for each sample event. As such, the laboratory pH values that are flagged for hold time exceedances are not used for sample assessment purposes.

Lead and peak samples were collected outside of laboratory operating hours. Therefore, lead and peak *E. coli* samples were analyzed outside of their hold times.

Trip Blank

There were no detections in the trip blank associated with these samples.

QA/QC Discussion – Comal Springs Stormwater Samples (Sampled March 28, 2018)

Issues associated with work order 560-72923

Method 8151A – Sample container for HCS210 Trail (560-72923-15) was received broken.

Method 8260 – The RPD for the MS/MSD recoveries was outside of acceptable limits for ethylene oxide. The associated LCS recovery was within acceptance limits. Therefore, the results are accepted.

Method 8270 – The percent recovery results for the MS/MSD associated with batch 560-149590 were outside acceptable limits for various analytes. The associated LCS was within acceptable limits, therefore, data are reported.

Method 8141A, 8141B– The 8141 continuing calibration verification (CCV) associated with batch 280-411566 recovered outside acceptance criteria, low biased, for Naled. A reporting limit (RL) standard was analyzed, and the target analyte was detected. Since the associated samples were non-detect for this analyte, the data have been reported. It is known that Naled breaks down into Dichlorvos. Dichlorvos was not detected in the samples and is an additional indicator that Naled is not present in the sample.

Method 8141A– The analyte Demeton recovered outside control limits (low) in the laboratory control sample and laboratory control sample duplicate (LCS/D) for preparation batch 280-409825 and analytical batch 280-411566. The laboratory Project Manager (PM) requested re-extraction/reanalysis for the sample out of hold and both sets of results reported for sample 560-72923-1.

Method 8141A– The RPD of the LCS and LCSD for preparation batch 280-409825 and analytical batch 280-411566 recovered outside control limits for Dimethoate and Fensulfothion.

Method 8141A – The initial calibration verification (ICV) results for batch 280-411566 was outside control limits for Mevinphos on the front column. The back column was in control. Sample results were non-detects and have been reported form the column in control.

Method 8141A – The following samples were diluted due to the dark color of the extract: HCS210 Lead 2 (560-72923-2) and HCS210 Peak (560-72923-10) Elevated reporting limits (RL) are provided. When the sample was run undiluted it caused the CCVs to fail. Because of this dilution, the surrogate spike concentration in the sample was reduced to a level where the recovery calculation does not provide useful information in preparation batch 280-409801 and analytical batch 280-411626.

Method 8141A – Surrogate is outside control limits for Chlormefos in HCS210 Peak.

Method 8141A – The CCV associated with batch 280-411626 recovered above the upper control limit for Famphur, Malathion, and Merphos on the front column. The back column was in control for the impacted compounds. The samples associated with this CCV were non-detects for the affected analytes; therefore, the data have been reported. The following samples are impacted: HCS210 Lead 2 (560-72923-2), HCS210 Lead 3 (560-72923-3) , HCS240 Lead (560-72923-4), HCS250 Lead (560-72923-5), HCS260 Lead 1 (560-72923-6), HCS260 Lead 2 (560-72923-7) , HCS260 Lead 3 (560-72923-8), HCS270 Lead (560-72923-9), HCS210 Peak (560-72923-10), HCS240 Peak (560-72923-11), HCS250 Peak (560-72923-12) , HCS260 Peak (560-72923-13) , HCS270 Peak (560-72923-14), HCS210 Trail (560-72923-15), HCS240 Trail (560-72923-16), FDHCS240 Trail (560-72923-17), HCS250 Trail (560-72923-18), HCS260 Trail (560-72923-19) , FDHCS260 Trail (560-72923-20), and HCS270 Trail (560-72923-21) .

The CCV associated with batch 280-411626 recovered outside acceptance criteria, low biased for Dchlorvos, Dimethoate, and Naled on one column. The other column is in control for the impacted compounds. A RL standard was analyzed, and the target was detected. Since the associated samples were non-detect for this analyte, the data have been reported from the in-control column. The following samples are impacted HCS210 Lead 2 (560-72923-2), HCS210 Lead 3 (560 – 72923-3), HCS240 Lead (560 – 72923-4) HCS250 Lead (560-72923-5), HCS260 Lead 1 (560-72923-6), HCS260 Lead 2 (560-72923-7), HCS260 Lead 3 (560-72923-8), HCS270 Lead (560 – 792923-9), HCS210 Peak (560-72923-10), HCS240 Peak (560-72923-11), HCS250 Peak (560-72923-12), HCS260 Peak (560-72923-13) HCS270 Peak (560-72923-14), HCS210 Trail (560-72923-15), HCS240 Trail (560-72923-16), FDHCS240 Trail (560-72923-17), HCS250 Trail (560-72923-18), HCS260 Trail (560-72923-19), FDHCS260 Trail (560-72923-20), and HCS270 Trail (560-72923-21).

Method 8141A – The ICV result for batch 280-411626 was outside control limits for Mevinphos (-16%) on the front column. The back column is in control. Sample results were non-detects, and have been reported as qualified data. All Mevinphos results are reported from the column in control.

Method 8141A – The CCV associated with batch 280-412706 recovered above the upper control limit for Famphur (+24%) on the front column. The back column is in control. The sample HCS210 Lead 1 (560-72923-1) associated with this CCV were non-detects for the affected analytes; therefore, the data have bene reported form the back, in control, column.

Method 8151A– The analyte 2,4-DB recovered outside control limits for the LCS associated with preparation batch 680-518203 and analytical batch 680-518575. This is not indicative of a systematic control problem because these were random marginal exceedances. Qualified results have been reported.

Method 8151 – The percent recovery results for MS/MSD associated with batch 518575 were outside acceptable limits for Mecprop. The LCS was within acceptable limits, therefore, data are reported and accepted.

Method 8151 – The percent recovery results for the MS/MSD pair associated with batch 518575 were outside acceptable limits for Mecprop and MCPA. The LCS was within acceptable limits, therefore, data are reported and accepted.

Method 8151A – The percent RPD between the primary and confirmation column/detector is >40% for 2,4-D. The lower values have been reported. Samples affected HCS210 Lead 3 and HCS260 Peak.

Method 8151A – MS and/or MSD Recovery is outside acceptance limits for MCPA and 2,4-D for analytical batch 518575. No MCPA was detected and the results are accepted.

Method 8151A – The percent RPD between the primary and confirmation column/detector is >40% for Dalapon for analytical batch 518575 and 518815; 2,4-D for analytical batch 518575; and Mecoprop for analytical batch 518815. The results are accepted.

Method 6020 – The serial dilution performed for the following sample associated with batch 560-149786 was outside control limits: Ba 46% (560-72923-T-21-A SD).

Method 6020 – The serial dilution performed for the following sampled associated with batch 560-149786 was outside control limits: Ba 27% (560-72923-T-20-A SD)

Method 6010B: The serial dilution performed for the following sample associated with batch 560-149808 was outside control limits: (560-72923-T-20-F SD)

Method 6010B– The serial dilution performed for the following sample associated with batch 560-149874 was outside control limits (560-72923-T-21-D SD)

Method 6010: Percent recovery results for the MS/MSD pair, the MS or the MSD associated with batch 149874 were outside acceptable limits for various analytes. The LCS was within acceptable limits, therefore, data are reported and accepted.

Method 6010 – The relative percent deviation (RPD) was outside acceptable limits for Calcium in the MS/MSD pair associated with batch 149874. The LCS was within acceptable limits, therefore, data are reported and accepted.

Method 300 – Percent recovery results for the MS/MSD pair associated with batches 149497 and 149534 were outside acceptable limits for Bromide and/or Sulfate and/or Nitrate. The LCS was within acceptable limits, therefore, data are reported and accepted.

Method 300 – The RPD was outside acceptable limits for Sulfate in the MS/MSD pair associated with batch 149497. The LCS was within acceptable limits, therefore, data are reported and accepted.

Method 351.2 - Percent recovery results for the MS/MSD pair, the MS or the MSD associated with batch 235972 were outside acceptable limits for TKN. The LCS was within acceptable limits, therefore, data are reported and accepted.

Method 7470A – MS and/or MSD recovery is outside acceptance limit for bromide in sample HCS210 Lead 1.

Method 7470A – MS and/or MSD recovery is outside acceptance limits for bromide and nitrate for sample HCS240 Peak; and Nitrogen, Kjeladahl for sample HCS270 Trail.

Method 3510C: The following samples formed emulsions during the extraction procedure: HCS210 Lead 2 (560-72923-2), HCS210 Lead 3 (560-72923-3), HCS210 Peak (560-72923-10), HCS210 Trail (560-72923-15) and HCS260 Trail (560-72923-19). The emulsions were broken up using pour backs on spins two and three for samples 2 and 3. Sample 10 and 19 used pour backs on the second spin only. Sample 15 used the pour back on the second spin only. Batch: 409801 Method: 351C Analysis: 8141A

Method 3510C: Insufficient sample volume was available to perform a matrix spike/matrix spike duplicate (MS/MSD) associated with Batch: 409825 Method: 3510C/8141

Method 3510C: The following sample formed emulsions during the extraction procedure: HCS210 Lead 1 (560-72923-1). The emulsions were broken up using a pour back on all three extractions. Batch: 409825 Method: 3510C/8141

Method(s) 3510C, 614: Insufficient sample volume was available to perform a matrix spike/matrix spike duplicate (MS/MSD) associated with preparation batch 280-411920. Method: 3510C/8141A/8141B/614

Data Group Numbers **(HCP stormwater samples collected May 4, 2018, at San Marcos):**

560-73550-1 (HSM 210 Lead 1)
560-73550-2 (HSM 210 Lead 2)
560-73550-3 (HSM 210 Lead 3)
560-73550-4 (HSM 230 Lead 1)
560-73550-5 (HSM 230 Lead 2)
560-73550-6 (HSM 230 Lead 3)
560-73550-7 (HSM 231 Lead)
560-73550-8 (HSM 240 Lead)
560-73550-9 (HSM 250 Lead)
560-73550-10 (HSM 260 Lead)
560-73550-11 (HSM 270 Lead)
560-73550-12 (HSM 210 Peak)
560-73550-13 (HSM 230 Peak)
560-73550-14 (HSM 231 Peak)
560-73550-15 (HSM 240 Peak)
560-73550-16 (HSM 250 Peak)
560-73550-17 (HSM 260 Peak)
560-73550-18 (HSM 270 Peak)
560-73550-19 (HSM 210 Trail)
560-73550-20 (FDHSM 210 Trail)
560-73550-21 (HSM 230 Trail)
560-73550-22 (FDHSM 230 Trail)
560-73550-23 (HSM 231 Trail)
560-73550-24 (HSM 240 Trail)
560-73550-25 (HSM 250 Trail)
560-73550-26 (HSM 260 Trail)
560-73550-27 (FDHSM 260 Trail)
560-73550-28 (HSM 270 Trail)
560-73550-29 (TB4)

General Comments

Although some analytical issues are noted for the data group, unless otherwise noted in the detailed discussion, the data are considered valid for the purposes of the investigation. pH values are collected in the field at the time of sample collection and are listed in the field parameters for each sample event. As such, the laboratory pH values that are flagged for hold time exceedances are not used for sample assessment purposes. Lead and peak samples were collected outside of laboratory operating hours. Therefore, lead and peak *E. coli* samples were analyzed outside of their hold times.

Trip Blanks

There were no detections in the trip blank associated with these samples.

QA/QC Discussion – San Marcos Stormwater Samples (Sampled May 4, 2018)

Issues associated with work order 560-73550

Method(s) 8260B: The method blank for analytical batch 560-150678 contained Methylene Chloride above the method detection limit. This target analyte concentration was less than the reporting limit (RL); therefore, re-extraction and/or re-analysis of samples were not performed. The results are accepted.

Method(s) 8270C: The continuing calibration verification (CCV) associated with batch 560-150689 recovered above the upper control limit for 4-Nitrophenol.The samples associated with this CCV were non-detects for the affected analytes; therefore, the data have been reported and are accepted.

Method 8270C: MS and/or MSD recovery is outside acceptance limits for multiple analytes in sample HSM231 Trail. No SVOCs were detected in this sample, and the results are accepted.

Method(s) 8141A: Several compounds were detected above the reporting limit (RL) in the method blank associated with preparation batch 280-414338 and 280-414338 and analytical batch 280-415420 for the following samples: HSM210 Lead 1 (560-73550-1), HSM210 Lead 2 (560-73550-2), HSM210 Lead 3 (560-73550-3), HSM230 Lead 1 (560-73550-4), HSM230 Lead 2 (560-73550-5), HSM230 Lead 3 (560-73550-6), HSM231 Lead (560-73550-7), HSM240 Lead (560-73550-8), HSM250 Lead (560-73550-9), HSM260 Lead (560-73550-10), HSM270 Lead (560-73550-11), HSM210 Peak (560-73550-12), HSM230 Peak (560-73550-13), HSM231 Peak (560-73550-14), HSM240 Peak (560-73550-15), HSM250 Peak (560-73550-16), HSM260 Peak (560-73550-17), HSM270 Peak (560-73550-18), HSM210 Trail (560-73550-19), HSM231 Trail (560-73550-23) and MS-HSM231 Trail (560-73550-23[MS]). The method blank also had ISTD failures due to contamination. All affected samples were re-extracted and re-analyzed outside of holding time. Both sets of data have been reported - all compounds other than Merphos are reported from the in hold analysis and the Merphos results are reported from the reextraction (out of hold). There was another client's sample that has been identified as contaminating the concentration equipment with Merphos. All Merphos results are reported from the reextraction because the impact of contamination is less substantial with all Merphos results less than 1/2 the RL. 8141. The results suggest no Merphos is present in the samples collected of stormwater during this event.

Sample 560-73550-14 also had detections for methyl parathion and EPN. These compounds were ND in the reextraction. These compounds, for this sample, are also being reported from the reextraction due to the possibility that the detections are due to the contamination. The results are accepted.

Method(s) 8141A: The continuing calibration verification (CCV) associated with batch 280-415420 recovered above the upper control limit for Dichlorvos. The samples associated with this CCV were non-detects for the affected analyte; therefore, the data have been reported and accepted. The following samples are impacted: HSM210 Lead 1 (560-73550-1), HSM210 Lead 2 (560-73550-2), HSM210 Lead 3 (560-73550-3), HSM230 Lead 1 (560-73550-4), HSM230 Lead 2 (560-73550-5), HSM230 Lead 3 (560-73550-6), HSM231 Lead (560-73550-7), HSM240 Lead (560-73550-8), HSM250 Lead (560-73550-9), HSM260 Lead (560-73550-10), HSM270 Lead (560-73550-11), HSM210 Peak (560-73550-12), HSM230 Peak (560-73550-13), HSM231 Peak (560-73550-14), HSM240 Peak (560-73550-15), HSM250 Peak (560-73550-16), HSM260 Peak (560-73550-17), HSM270 Peak (560-73550-18), HSM210 Trail (560-73550-19) and HSM231 Trail (560-73550-23).

Method(s) 8141A: Surrogate recovery for the following sample was outside control limits (low) for the reextraction: HSM270 Lead (560-73550-11). The original analysis had in control surrogate recoveries. Data is being reported for Merphos only. 8141 preparation batch 280-415813 and analytical batch 280-417946. Blank sample data suggest Merphos is not present in the samples analyzed.

Triphenylphosphate 58% (limits 60-154%) Chlormefos 48% (limits 49-171%). The results are accepted.

Method(s) 8141A: The continuing calibration verification (CCV) associated to the following samples were out of control for Merphos and Chlormefos: HSM210 Lead 1 (560-73550-1), HSM210 Lead 2 (560-73550-2), HSM210 Lead 3 (560-73550-3), HSM230 Lead 1 (560-73550-4), HSM230 Lead 2 (560-73550-5), HSM230 Lead 3 (560-73550-6), HSM231 Lead (560-73550-7), HSM240 Lead (560-73550-8), HSM250 Lead (560-73550-9), HSM260 Lead (560-73550-10), HSM270 Lead (560-73550-11), HSM210

Peak (560-73550-12), HSM230 Peak (560-73550-13), HSM231 Peak (560-73550-14), HSM240 Peak (560-73550-15), HSM250 Peak (560-73550-16), HSM260 Peak (560-73550-17), HSM270 Peak (560-73550-18), HSM210 Trail (560-73550-19), HSM231 Trail (560-73550-23), MS-HSM231 Trail (560-73550-23[MS]) and MSD-HSM231 Trail (560-73550-23[MSD]). The surrogate, Chlormefos, was below the lower control limit on the front column. It was in control on the back column. All surrogate recoveries are reported from the back, in control, column. Merphos recovered above the upper control limit for the closing CCV. All Merphos results are estimated values that are well below 1/2 the reporting limit. The Merphos results are further estimated values because of the presence of a known low level Merphos contamination in the extract concentration equipment that has been observed in all extracts extracted and concentrated at the time of this batch. 8141 preparation batch 280-415813 and analytical batch 280-417946. The blank sample analysis results suggests Merphos was not present in the stormwater samples collected.

CCVIS (front) Chlormefos -16%; (back) in control CCV (front) Chlormefos -17%; (back) in control CCV (front) Chlormefos -16% and Merphos +16%; (back) Merphos +17%. The blank sample analysis results suggest Merphos was not present in the stormwater samples collected.

Method 8141A: MS and/or MSD recovery is outside acceptance limits for Chlorpyrifos in sample HSM231 Trail.

Method 8141 A: MS/MSD RPD exceeds control limits for chlorpyrifos, malathion, and tetrachlorvinphos in HSM231 Trail.

Method(s) 8081B: Surrogate recovery for the following sample was outside the upper control limit: HSM250 Lead (560-73550-9). This sample did not contain any target analytes; therefore, re-extraction and/or re-analysis was not performed. The results are accepted.

Method(s) 8151A: The method blank for preparation batch 680-523351 and analytical batch 680-523880 contained 2,4-D above the method detection limit (MDL). Associated samples were not re-analyzed because results were less than the reporting limit (RL).

Method(s) 6010B: The method blank for preparation batch 560-150691 and analytical batch 560-150718 contained Na above the method detection limit. This target analyte concentration was less than the reporting limit (RL); therefore, re-extraction and/or re-analysis of samples was not performed.

Method(s) 6020: The method blank for preparation batch 560-150698 and analytical batch 560-150732 contained Ni above the reporting limit (RL). This target analyte concentration was less than the project-specific action limit; therefore, re-extraction and/or re-analysis of samples was not performed.

Method 6020 – Selenium was found in the blank and sample for HSM210 Lead 1, HSM210 Lead 2, HSM 210 Lead 3, HSM240 Lead, HSM250 Lead, HSM260 Lead, HSM 270 Lead, HSM 230 Lead 1, HSM 230 Lead 2, HSM 230 Lead 3, HSM 231 Lead, HSM210 Trail, FDHSM 210 Trail, and HSM231 Trail.

Method 6020: Aluminum was found in the blank and sample for HSM231 Trail.

Method 6020: Iron was found in the blank and sample for FDHSM210 Trail.

Method 6020: Zinc was found in the blank and sample for HSM230 Trail and FDHSM230 Trail.

Method(s) 300.0: Spike compound Bromide was inadvertently omitted during the extraction process for the matrix spike/matrix spike duplicate (MS/MSD); therefore, matrix spike recoveries are unavailable for analytical batch 560-150739. The associated laboratory control sample (LCS) met acceptance criteria.

Method(s) 300.0: The method blank for analytical batch 560-150792 contained chloride above the method detection limit. This target analyte concentration was less than the reporting limit (RL); therefore, re-extraction and/or re-analysis of samples was not performed.

Method(s) 9060, SM 5310B: The matrix spike / matrix spike duplicate / sample duplicate (MS/MSD/DUP) precision for analytical batch 560-150841 was outside control limits. Sample matrix interference and/or non-homogeneity are suspected because the associated laboratory control sample / laboratory control sample duplicate (LCS/LCSD) precision was acceptance limits.

Method(s) 9060, SM 5310B: The matrix spike / matrix spike duplicate (MS/MSD) recoveries for analytical batch 560-150841 were outside control limits. Sample matrix interference and/or non-homogeneity are suspected because the associated laboratory control sample (LCS) recovery was within acceptance limits.

Method(s) 300.0: The method blank for analytical batch 560-150792 contained Chloride above the method detection limit. This target analyte concentration was less than the reporting limit (RL); therefore, re-extraction and/or re-analysis of samples was not performed.

Method(s) 300.0: All samples were received with less than 2 days remaining on the holding time or less than one shift (8 hours) remaining on a test with a holding time of 48 hours or less. As such, the laboratory had insufficient time remaining to perform the analysis within holding time.

Method(s) 3510C: The following samples formed emulsions during the extraction procedure: HSM230 Lead 1 (560-73550-4), HSM230 Lead 2 (560-73550-5), HSM230 Lead 3 (560-73550-6), HSM231 Lead (560-73550-7), HSM250 Lead (560-73550-9), HSM260 Lead (560-73550-10), HSM230 Peak (560-73550-13), HSM250 Peak (560-73550-16) and HSM270 Peak (560-73550-18). The emulsions were broken up using a pour back on all three extractions. Batch: 414338 Method: 3510C/8141

Method(s) 3520C: Due to insufficient sample volume sent for analysis the sample had to be re-extracted using 6 unpreserved VOA vials.

Data Group Numbers (HCP sediment samples collected June 27, 2018, at Comal and San Marcos Springs):

600-168455-1 (HCS 310)
600-168455-2 (HCS 320)
600-62017-3 (HCS 330)
600-62017-4 (FDHCS 330)
600-62017-5 (HCS 340)
600-62017-6 (HCS 360)

600-168454-1 (HSM 310)
600-168454-2 (HSM 320)
600-168454-3 (HSM 330)
600-168454-4 (HSM 340)
600-168454-5 (HSM 350)
600-168454-6 (HSM 360)
600-168454-7 (HSM 370)
600-168454-8 (FDHSM370)
600-168454-9 (Trip Blank 08)

560-74637-1 (Equipment Blank 1)
560-74637-2 (Equipment Blank 2)

General Comments

Although some analytical issues are noted for the data group, unless otherwise noted in the detailed discussion, the data are considered valid for the purposes of the investigation. Samples were collected in glass jars using stainless-steel trowels. The water depth and sediment availability at HCS 330 made collection with a trowel impossible. The HCS 330 sample was collected in a plastic sleeve using a hand core sampler and extruded into the glass sample jars.

Trip Blanks

There were no detections in the trip blanks associated with these samples.

Equipment Blanks

Two equipment blanks were collected. One sample was collected by pouring American Society for Testing and Materials (ASTM) Type II Reagent Grade water over a decontaminated trowel. The second sample was collected by pouring ASTM Type II Reagent Grade water through a new sample tube.

There were several compounds detected in both of the two equipment blanks. The detections are similar between each blank despite the differences in sampling equipment. SWCA suspects that the detected compounds were present in the ASTM Type II Reagent Grade water used or the compounds were introduced as laboratory contaminants. The plastic sample tube was a new, single-use tube from the box and was therefore not decontaminated, eliminating decontamination procedures as the source of interference. Many of the detections were "J" flagged and substantially lower than the levels detected in the sediment samples. Therefore, the equipment blank analyses results are not anticipated to have affected the usability of results of the sediment sample analyses. The equipment blank detections are summarized in Table 1.

Table 1. Detections in Sediment Equipment Blanks July 2018

Sample	Associated Equipment	Bis(2-ethylhexyl) Phthalate µg/L	Total Organic Carbon mg/L	Dissolved Organic Carbon mg/L	Zinc mg/L
EB01	Trowel	8.54 J	0.492 J B	0.466 J B	<0.00355
EB02	Sample tube	<5.00	0.410 J B	0.452 J B	0.0103 J

QA/QC Discussion – Comal and San Marcos Springs Sediment Samples
(Sampled June 27 and 28, 2018)

Issues associated with work order 600-168455

Method 8270C: The matrix spike / matrix spike duplicate (MS/MSD) recoveries and precision for preparation batch 600-242068 and analytical batch 600-242077 were outside control limits. Sample matrix interference and/or non-homogeneity are suspected.

Method 8270C: The laboratory control sample for preparation batch 600-242068 and analytical batch 600-242094 recovered outside control limits for the following analyte(s): Benzidine. Benzidine has been identified as a poor performing analyte when analyzed using this method; therefore, re-extraction/re-analysis was not performed. These results have been reported and qualified.

Method 8270C: Six surrogates are used for this analysis. The laboratory's SOP allows one acid and one base of these surrogates to be outside acceptance criteria without performing re-extraction/re-analysis. The following sample contained an allowable number of surrogate compounds outside limits: FDHCS 330 (600-168455-4). These results have been reported and qualified.

Method 8270C: The continuing calibration verification (CCV) associated with batch 600-242094 recovered above the upper control limit for Phenol and 2,2-oxybis(1-chloropropane). The samples associated with this CCV were non-detects for the affected analytes; therefore, the data have been reported. The following sample is impacted: (CCVIS 600-242094/2).

Method 8141A: The continuing calibration verification (CCV) associated with batch 280-423952 recovered above the upper control limit for Dichlorvos and Mevinphos. The samples associated with this CCV were non-detects for the affected analytes; therefore, the data have been reported. The following samples are impacted: HCS 310 (600-168455-1), HCS 330 (600-168455-3), HCS 340 (600-168455-5), HCS 360 (600-168455-6), (600-168455-F-5-C MS) and (600-168455-F-5-D MSD). CCV (front) Dichlorvos +23% and Mevinphos +20%; (back) In control CCV (front) Dichlorvos +45% and Mevinphos +17%; (back) Dichlorvos +43%

Method 8141A: The following samples were diluted due to the extracts being dark brown and viscous: HCS 310 (600-168455-1), HCS 330 (600-168455-3), HCS 340 (600-168455-5), HCS 360 (600-168455-6), (600-168455-F-5-C MS) and (600-168455-F-5-D MSD). Elevated reporting limits (RL) are provided. The dilution was performed to protect the analytical instrumentation. Because of this dilution, the surrogate spike and matrix spike concentration in the samples was reduced to a level where the recovery calculation does not provide useful information. 8141 preparation batch 280-421840 and analytical batch 280-423952.

Method 8141A: The laboratory control sample (LCS) associated with preparation batch 280-421596 and analytical batch 280-424441 was outside acceptance criteria (low) for most compounds. Re-extraction could not be performed within hold; therefore, the data have been reported. The batch matrix spike/matrix spike duplicate (MS/MSD) was within acceptance limits and may be used to evaluate matrix performance. 8141 HCS 320 (600-168455-2), FDHCS 330 (600-168455-4), (600-168454-F-1-A), (600-168454-F-1-B MS) and (600-168454-F-1-C MSD).

Method 8141A: The following samples were diluted due to the extract being viscous and being very dark: HCS 320 (600-168455-2), FDHCS 330 (600-168455-4), (600-168454-F-1-A), (600-168454-F-1-B MS) and (600-168454-F-1-C MSD). Elevated reporting limits (RL) are provided. The samples were diluted to protect the analytical instrumentation. Because of this dilution, the surrogate spike concentration in the samples was reduced to a level where the recovery calculation does not provide useful information. 8141 preparation batch 280-421596 and analytical batch 280-424441.

Method 8141A: The continuing calibration verification (CCV) associated with batch 280-424441 recovered above the upper control limit for Dichlorvos. The samples associated with this CCV were non-detects for the affected analytes; therefore, the data have been reported. The following samples are impacted: HCS 320 (600-168455-2), FDHCS 330 (600-168455-4), (600-168454-F-1-A), (600-168454-F-1-B MS) and (600-168454-F-1-C MSD).

The continuing calibration verification (CCV) associated with batch 280-424441 recovered outside acceptance criteria, low biased, for Demeton, Total and Disulfoton. A reporting limit (RL) standard was analyzed, and the target analyte was detected. Since the associated samples were non-detect for this analyte, the data have been reported. 8141 CCV (front) Dichlorvos +22%; (back) In control CCV (front) Demeton, Total -18%, Dichlorvos +45% and Disulfoton -16%; (back) Dichlorvos +33% CCV (front) Dichlorvos +43%; (back) Dichlorvos +31%.

Method 8082: Surrogate recovery for the following samples were outside control limits: HCS 310 (600-168455-1), HCS 320 (600-168455-2), FDHCS 330 (600-168455-4) and HCS 340 (600-168455-5). Evidence of matrix interference is present; therefore, re-extraction and/or re-analysis was not performed.

Method 8082: Compound Tetrachloro-m-xylene eluted outside the retention time window on the RTX-CLPesticides 1 column for the following sample: (LCS 600-242314/3-A). This retention time shift was taken into account when reviewing the sample(s) for target compounds.

Method 8082: Surrogate recovery for the following sample was outside control limits: HCS 360 (600-168455-6). Evidence of matrix interference is present; therefore, re-extraction and/or re-analysis was not performed.

Method 8151A: The continuing calibration verification (CCV) associated with batch 600-242533 recovered above the upper control limit for Dinoseb(25.5%). The samples associated with this CCV were non-detects for the affected analytes; therefore, the data have been reported. The following sample is impacted: (CCVRT 600-242533/2).

Method 8151A: The matrix spike / matrix spike duplicate (MS/MSD) recoveries for preparation batch 600-242376 and analytical batch 600-242533 were outside control limits. Sample matrix interference and/or non-homogeneity are suspected because the associated laboratory control sample (LCS) recovery was within acceptance limits.

Method 8151A: The matrix spike / matrix spike duplicate / sample duplicate (MS/MSD/DUP) precision for preparation batch 600-242376 and analytical batch 600-242533 was outside control limits. Sample matrix interference and/or non-homogeneity are suspected.

Method 8151A: The continuing calibration verification (CCV) associated with batch 600-242533 recovered above the upper control limit for DCAA(23.4%), Dichlorprop(16.3%) and 2,4,5-TP(18.7%). The samples associated with this CCV were non-detects for the affected analytes; therefore, the data have been reported. The following sample is impacted: (CCV 600-242533/35).

Method 8151A: Surrogate recovery for the following samples were outside control limits: HCS 310 (600-168455-1), HCS 320 (600-168455-2), HCS 330 (600-168455-3), FDHCS 330 (600-168455-4), HCS 340 (600-168455-5) and HCS 360 (600-168455-6). Evidence of matrix interference is present; therefore, re-extraction and/or re-analysis was not performed.

Method 8081A: The matrix spike / matrix spike duplicate (MS/MSD) recoveries for preparation batch 600-242314 and analytical batch 600-242318 were outside control limits. Sample matrix

Method 8081A: The matrix spike / matrix spike duplicate / sample duplicate (MS/MSD/DUP) precision for preparation batch 600-242314 and analytical batch 600-242318 was outside control limits. Sample matrix interference and/or non-homogeneity are suspected.

Method 8081A: Surrogate recovery for the following samples were outside control limits: HCS 310 (600-168455-1), HCS 320 (600-168455-2), HCS 330 (600-168455-3), HCS 340 (600-168455-5), (600-168454-A-2-E), (600-168454-A-2-F MS) and (600-168454-A-2-G MSD). Evidence of matrix interference is present; therefore, re-extraction and/or re-analysis was not performed.

Method 8081A: Surrogate recovery for the following sample was outside control limits: HCS 360 (600-168455-6). Evidence of matrix interference is present; therefore, re-extraction and/or re-analysis was not performed.

Method 8082: The following sample was diluted to bring the concentration of target analytes within the calibration range: HCS 320 (600-168455-2). Elevated reporting limits (RLs) are provided.

Method 8082: Surrogate recovery for the following sample was outside control limits: HCS 320 (600-168455-2). Evidence of matrix interference is present; therefore, re-extraction and/or re-analysis was not performed.

Method 6010C: The matrix spike (MS) recoveries for preparation batch 160-377514 and analytical batch 160-378210 were outside control limits for Silicon. Sample matrix interference is suspected because the associated laboratory control sample (LCS) recovery was within acceptance limits. (600-168454-H-1-B MS ^2)

Method 6010C: preparation batch 160-377514 and analytical batch 160-378210 The following sample was diluted due to the nature of the sample matrix, samples that are high in salts could cause instrument and QC failure: HCS 320 (600-168455-2). Elevated reporting limits (RLs) are provided.

Method 6010C: preparation batch 160-377514 and analytical batch 160-378210 The following samples were diluted to bring the concentration of target analytes within the calibration range: HCS 310 (600-168455-1), (600-168454-H-1-A ^2), (600-168454-H-1-B MS ^2), (600-168454-H-1-C MSD ^2) and (600-168454-H-1-A SD ^10). Elevated reporting limits (RLs) are provided.

Method 6010C: preparation batch 160-377514 and analytical batch 160-379162 The following samples were diluted to bring the concentration of target analytes within the calibration range: HCS 330 (600-168455-3), FDHCS 330 (600-168455-4), HCS 340 (600-168455-5) and HCS 360 (600-168455-6). Elevated reporting limits (RLs) are provided.

Method 7471A: The sample duplicate (DUP) precision for preparation batch 600-242400 and analytical batch 600-242735 was outside control limits. Sample non-homogeneity is suspected.

Method 6010B: The method blank for Prep Batch 242288 contained Barium, Manganese and Zinc above the method detection limit. These target analyte concentrations were less than the reporting limit (RL); therefore, re-extraction and/or re-analysis of samples was not performed.

Method 6010B: The method blank for Prep Batch 242928 contained Barium, Calcium and Sodium above the method detection limit. These target analyte concentrations were less than the reporting limit (RL); therefore, re-extraction and/or re-analysis of samples was not performed.

Method 6010B: The method blank for Prep Batch 243344 contained Aluminum, Sodium, Calcium and Strontium above the method detection limit. These target analyte concentrations were less than the reporting limit (RL); therefore, re-extraction and/or re-analysis of samples was not performed.

Method 3546: The following samples required a Florisil clean-up, via EPA Method 3620B, to reduce matrix interferences: HCS 310 (600-168455-1), HCS 320 (600-168455-2), HCS 330 (600-168455-3), FDHCS 330 (600-168455-4), HCS 340 (600-168455-5) and HCS 360 (600-168455-6).

Method 3546: The following samples required a sulfuric acid clean-up, via EPA Method 3665A, to reduce matrix interferences: HCS 310 (600-168455-1), HCS 320 (600-168455-2), HCS 330 (600-168455-3), FDHCS 330 (600-168455-4), HCS 340 (600-168455-5) and HCS 360 (600-168455-6).

Issues associated with work order 600-168454

Analytical batch 600-242077 were outside control limits. Sample matrix interference and/or non-homogeneity are suspected.

Method 8270C: The laboratory control sample for preparation batch 600-242068 and analytical batch 600-242094 recovered outside control limits for the following analyte(s): Benzidine. Benzidine has been identified as a poor performing analyte when analyzed using this method; therefore, re-extraction/re-analysis was not performed. These results have been reported and qualified.

Method 8270C: The continuing calibration verification (CCV) associated with batch 600-242094 recovered above the upper control limit for Phenol and 2,2-oxybis(1-chloropropane). The samples associated with this CCV were non-detects for the affected analytes; therefore, the data have been reported. The following sample is impacted: (CCVIS 600-242094/2).

Method 8270C: Six surrogates are used for this analysis. The laboratory's SOP allows one acid and one base of these surrogates to be outside acceptance criteria without performing re-extraction/re-analysis. The following sample contained an allowable number of surrogate compounds outside limits: HSM 350 (600-168454-6). These results have been reported and qualified.

Method 8270C: The following samples were diluted due to the nature of the sample matrix: HSM 320 (600-168454-2), HSM 330 (600-168454-3) and FDHSM 330 (600-168454-4). Elevated reporting limits (RLs) are provided.

Method 8141A: The continuing calibration verification (CCV) associated with batch 280-423952 recovered above the upper control limit for Dichlorvos and Mevinphos. The samples associated with this CCV were non-detects for the affected analytes; therefore, the data have been reported. The following samples are impacted: HSM 330 (600-168454-3), FDHSM 330 (600-168454-4) and HSM 340 (600-168454-5). CCV (front) Dichlorvos +23% and Mevinphos +20%; (back) In control CCV (front) Dichlorvos +45% and Mevinphos +17%; (back) Dichlorvos +43%

Method 8141A: The following samples were diluted due to the extracts being dark brown and viscous: HSM 330 (600-168454-3), FDHSM 330 (600-168454-4), HSM 340 (600-168454-5), (600-168455-F-5-B), (600-168455-F-5-C MS) and (600-168455-F-5-D MSD). Elevated reporting limits (RL) are provided. The dilution was performed to protect the analytical instrumentation. Because of this dilution, the surrogate spike and matrix spike concentration in the samples was reduced to a level where the recovery calculation does not provide useful information. 8141 preparation batch 280-421840 and analytical batch 280-423952

Method 8141A: The laboratory control sample (LCS) associated with preparation batch 280-421596 and analytical batch 280-424441 was outside acceptance criteria (low) for most compounds. Re-extraction could not be performed within hold; therefore, the data have been reported. The batch matrix spike/matrix spike duplicate (MS/MSD) was within acceptance limits and may be used to evaluate matrix performance. 8141 HSM 310 (600-168454-1), HSM 320 (600-168454-2), HSM 350 (600-168454-6), HSM 360 (600-168454-7), HSM 370 (600-168454-8), (600-168454-F-1-B MS) and (600-168454-F-1-C MSD).

Method 8141A: The following samples were diluted due to the extract being viscous and being very dark: HSM 310 (600-168454-1), HSM 320 (600-168454-2), HSM 350 (600-168454-6), HSM 360 (600-168454-7), HSM 370 (600-168454-8), (600-168454-F-1-B MS) and (600-168454-F-1-C MSD). Elevated reporting limits (RL) are provided. The samples were diluted to protect the analytical instrumentation. Because of this dilution, the surrogate spike concentration in the samples was reduced to a level where the recovery calculation does not provide useful information. 8141 preparation batch 280-421596 and analytical batch 280-424441

Method 8141A: The continuing calibration verification (CCV) associated with batch 280-424441 recovered above the upper control limit for Dichlorvos. The samples associated with this CCV were non-detects for the affected analytes; therefore, the data have been reported. The following samples are impacted: HSM 310 (600-168454-1), HSM 320 (600-168454-2), HSM 350 (600-168454-6), HSM 360 (600-168454-7), HSM 370 (600-168454-8), (600-168454-F-1-B MS) and (600-168454-F-1-C MSD).

The continuing calibration verification (CCV) associated with batch 280-424441 recovered outside acceptance criteria, low biased, for Demeton, Total and Disulfoton. A reporting limit (RL) standard was analyzed, and the target analyte was detected. Since the associated samples were non-detect for this analyte, the data have been reported. 8141 CCV (front) Dichlorvos +22%; (back) In control CCV (front) Demeton, Total -18%, Dichlorvos +45% and Disulfoton -16%; (back) Dichlorvos +33% CCV (front) Dichlorvos +43%; (back) Dichlorvos +31%

Method 8082: The matrix spike / matrix spike duplicate (MS/MSD) recoveries for preparation batch 600-242314 and analytical batch 600-242426 were outside control limits. Sample matrix interference and/or non-homogeneity are suspected because the associated laboratory control sample (LCS) recovery was within acceptance limits.

Method 8082: Surrogate recovery for the following samples were outside control limits: HSM 320 (600-168454-2), (600-168454-A-2-H MS) and (600-168454-A-2-I MSD). Evidence of matrix interference is present; therefore, re-extraction and/or re-analysis was not performed.

Method 8082: Compound Tetrachloro-m-xylene eluted outside the retention time window on the RTX-CLPesticides 1 column for the following sample: (LCS 600-242314/3-A). This retention time shift was taken into account when reviewing the sample(s) for target compounds.

Method 8151A: The continuing calibration verification (CCV) associated with batch 600-242533 recovered above the upper control limit for Dinoseb(25.5%). The samples associated with this CCV were non-detects for the affected analytes; therefore, the data have been reported. The following sample is impacted: (CCVRT 600-242533/2).

Method 8151A: Surrogate recovery for the following samples were outside control limits: HSM 310 (600-168454-1), HSM 330 (600-168454-3), HSM 360 (600-168454-7) and HSM 370 (600-168454-8). Evidence of matrix interference is present; therefore, re-extraction and/or re-analysis was not performed.

Method 8151A: The matrix spike / matrix spike duplicate (MS/MSD) recoveries for preparation batch 600-242376 and analytical batch 600-242533 were outside control limits. Sample matrix interference and/or non-homogeneity are suspected because the associated laboratory control sample (LCS) recovery was within acceptance limits.

Method 8151A: The matrix spike / matrix spike duplicate / sample duplicate (MS/MSD/DUP) precision for preparation batch 600-242376 and analytical batch 600-242533 was outside control limits. Sample matrix interference and/or non-homogeneity are suspected.

Method 8151A: The continuing calibration verification (CCV) associated with batch 600-242533 recovered above the upper control limit for 2,4-DB(16),DCAA(23.4%),Dichloroprop(16.3), and 2,4,5-TP(18.7%). The samples associated with this CCV were non-detects for the affected analytes; therefore, the data have been reported. The following sample is impacted: (CCV 600-242533/35).

Method 8081A: The matrix spike / matrix spike duplicate (MS/MSD) recoveries for preparation batch 600-242314 and analytical batch 600-242318 were outside control limits. Sample matrix interference and/or non-homogeneity are suspected because the associated laboratory control sample (LCS) recovery was within acceptance limits.

Method 8081A: The matrix spike / matrix spike duplicate / sample duplicate (MS/MSD/DUP) precision for preparation batch 600-242314 and analytical batch 600-242318 was outside control limits. Sample matrix interference and/or non-homogeneity are suspected.

Method 8081A: Surrogate recovery for the following samples were outside control limits: HSM 310 (600-168454-1), HSM 320 (600-168454-2), HSM 340 (600-168454-5), HSM 350 (600-168454-6), HSM 370 (600-168454-8), (600-168454-A-2-F MS) and (600-168454-A-2-G MSD). Evidence of matrix interference is present; therefore, re-extraction and/or re-analysis was not performed.

Method 8082: Compound Tetrachloro-m-xylene eluted outside the retention time window on the RTX-CLPesticides 1 column for the following sample: HSM 340 (600-168454-5). This retention time shift was taken into account when reviewing the sample(s) for target compounds.

Method 8082: Surrogate recovery for the following samples were outside control limits: HSM 310 (600-168454-1), HSM 340 (600-168454-5), HSM 350 (600-168454-6) and HSM 370 (600-168454-8). Evidence of matrix interference is present; therefore, re-extraction and/or re-analysis was not performed.

Method 6010C: The matrix spike (MS) recoveries for preparation batch 160-377514 and analytical batch 160-378210 were outside control limits for Silicon. Sample matrix interference is suspected because the associated laboratory control sample (LCS) recovery was within acceptance limits. (600-168454-H-1-B MS ^2)

Method 6010C: preparation batch 160-377514 and analytical batch 160-378210 The following samples were diluted due to the nature of the sample matrix, samples that are high in salts could cause instrument and QC failure: HSM 330 (600-168454-3) and FDHSM 330 (600-168454-4). Elevated reporting limits (RLs) are provided.

Method 6010C: preparation batch 160-377514 and analytical batch 160-378210 The following samples were diluted to bring the concentration of target analytes within the calibration range: HSM 310 (600-168454-1), HSM 320 (600-168454-2), HSM 340 (600-168454-5), HSM 350 (600-168454-6), HSM 360 (600-168454-7), HSM 370 (600-168454-8), (600-168454-H-1-B MS ^2), (600-168454-H-1-C MSD ^2) and (600-168454-H-1-A SD ^10). Elevated reporting limits (RLs) are provided.

Method 7471A: The sample duplicate (DUP) precision for preparation batch 600-242400 and 600-242417 and analytical batch 600-242735 was outside control limits. Sample non-homogeneity is suspected.

Method 6010B: The method blank for Prep Batch 242288 contained Barium, Manganese and Zinc above the method detection limit. These target analyte concentrations were less than the reporting limit (RL); therefore, re-extraction and/or re-analysis of samples was not performed.

Method 6010B: The method blank for Prep Batch 242928 contained Barium, Calcium and Sodium above the method detection limit. These target analyte concentrations were less than the reporting limit (RL); therefore, re-extraction and/or re-analysis of samples was not performed.

Method 6010B: The method blank for Prep Batch 243344 contained Aluminum, Sodium, Calcium and Strontium above the method detection limit. These target analyte concentrations were less than the reporting limit (RL); therefore, re-extraction and/or re-analysis of samples was not performed.

Method 3546: The following samples required a Florisil clean-up, via EPA Method 3620B, to reduce matrix interferences: HSM 310 (600-168454-1), HSM 320 (600-168454-2), HSM 330 (600-168454-3), FDHSM 330 (600-168454-4), HSM 340 (600-168454-5), HSM 350 (600-168454-6), HSM 360 (600-168454-7), HSM 370 (600-168454-8), (600-168454-A-2 MS) and (600-168454-A-2 MSD).

Method 3546: The following samples required a sulfuric acid clean-up, via EPA Method 3665A, to reduce matrix interferences: HSM 310 (600-168454-1), HSM 320 (600-168454-2), HSM 330 (600-168454-3), FDHSM 330 (600-168454-4), HSM 340 (600-168454-5), HSM 350 (600-168454-6), HSM 360 (600-168454-7), HSM 370 (600-168454-8), (600-168454-A-2 MS) and (600-168454-A-2 MSD).

Issues associated with work order 560-74637

Method 8141A: The 8141 continuing calibration verification (CCV) associated with batch 280-422881 recovered above the upper control limit for Dichlorvos, Atrazine, Mevinphos and propazine. The samples associated with this CCV were non-detects for the affected analytes; therefore, the data have been reported. The following samples are impacted: EB1 (560-74637-1) and EB2 (560-74637-2).

The continuing calibration verification (CCV) associated with batch 280-422881 recovered outside acceptance criteria, low biased, for Azinphos-methyl and Famphur. A reporting limit (RL) standard was analyzed, and the target analyte was detected. Since the associated samples were non-detect for this analyte, the data have been reported. CCVIS (front) Atrazine +21%; (back) In control CCV (front) Azinphos-methyl -24%, Atrazine +27%, Dichlorvos +51%, Mevinphos +22% and Propazine +21%; (back) Azinphos-methyl -28%, Famphur -18% and Dichlorvos +42%

Method 8151A: The continuing calibration verification (CCV) associated with batch 680-531994 recovered above the upper control limit on column one for 2,4,5-T +20.5%D, and on column two for 2,4-DB +24.6%D and Dinoseb+24.7%D. The samples associated with this CCV were non-detects for the affected analytes; therefore, the data have been reported. The following samples are impacted: (280-111628-D-5-B), (280-111628-C-5-D MS) and (280-111628-D-5-D MSD).

Method 8151A: The laboratory control sample and/or the laboratory control sample duplicate (LCS/LCSD) for preparation batch 680-531411 and analytical batch 680-531994 recovered outside control limits for the following analyte(s): Dinoseb. Dinoseb has been identified as a poor performing analyte when analyzed using this method; therefore, re-extraction/re-analysis was not performed. Batch precision also exceeded control limits for these analyte(s). These results have been reported and qualified.

Method 6010B: The serial dilution performed for the following sample associated with batch 560-152944 was outside control limits:Mg 11% (560-74631-A-3-B SD)

Method 9060: The method blank for analytical batch 560-152878 contained Total Organic Carbon above the method detection limit. This target analyte concentration was less than the reporting limit (RL); therefore, re-extraction and/or re-analysis of samples was not performed.

Method 9060: The method blank for analytical batch 560-152893 contained Dissolved Organic Carbon above the method detection limit. This target analyte concentration was less than the reporting limit (RL); therefore, re-extraction and/or re-analysis of samples was not performed.

Method(s) 3510C, 614: An incorrect volume of surrogate spiking solution was inadvertently added the following samples: EB1 (560-74637-1) and EB2 (560-74637-2). Percent recoveries are based on the amount spiked.

Surrogate 81/82 #103 was added inadvertently to the samples, however, the analyst did not reject the samples because the analytical method may separate interferences. A reprep has been scheduled.

Edit 7/16/18 AMB: Analysis of the inadvertently added 8081 surrogate on the 8141 instrument/detector indicate that this additional surrogate will not affect the data. Re-extraction canceled. 422130 3510C/8081/2/608

Method 3510C, 614: Insufficient sample volume was available to perform a matrix spike/matrix spike duplicate (MS/MSD) associated with preparation batch 280-422130. 422130 3510C/8141A

Data Group Numbers (HCP PDS deployed February 1–15, 2018, at Comal and San Marcos Springs):

HCS 410 ***00794398***
HCS 420 ***00794399***
HCS 430 ***00794400***
HCS 440 ***00794401***
FDHCS 440 ***00794402***
HCS 460 ***00794403***

Trip Blank ***00794412***

HSM 410 ***00794404***
HSM 420 ***00794405***
FDHSM 420 ***00794406***
HSM 430 ***00794407***
HSM 440 ***00794408***
HSM 450 ***00794409***
HSM 460 ***00794410***
HSM 470 ***00794411***

General Comments

No analytical issues are noted for the data group, unless otherwise noted in the detailed discussion, the data are considered valid for the purposes of the investigation. PDSs were deployed from February 1 through 15, 2018.

Trip Blanks

There were no detections in the trip blank associated with these samples.

Equipment Blanks

Equipment blanks were not applicable due to sampler type.

Data Group Numbers (HCP PDS deployed April 2–16, 2018, at Comal and San Marcos Springs):

HCS 410 ***00794529***
HCS 420 ***00794530***
HCS 430 ***00794528***
HCS 440 ***00794531***
FDHCS 440 ***00794532***
HCS 460 ***00794533***

Trip Blank ***00794542***

HSM 410 ***00794534***
HSM 420 ***00794535***
FDHSM 420 ***00794536***
HSM 430 ***00794537***
HSM 440 ***00794538***
HSM 450 ***00794539***
HSM 460 ***00794540***
HSM 470 ***00794541***

General Comments

No analytical issues are noted for the data group, unless otherwise noted in the detailed discussion, the data are considered valid for the purposes of the investigation. PDSs were deployed from April 2 through 16, 2018.

Trip Blanks

There were no detections in the trip blank associated with these samples.

Equipment Blanks

Equipment blanks were not applicable due to sampler type.

Data Group Numbers (HCP PDS deployed June 1–15, 2018, at Comal and San Marcos Springs):

HCS 410 ***00795060***
HCS 420 ***00795061***
HCS 430 ***00795062***
HCS 440 ***00795063***
FDHCS 440 ***00795064***
HCS 460 ***00795065***

Trip Blank 09 ***00795074***

HSM 410 ***00795066***
HSM 420 ***00795067***
FDHSM 420 ***00795071***
HSM 430 ***00795068***
HSM 440 ***00795069***
HSM 450 ***00795070***
HSM 460 ***00795072***
HSM 470 ***00795073***

General Comments

No analytical issues are noted for the data group, unless otherwise noted in the detailed discussion, the data are considered valid for the purposes of the investigation. PDSs were deployed from June 1 through 15, 2018.

Trip Blanks

There were no detections in the trip blank associated with these samples.

Equipment Blanks

Equipment blanks were not applicable due to sampler type.

Data Group Numbers (HCP PDS deployed August 1–16, 2018, at Comal and San Marcos Springs):

HCS 410 ***00798365***
HCS 420 ***00798372***
FDHCS 420 ***00798373***
HCS 440 ***00798374***
HCS 460 ***00798364***

Trip Blank ***00798376***

HSM 410 ***00798356***
HSM 420 ***00798357***
HSM 430 ***00798358***
HSM 440 ***00798359***
HSM 450 ***00798360***
FDHSM 450 ***00798361***
HSM 460 ***00798362***
HSM 470 ***00798363***

General Comments

No analytical issues are noted for the data group, unless otherwise noted in the detailed discussion, the data are considered valid for the purposes of the investigation. PDSs were deployed from August 1 through 16 and 17, 2018. Sampler HSM440, HSM450, and FDHSM450 were not sampled due to evidence of human tampering of the deployment devices in the field. Sampler HSM420 was used as the duplicate as per SWCA request.

Trip Blanks

There were no detections in the trip blank associated with these samples.

Equipment Blanks

Equipment blanks were not applicable due to sampler type.

Data Group Numbers (HCP PDS deployed October 1–15, 2018, at Comal and San Marcos Springs):

HCS 410 ***00800701***
HCS 420 ***00800702***
HCS 430 ***00800703***
HCS 440 ***00800704***
FDHCS 440 ***00800705***
HCS 460 ***00800706***

Trip Blank 10 ***00800715***

HSM 410 ***00800707***
HSM 420 ***00800708***
FDHSM 420 ***00800709***
HSM 430 ***00800710***
HSM 440 ***00800711***
HSM 450 ***00800712***
HSM 460 ***00800713***
HSM 470 ***00800714***

General Comments

No analytical issues are noted for the data group, unless otherwise noted in the detailed discussion, the data are considered valid for the purposes of the investigation. PDSs were deployed from October 1 through 15, 2018.

Trip Blanks

There were no detections in the trip blank associated with these samples.

Equipment Blanks

Equipment blanks were not applicable due to sampler type.

Data Group Numbers (HCP PDS deployed December 3–17, 2018, at Comal and San Marcos Springs):

HCS 410 ***00800867***
HCS 420 ***00800868***
HCS 430 ***00800869***
HCS 440 ***00800870***
FDHCS 440 ***00800871***
HCS 460 ***00800872***

Trip Blank 10 ***00800881***

HSM 410 ***00800873***
HSM 420 ***00800874***
HSM 430 ***00800875***
HSM 440 ***00800876***
HSM 450 ***00800877***
FDHSM 450 ***00800878***
HSM 460 ***00800879***
HSM 470 ***00800880***

General Comments

No analytical issues are noted for the data group, unless otherwise noted in the detailed discussion, the data are considered valid for the purposes of the investigation. PDSs were deployed from December 3 through 17, 2018.

Trip Blanks

There were no detections in the trip blank associated with these samples.

Equipment Blanks

Equipment blanks were not applicable due to sampler type.

Data Group Numbers **(HCP POCIS deployed February 1 - March 2, 2018, at Comal and San Marcos Springs):**

HSM470 ***8C13012-02***
Extraction Blank ***8C13012-02***

General Comments

The laboratory was provided with a field collected sample to analyze, HSM470, and an extraction blank. The extraction blank is an unused portion of the solvent used to extract the sample membranes. The extraction blank is sent to the laboratory to evaluate if any constituents are either present in the extraction blank, or if constituents are introduced to the samples by the laboratory during processing or analysis. Essentially, if a constituent is detected in the extraction blank, the amount detected can be subtracted from concentrations detected in the field samples.

The data are considered valid for the purposes of the investigation. POCIS were deployed from February 1 through March 2, 2018.

Trip Blanks

There were no trip blanks associated with these samples.

Equipment Blanks

Equipment blanks were not applicable due to sampler type.

Extraction Blank

The following constituents were detected in the Extraction Blank: Triclosan at 110,000 ng/L; Caffeine at 1,200 ng/L; Galaxolide (HHCB) at 120,000 ng/L; Oxybenzone at 2,700 ng/L; TCPP at 26,000 ng/L; and TDCPP at 1,200 ng/L. These concentrations can theoretically be subtracted from the concentrations detected in sample HSM470. All results were presented in the annual report without subtracting any amounts from the detected concentrations in HSM470.

QA/QC Discussion – Comal and San Marcos Springs POCIS Samples (Sampled February 1 - March 3, 2017)

Issues associated with all POCIS samples

For Diethylstibestrol and Estriol for the method blank the RPD results exceeded the QC control limits; both percent recoveries were acceptable. Sample results for the QC batch were accepted based on the percent recoveries and/or other acceptable QC data.

For TCPP in the method blank, the QC sample was reanalyzed to complement samples that require re-analysis on different date.

Issues specific to individual samples

No issues were listed for individual samples.

Data Group Numbers (HCP POCIS deployed April 2 - May 3, 2018, at Comal and San Marcos Springs):

HCS460 ***8E15015-01***
HSM470 ***8E15015-02***
Extraction Blank ***8E15015-03***

General Comments

The laboratory was provided with a field collected sample to analyze, HSM470, and an extraction blank. The extraction blank is an unused portion of the solvent used to extract the sample membranes. The extraction blank is sent to the laboratory to evaluate if any constituents are either present in the extraction blank, or if constituents are introduced to the samples by the laboratory during processing or analysis. Essentially, if a constituent is detected in the extraction blank, the amount detected can be subtracted from concentrations detected in the field samples.

The data are considered valid for the purposes of the investigation. POCIS were deployed from April 2 through May 3, 2018.

Trip Blanks

There were no trip blanks associated with these samples.

Equipment Blanks

Equipment blanks were not applicable due to sampler type.

Extraction Blank

The following constituents were detected in the Extraction Blank: Triclosan at 16,000 ng/L; Galaxolide (HHCB) at 29,000 ng/L; TCPP at 48,000 ng/L; and TDCPP at 1,900 ng/L. These concentrations can theoretically be subtracted from the concentrations detected in samples HCS460 and HSM470. All results were presented in the annual report without subtracting any amounts from the detected concentrations in HCS460 or HSM470.

QA/QC Discussion – Comal and San Marcos Springs POCIS Samples (Sampled April 2 - May 3, 2018)

Issues associated with all POCIS samples

For TCPP in HCS460 and HSM470, the concentration indicated for this analyte is an estimated value above the calibration range.

For testosterone, primidone, and TCPP in the method blank, the RPD result exceeded the QC control limits; however, both percent recoveries were acceptable, Sample results for the QC batch were accepted based on the percent recoveries and/or other acceptable QC data.

For multiple analytes in the method blank, the QC sample was reanalyzed to complement samples that require re-analysis on different date.

For amoxicillin in the method blank, high bias in the QC sample does not affect sample result since analyte was not detected or below the reporting limit.

Issues specific to individual samples

No issues were listed for individual samples.

Data Group Numbers **(HCP POCIS deployed June 1 – July 2, 2018, at Comal and San Marcos Springs):**

HCS460
HSM470
Extraction Blank

General Comments

POCIS membranes were installed at HCS460 and HSM470 downstream locations in June. The POCIS membrane could not be located at HCS460 during retrieval. The HSM470 sampler was submitted to EST Laboratories. EST Laboratories then shipped the eluted sample to Weck Laboratories, Inc. Weck Laboratories received the sampler; however, Weck Laboratories lost the sample and could not provide any analyses results.

QA/QC Discussion – Comal and San Marcos Springs POCIS Samples (Sampled August 1 – August 31, 2018)

Issues associated with all POCIS samples

No issues were associated with the POCIS samples.

Issues specific to individual samples

No issues were listed for individual samples.

Data Group Numbers **(HCP POCIS deployed August 1 – August 31, 2018, at Comal and San Marcos Springs):**

HCS460 - ***8I18035-02***
HSM470 – ***8I18035-03***
Extraction Blank – ***8I18035-01***

General Comments

The laboratory was provided with field collected samples to analyze, HCS460 and HSM470, and an extraction blank. The extraction blank is an unused portion of the solvent used to extract the sample membranes. The extraction blank is sent to the laboratory to evaluate if any constituents are either present in the extraction blank, or if constituents are introduced to the samples by the laboratory during processing or analysis. Essentially, if a constituent is detected in the extraction blank, the amount detected can be subtracted from concentrations detected in the field samples.

The data are considered valid for the purposes of the investigation. POCIS were deployed from August 1 through August 31, 2018.

Trip Blanks

There were no trip blanks associated with these samples.

Equipment Blanks

Equipment blanks were not applicable due to sampler type.

Extraction Blank

The following constituents were detected in the Extraction Blank: Triclosan at 10,000 ng/L; Galaxolide (HHCB) at 28,000 ng/L; TCPP at 34,000 ng/L; and TDCPP at 2,700 ng/L. These concentrations can theoretically be subtracted from the concentrations detected in samples HCS460 and HSM470. All results were presented in the annual report without subtracting any amounts from the detected concentrations in HCS460 or HSM470.

QA/QC Discussion – Comal and San Marcos Springs POCIS Samples (Sampled August 1 – August 31, 2018)

Issues associated with all POCIS samples

For analytes Diethylstilbestrol, Epitestosterone, and Testosterone, The RPD result exceeded the QC control limits; however, both percent recoveries were acceptable. Sample results for the QC batch were accepted based on the percent recoveries and/or other acceptable QC data.

For Quinoline, high bias in the QC sample does not affect sample results since the analyte was not detected or was below the reporting limit.

Issues specific to individual samples

For TCPP in HSM470, the concentration indicated for this analyte is an estimated value above the calibration range.

For TDCPP and DEET in HCS460 and HSM470, the concentration indicated for this analyte is an estimated value above the calibration range.

Data Group Numbers **(HCP POCIS deployed October 1 – October 31, 2018, at Comal and San Marcos Springs):**

HCS460 – 8K19031-02
HSM470 – 8K19031-03
Extraction Blank - 8K19031-01

General Comments

The laboratory was provided with two field collected samples to analyze, HCS460 and HSM470, and an extraction blank. The extraction blank is an unused portion of the solvent used to extract the sample membranes. The extraction blank is sent to the laboratory to evaluate if any constituents are either present in the extraction blank, or if constituents are introduced to the samples by the laboratory during processing or analysis. Essentially, if a constituent is detected in the extraction blank, the amount detected can be subtracted from concentrations detected in the field samples.

The data are considered valid for the purposes of the investigation. POCIS were deployed from October 1 through October 31, 2018.

Trip Blanks

There were no trip blanks associated with these samples.

Equipment Blanks

Equipment blanks were not applicable due to sampler type.

Extraction Blank

The following constituents were detected in the Extraction Blank: Triclosan at 10,000 ng/L; Galaxolide (HHCB) at 28,000 ng/L; TCPP at 34,000 ng/L; and TDCPP at 2,700 ng/L. These concentrations can theoretically be subtracted from the concentrations detected in samples HCS460 and HSM470. All results were presented in the annual report without subtracting any amounts from the detected concentrations in HCS460 or HSM470.

QA/QC Discussion – Comal and San Marcos Springs POCIS Samples (Sampled October 1 – October 31, 2018)

Issues associated with all POCIS samples

For Diethylstilbestrol, Progesterone, Epitestosterone, Testosterone, and Amoxicillin, high bias in the QC sample does not affect sample results since analytes were not detected or were below the reporting limits.

For Estrone, Primidone, Quinoline, and Sucralose, the RPD result exceeded the QC control limits; however, both percent recoveries were acceptable. Sample results for the QC batch were accepted based on the percent recoveries and/or other acceptable QC data.

For Phenytoin (Dilantin), Sucralose, and TCPP, the QC sample was reanalyzed to complement samples that require re-analysis on different date.

Issues specific to individual samples

No issues specific to individual samples were noted by the laboratory.

Data Group Numbers (HCP POCIS deployed December 1 – December 31, 2018, at Comal and San Marcos Springs):

HCS460 – 9A11007-01
HSM470 – 9A11007-02
Extraction Blank – 9A11007-03

General Comments

The laboratory was provided with two field collected samples to analyze, HCS460 and HSM470, and an extraction blank. The extraction blank is an unused portion of the solvent used to extract the sample membranes. The extraction blank is sent to the laboratory to evaluate if any constituents are either present in the extraction blank, or if constituents are introduced to the samples by the laboratory during processing or analysis. Essentially, if a constituent is detected in the extraction blank, the amount detected can be subtracted from concentrations detected in the field samples.

The data are considered valid for the purposes of the investigation. POCIS were deployed from December 1 through December 31, 2018.

Trip Blanks

There were no trip blanks associated with these samples.

Equipment Blanks

Equipment blanks were not applicable due to sampler type.

Extraction Blank

The following constituents were detected in the Extraction Blank: Bisphenol A at 8,800 ng/L, Triclosan at 51,000 ng/L, Caffeine at 2,000 ng/L, DEET at 43,000 ng/L, Galaxolide (HHCB) at 160,000 ng/L, Oxybenzone at 7,000 ng/L, Quinoline at 2,100 ng/L, TCEP at 8,400 ng/L, TCPP at 200,000 ng/L, and TDCPP at 58,000 ng/L. These concentrations can theoretically be subtracted from the concentrations detected in samples HCS460 and HSM470. All results were presented in the annual report without subtracting any amounts from the detected concentrations in HCS460 or HSM470.

QA/QC Discussion – Comal and San Marcos Springs POCIS Samples (Sampled December 1 – December 31, 2018)

Issues associated with all POCIS samples

For Diethylstilbestrol, Progesterone, Epitestosterone, Testosterone, and Amoxicillin, high bias in the QC sample does not affect sample results since analytes were not detected or were below the reporting limits.

For Estrone, Primidone, Quinoline, and Sucralose, the RPD result exceeded the QC control limits; however, both percent recoveries were acceptable. Sample results for the QC batch were accepted based on the percent recoveries and/or other acceptable QC data.

For Phenytoin (Dilantin), Sucralose, and TCPP, the QC sample was reanalyzed to complement samples that require re-analysis on different date.

Issues specific to individual samples

For samples HSM470 and the Extraction Blank, the concentration indicated for TCPP is an estimated value above the calibration range.

Relative Percent Differences between Field Samples and Their Duplicates

RPD values for parent samples and associated duplicate samples are provided in Table 2 below. In general, the RPD for stormwater and PDS samples are less than 20% indicating parent and duplicate sample constituent concentrations are similar. Greater differences are present in the sediment sample data. Some differences observed in water samples may be the result of concentrations that vary naturally due to stream flow. Because the streams sampled are constantly flowing, constituent concentrations can change or fluctuate during the time period in which multiple sample bottles, which are all part of the same sample, are filled. Although sediment sample cores were collected in close proximity to one another, soil concentrations may vary spatially, which can cause differences between parent and duplicate sample constituent concentrations.

The differences observed do not show wide variations where a parent sample concentration exceeds a regulatory threshold or comparison value and a duplicate does not, or vice versa.

It should be noted that the RPDs between parent and duplicate field samples not only show differences between the parent and duplicate samples but also include differences inherent to laboratory procedures when the two separate samples are analyzed. Therefore, the laboratory RPDs contribute to the parent and field duplicate constituent concentration RPDs.

Table 2. Relative Percent Differences between Field Samples and Their Duplicates

Sample Location	Date Collected	Analyte	Units	Field Sample	Qualifiers	Duplicate	Qualifiers	RPD
Stormwater								
HCS240	3/28/2018	Silicon	mg/L	5.35		5.42		1.30%
		Strontium	mg/L	0.648		0.644		0.62%
		Calcium	mg/L	81.7		81.2		0.61%
		Potassium	mg/L	1.58		1.62		2.50%
		Magnesium	ng/L	15.7		15.7		0.00%
		Sodium	mg/L	12.3		11.9		3.31%
		Barium	mg/L	0.0502		0.051		1.58%
		Bromide	mg/L	0.376	J	0.375	J	0.27%
		Chloride	mg/L	16.5		17.6		6.45%
		Nitrate	mg/L	1.56		1.56		0.00%
		Sulfate	mg/L	24		23.9		0.42%
		Fluoride	mg/L	0.221		0.213		3.69%
		Phosphorous, total	mg/L	0.0433	J	0.041		5.46%
		pH	SU	7.4	HF	7.4	HF	0.00%
		Alkalinity	mg/L	196		194		1.03%
		Bicarbonate	mg/L	196	J	194		1.03%
		TDS	mg/L	235		278		16.76%
		TSS	mg/L	5.5		6.5		16.67%
		E. coli	MPN/100 mL	2400		2400		0.00%
HCS260 Trail	3/28/2018	Silicon	mg/L	4.29		4.3		0.23%
		Strontium	mg/L	0.519		0.5		3.73%
		Calcium	mg/L	65.7		61.7		6.28%
		Potassium	mg/L	2.3		2.42		5.08%
		Magnesium	ng/L	11.7		10.7		8.93%
		Sodium	mg/L	17.1		17.8		4.01%
		Aluminum	mg/L	0.05		0.0577	J	14.30%
		Barium	mg/L	0.0437		0.0442		1.14%
		Chromium	mg/L	0.0014		0.00147	J	4.88%
		Manganese	mg/L	0.0173	J	0.0195	J	11.96%

Sample Location	Date Collected	Analyte	Units	Field Sample	Qualifiers	Duplicate	Qualifiers	RPD
		Selenium	mg/L	0.00108		0.00172	J	45.71%
		Bromide	mg/L	0.392	J	0.4	J	2.02%
		Chloride	mg/L	16.2		18.5		13.26%
		Nitrate	mg/L	1.17		1.16		0.86%
		Sulfate	mg/L	33.4		37.3		11.03%
		Fluoride	mg/L	0.177		0.178		0.56%
		Nitrogen, Kjeldahl	mg/L	1.13		0.921	J	20.38%
		Phosphorous, total	mg/L	0.174		0.167		4.11%
		pH	SU	7.5	HF	7.5	HF	0.00%
		TOC	mg/L	3.76		2.04		59.31%
		Alkalinity	mg/L	206		160		25.14%
		Bicarbonate	mg/L	206		160		25.14%
		TDS	mg/L	256		283		10.02%
		TSS	mg/L	205		204		0.49%
		DOC	mg/L	2.45		2.33		5.02%
		2,4-D	ug/L	0.0753	J	0.0995	J	27.69%
		E.coli	MPN/100 mL	6500		4100		45.28%
		Caffeine	ng/L	5		5.11		2.18%
HSM210 Trail	5/4/2018	Silicon	mg/L	0.6540		0.668		2.12%
		Strontium	mg/L	82.3		83.2		1.09%
		Calcium	mg/L	2.03		2.06		1.47%
		Potassium	mg/L	19.2		19.4		1.04%
		Magnesium	mg/L	14.8	B	15		1.34%
		Sodium	ng/l	0.00178	J	0.00247	J	32.47%
		Arsenic	mg/L	0.0394		0.0337		15.60%
		Barium	mg/L	0.308		0.176	J B	54.55%
		Iron	mg/L	0.00227	J	0.000733		102.36%
		Lead	mg/L	0.102		0.064		45.78%
		Manganese	mg/L			0.00111	J	100.00%
		Selenium	mg/L	0.0165	J	0.00355		129.18%
		Zinc	mg/L	0.401	J	0.401	J	0.00%

Sample Location	Date Collected	Analyte	Units	Field Sample	Qualifiers	Duplicate	Qualifiers	RPD
		Bromide	mg/L	26.3		26.2		0.38%
		Chloride	mg/L	0.434	J H	0.435	J H	0.23%
		Nitrate	mg/L	32.9		32.9		0.00%
		Sulfate	mg/L	0.226		0.222		1.79%
		Fluoride	mg/L	0.459		0.437		4.91%
		Nitrogen, Kjeldahl	mg/L	7.4	HF	7.3	HF	1.36%
		pH	SU	0.71	J	0.815	J	13.77%
		TOC	mg/L	205		207		0.97%
		Alkalinity	mg/L	205		207		0.97%
		Bicarbonate	mg/L	344		347		0.87%
		TDS	mg/L	3.8		4.5		16.87%
		TSS	mg/L	0.925	J	1.31		34.45%
		DOC	mg/L	5		5.18	J	3.54%
		Acetone	mg/L	0.000296	J H B	0.000172		52.99%
		Merphos	mg/L	1000		870		13.90%
		E.coli	MPN/100 mL	5		5.11		2.18%
HSM2230 Trail	5/4/2018	Silicon	mg/L	2.93		2.83		3.47%
		Strontium	mg/L	0.183		0.1700		7.37%
		Calcium	mg/L	48.8		47.1		3.55%
		Potassium	mg/L	2.07		2.03		1.95%
		Magnesium	mg/L	5.54		5.25		5.38%
		Sodium	ng/l	6.4		6.2		3.17%
		Arsenic	mg/L	0.00197	J	0.00242	J	20.50%
		Barium	mg/L	0.0197		0.0019		164.81%
		Copper	mg/L	0.00252	J	0.00446	J	55.59%
		Manganese	mg/L	0.0167	J	0.0151	J	10.06%
		Zinc	mg/L	0.0118	J B	0.0234	J B	65.91%
		Chloride	mg/L	9.65		9.6		0.52%
		Nitrate	mg/L	0.829	H	0.828	H	0.12%
		Sulfate	mg/L	19.8		19.9		0.50%

Sample Location	Date Collected	Analyte	Units	Field Sample	Qualifiers	Duplicate	Qualifiers	RPD
		Fluoride	mg/L	0.114		0.124		8.40%
		Nitrogen, Kjeldahl	mg/L	0.674		0.742		9.60%
		Phosphorous, total	mg/L	0.0826	J	0.126		41.61%
		pH	SU	7.4	HF	7.3	HF	1.36%
		TOC	mg/L	3.82		3.97		3.85%
		Alkalinity	mg/L	104		100		3.92%
		Bicarbonate	mg/L	104		100		3.92%
		TDS	mg/L	200		216		7.69%
		TSS	mg/L	14.5		12		18.87%
		DOC	mg/L	3.36		4.79		35.09%
		Acetone	mg/L	14.7		26.2		56.23%
		E.Coli	MPN/100 mL	3300		4200		24.00%
		Caffeine	ng/L	270		220		20.41%
Sediment								
HCS360	6/27/2018	Calcium	mg/Kg	185000	B	70900		89.18%
		Aluminum	mg/Kg	1780		19100		165.90%
		Potassium	mg/Kg	1060		3450		105.99%
		Arsenic	mg/Kg	1.57		3.66		79.92%
		Magnesium	mg/Kg	1800		3550		65.42%
		Barium	mg/Kg	15.7	B	67.8	B	124.79%
		Sodium	mg/Kg	90.8	J	79.5	J	13.27%
		Beryllium	mg/Kg	0.137	J	0.946		149.40%
		Cadmium	mg/Kg	0.119	J	0.462		118.07%
		Strontium	mg/Kg	180		141		24.30%
		Chromium	mg/Kg	3.22		17.3		137.23%
		Copper	mg/Kg	1.66		11.1		147.96%
		Iron	mg/Kg	2080		15100		151.57%
		Manganese	mg/Kg	57.6	B	150	B	89.02%
		Nickel	mg/Kg	2.27		16.1		150.57%
		Lead	mg/Kg	6.31		16.1		87.37%
		Antimony	mg/kg	0.274		0.581	J	71.81%

Sample Location	Date Collected	Analyte	Units	Field Sample	Qualifiers	Duplicate	Qualifiers	RPD
		Zinc	mg/Kg	10.5	B	54.3	B	135.19%
		Silicon	mg/Kg	3320		4930		39.03%
		Mercury	ug/kg	14.3	J	9.38	J	41.55%
		Total Phosphorous	mg/Kg	496		231		72.90%
		TOC	mg/Kg	0.923		0.585		44.83%
		Alkalinity	mg/Kg	192		348		57.78%
		Bicarbonate	mg/kg	192		348		57.78%
		Benzo(b)fluoranthene	ug/kg	64.9	J	31.3		69.85%
		Benzo(k)fluoranthene	ug/kg	36.8	J	47.5		25.39%
		Acetone	ug/kg	2.22		36.5		177.07%
HSM330	6/28/2018	Calcium	mg/Kg	312000	B	273000	B	13.33%
		Aluminum	mg/Kg	422		1360	B	105.27%
		Potassium	mg/Kg	275		241		13.18%
		Arsenic	mg/Kg	5.6		5.96		6.23%
		Magnesium	mg/Kg	2060		2510		19.69%
		Barium	mg/Kg	12	B	23.5	B	64.79%
		Sodium	mg/Kg	87.4	J	93.7	J B	6.96%
		Beryllium	mg/Kg	0.102	J	0.212	J	70.06%
		Cadmium	mg/Kg	0.142	J	0.199	J	33.43%
		Strontium	mg/Kg	177		120	B	38.38%
		Chromium	mg/Kg	2.24		6.65		99.21%
		Copper	mg/Kg	2.36		5.99		86.95%
		Iron	mg/Kg	6240		8610		31.92%
		Manganese	mg/Kg	120	B	260		73.68%
		Nickel	mg/Kg	4.03		5.42		29.42%
		Lead	mg/Kg	4.49		6.22		32.31%
		Antimony	mg/Kg	0.955	J	0.393	J	83.38%
		Thallium	mg/kg	0.314		0.657	J	70.65%
		Zinc	mg/Kg	11.2	B	27		82.72%
		Silicon	ug/kg	513		758		38.55%
		Mercury	ug/kg	4.25	J	7.05		49.56%
		Total Phosphorous	mg/Kg	100		112		11.32%

Sample Location	Date Collected	Analyte	Units	Field Sample	Qualifiers	Duplicate	Qualifiers	RPD
		TOC	%	0.418		0.422		0.95%
		Alkalinity	mg/Kg	242		113		72.68%
		Bicarbonate	mg/Kg	242		113		72.68%
		Benzo(b)fluoranthene	ug/kg	743	J	235		103.89%

Passive Diffusion Sampling								
HCS440	2/15/2018	Tetrachloroethene	ug	0.41		0.45		9.30%
		TPH	uh	0.6		0.5		18.18%
	4/16/2018	Tetrachloroethene	ug	0.3		0.29		3.39%
	6/15/2018	TPH	ug	0.81		1.06		26.74%
		Tetrachloroethene	ug	0.24		0.33		31.58%
	8/16/2018	Tetrachloroethene	ug	0.39		0.39		0.00%
		TPH	ug	0.75		0.77		2.63%
	10/15/2018	TPH	ug	2.23		0.89		85.90%
HCS420	8/16/2018	TPH	ug	0.84		0.96		13.33%
		Tetrachloroethene	ug	0.19		0.2		5.13%
HSM420	2/15/2018	TPH	ug	0.73		0.62		16.30%
		Tetrachloroethene	ug	0.21		0.19		10.00%
	4/16/2018	Tetrachloroethene	ug	0.27		0.24		11.76%
	6/15/2018	TPH	ug	1		1.19		17.35%
		Tetrachloroethene	ug	0.1		0.11		9.52%
	8/16/2018	TPH	ug	0.73		0.5		37.40%
		Tetrachloroethene	ug	0.16		0.16		0.00%
	10/15/2018	TPH	ug	1.11		1.08		2.74%
		Tetrachloroethene	ug	0.14		0.14		0.00%

Method detection limits or reporting limits were used to calculate RPD for results not detected above these limits.

APPENDIX I

SAMPLE RECORD

COMAL STORM WATER

Location / Sample Name	Date Sampled	Time Sampled	Latitude (dd)	Longitude (dd)	County	Location Generic Name
HCS210 Lead 1	3/28/2018	03:33	29.72043	-98.12525	Comal	Upper Springs
HCS210 Lead 2	3/28/2018	04:18	29.72043	-98.12525	Comal	Upper Springs
HCS210 Lead 3	3/28/2018	04:24	29.72043	-98.12525	Comal	Upper Springs
HCS240 Lead	03/28/2018	03:26	29.710221	-98.129534	Comal	Upper Old Channel
HCS250 Lead	03/28/2018	03:56	29.709491	-98.122578	Comal	Lower Old Channel
HCS260 Lead 1	03/28/2018	03:42	29.708007	-98.127301	Comal	New Channel
HCS260 Lead 2	03/28/2018	04:18	29.708007	-98.127301	Comal	New Channel
HCS260 Lead 3	03/28/2018	04:33	29.708007	-98.127301	Comal	New Channel
HCS270 Lead	03/28/2018	03:26	29.704014	-98.115791	Comal	Comal River above confluence
HCS210 Peak	03/28/2018	06:33	29.72043	-98.12525	Comal	Upper Springs
HCS240 Peak	03/28/2018	06:23	29.710221	-98.129534	Comal	Upper Old Channel
HCS250 Peak	03/28/2018	06:54	29.709491	-98.122578	Comal	Lower Old Channel
HCS260 Peak	03/28/2018	06:38	29.708007	-98.127301	Comal	New Channel
HCS270 Peak	03/28/2018	06:15	29.704014	-98.115791	Comal	Comal River above confluence
HCS210 Trail	03/28/2018	09:29	29.72043	-98.12525	Comal	Upper Springs
HCS240 Trail	03/28/2018	09:56	29.710221	-98.129534	Comal	Upper Old Channel
FDHCS240 Trail	03/28/2018	09:56	29.710221	-98.129534	Comal	Upper Old Channel
HCS250 Trail	03/28/2018	10:25	29.709491	-98.122578	Comal	Lower Old Channel
HCS260 Trail	03/28/2018	10:00	29.708007	-98.127301	Comal	New Channel
FDHCS260 Trail	03/28/2018	10:00	29.708007	-98.127301	Comal	New Channel
HCS270 Trail	03/28/2018	10:30	29.704014	-98.115791	Comal	Comal River above confluence

COMAL SEDIMENT

Location / Sample Name	Date Sampled	Time Sampled	Latitude (dd)	Longitude (dd)	County	Location Generic Name
HCS310	6/27/2018	11:17	29.72043	-98.12525	Comal	Upper Springs
HCS320	6/27/2018	11:38	29.718084	-98.131644	Comal	Upper Landa Lake
HCS330	6/27/2018	15:33	29.709566	-98.133749	Comal	Lower Landa Lake
HCS340	6/27/2018	16:04	29.710221	-98.129534	Comal	Upper Old Channel
HCS360	6/27/2018	12:49	29.707454	-98.122762	Comal	USGS Gauge
FDHCS360	6/27/2018	13:46	29.707454	-98.122762	Comal	USGS Gauge
TB07	6/27/2018	0:00	NA	NA	Comal	Trip Blank
EB01	7/9/2018	13:39	NA	NA	Comal/Hays	Equipment Blank
EB02	7/9/2018	15:50	NA	NA	Comal	Equipment Blank

COMAL PDS

Location / Sample Name	Installed	Retrieved	Latitude (dd)	Longitude (dd)	County	Location Generic Name
HCS410	02/01/18 10:41	02/15/18 9:27	29.72043	-98.12525	Comal	Upper Springs
HCS420	02/01/18 10:57	2/15/18 9:38	29.718084	-98.131644	Comal	Upper Landa Lake
HCS430	2/01/18 10:17	2/15/18 9:15	29.709566	-98.133749	Comal	Lower Landa Lake
HCS440	2/01/18 11:14	2/15/18 9:48	29.710221	-98.129534	Comal	Upper Old Channel
FDHCS440	2/01/18 11:14	2/15/18 9:48	29.710221	-98.129534	Comal	Upper Old Channel
HCS460	2/01/18 11:32	2/15/18 10:01	29.707454	-98.122762	Comal	USGS Gauge
Trip Blank (TB1)	2/01/18	2/15/18	NA	NA	Comal/ Hays	Trip Blank
HCS410	4/02/18 9:19	4/16/18 9:34	29.72043	-98.12525	Comal	Upper Springs
HCS420	4/02/18 9:30	4/16/18 9:43	29.718084	-98.131644	Comal	Upper Landa Lake
HCS430	4/02/18 9:04	4/16/18 9:19	29.709566	-98.133749	Comal	Lower Landa Lake
HCS440	4/02/18 9:46	4/16/18 9:52	29.710221	-98.129534	Comal	Upper Old Channel
FDHCS440	4/02/18 9:46	4/16/18 9:52	29.710221	-98.129534	Comal	Upper Old Channel
HCS460	4/02/18 10:03	4/16/18 10:03	29.707454	-98.122762	Comal	USGS Gauge
Trip Blank (TB2)	4/02/18	4/16/18	NA	NA	Comal/ Hays	Trip Blank
HCS410	6/01/18 10:08	6/15/18 8:26	29.72043	-98.12525	Comal	Upper Springs
HCS420	6/01/18 10:18	6/15/18 8:36	29.718084	-98.131644	Comal	Upper Landa Lake
HCS430	6/01/18 9:50	6/15/18 8:12	29.709566	-98.133749	Comal	Lower Landa Lake
HCS440	6/01/18 10:30	6/15/18 8:47	29.710221	-98.129534	Comal	Upper Old Channel
FDHCS440	6/01/18 10:30	6/15/18 8:47	29.710221	-98.129534	Comal	Upper Old Channel
HCS460	6/01/18 10:45	6/15/18 8:57	29.707454	-98.122762	Comal	USGS Gauge
Trip Blank (TB5)	6/01/18	6/15/18	NA	NA	Comal/ Hays	Trip Blank
HCS410	8/1/18 15:01	8/15/18 10:07	29.72043	-98.12525	Comal	Upper Springs

Location / Sample Name	Installed	Retrieved	Latitude (dd)	Longitude (dd)	County	Location Generic Name
HCS420	8/1/18 15:08	8/16/18 9:24	29.718084	-98.131644	Comal	Upper Landa Lake
HCS430	8/1/18 15:31	8/16/18 9:54	29.709566	-98.133749	Comal	Lower Landa Lake
HCS440	8/1/18 15:20	8/16/18 9:36	29.710221	-98.129534	Comal	Upper Old Channel
FDHCS420	8/1/18 15:10	8/16/16 9:24	29.718084	-98.131644	Comal	Upper Landa Lake
HCS460	8/1/18 14:37	8/16/18 9:56	29.707454	-98.122762	Comal	USGS Gauge
TB10	8/1/18	8/16/18	NA	NA	Comal/Hays	Test Blank
HCS410	10/1/2018 11:12	10/15/2018 10:06	29.72043	-98.12525	Comal	Upper Springs
HCS420	10/1/2018 11:35	10/15/2018 10:16	29.718084	-98.131644	Comal	Upper Landa Lake
HCS430	10/1/2018 10:52	10/15/2018 9:46	29.709566	-98.133749	Comal	Lower Landa Lake
HCS440	10/1/2018 11:24	10/15/2018 10:25	29.710221	-98.129534	Comal	Upper Old Channel
FDHCS440	10/1/2018 11:26	10/15/2018 10:25	29.710221	-98.129534	Comal	Upper Old Channel
HCS460	10/1/2018 15:57	10/15/2018 10:55	29.707454	-98.122762	Comal	USGS Gauge
TB16	10/1/2018	10/15/2018	NA	NA	Comal/Hays	Test Blank
HCS410	12/3/2018 9:33	12/17/2018 10:10	29.72043	-98.12525	Comal	Upper Springs
HCS420	12/3/2018 9:45	12/17/2018 10:18	29.718084	-98.131644	Comal	Upper Landa Lake
HCS430	12/3/2018 9:18	12/17/2018 9:56	29.709566	-98.133749	Comal	Lower Landa Lake
HCS440	12/3/2018 9:58	12/17/2018 10:29	29.710221	-98.129534	Comal	Upper Old Channel
FDHCS440	12/3/2018 9:58	12/17/2018 10:29	29.710221	-98.129534	Comal	Upper Old Channel
HCS460	12/3/2018 10:16	12/17/2018 10:442	29.707454	-98.122762	Comal	USGS Gauge
Trip Blank	12/3/2018	12/17/2018	NA	NA	Comal/Hays	Test Blank

COMAL POCIS

Location / Sample Name	Installed	Retrieved	Latitude (dd)	Longitude (dd)	County	Location Generic Name
HCS460	2/01/18 11:32	3/2/18	29.707454	-98.122762	Comal	USGS Gauge
HCS460	4/02/18 10:03	5/3/18	29.707454	-98.122762	Comal	USGS Gauge
HCS460	6/01/18 10:45	7/2/18	29.707454	-98.122762	Comal	USGS Gauge
HCS460	8/1/18 14:37	8/31/18	29.707454	-98.122762	Comal	USGS Gauge
HCS460	10/1/2018 15:57	10/31/18	29.707454	-98.122762	Comal	USGS Gauge
HCS460	12/3/2018 10:16	12/31/18	29.707454	-98.122762	Comal	USGS Gauge

SAN MARCOS STORM WATER

Location / Sample Name	Date Sampled	Time Sampled	Latitude (dd)	Longitude (dd)	County	Location Generic Name
HSM210 Lead 1	05/04/2018	10:49	29.893566	-97.927631	Hays	Sink Creek
HSM210 Lead 2	05/04/2018	11:49	29.893566	-97.927631	Hays	Sink Creek
HSM210 Lead 3	05/04/2018	12:30	29.893566	-97.927631	Hays	Sink Creek
HSM230 Lead 1	05/04/2018	11:07	29.889831	-97.935957	Hays	Sessoms Creek
HSM230 Lead 2	05/04/2018	12:08	29.889831	-97.935957	Hays	Sessoms Creek
HSM230 Lead 3	05/04/2018	12:25	29.889831	-97.935957	Hays	Sessoms Creek
HSM231 Lead	05/04/2018	11:27	29.886254	-97.935891	Hays	Dog Beach Outflow
HSM240 Lead	05/04/2018	10:50	29.884145	-97.935554	Hays	City Park
HSM250 Lead	05/04/2018	11:20	29.882213	-97.934867	Hays	Purgatory Creek
HSM260 Lead	05/04/2018	10:56	29.87484	-97.931713	Hays	I-35 Reach
HSM270 Lead	05/04/2018	11:25	29.868809	-97.930378	Hays	Capes Dam
HSM210 Peak	05/04/2018	13:05	29.893566	-97.927631	Hays	Sink Creek
HSM230 Peak	05/04/2018	13:12	29.889831	-97.935957	Hays	Sessoms Creek
HSM231 Peak	05/04/2018	13:42	29.886254	-97.935891	Hays	Dog Beach Outflow
HSM240 Peak	05/04/2018	13:25	29.884145	-97.935554	Hays	City Park
HSM250 Peak	05/04/2018	13:50	29.882213	-97.934867	Hays	Purgatory Creek
HSM260 Peak	05/04/2018	13:10	29.87484	-97.931713	Hays	I-35 Reach
HSM270 Peak	05/04/2018	13:30	29.868809	-97.930378	Hays	Capes Dam
HSM210 Trail	05/04/2018	18:10	29.893566	-97.927631	Hays	Sink Creek
FDHSM210 Trail	05/04/2018	18:10	29.893566	-97.927631	Hays	Sink Creek
HSM230 Trail	05/04/2018	17:02	29.889831	-97.935957	Hays	Sessoms Creek
FDHSM230 Trail	05/04/2018	17:02	29.889831	-97.935957	Hays	Sessoms Creek
HSM231 Trail	05/04/2018	17:30	29.886254	-97.935891	Hays	Dog Beach Outflow
HSM240 Trail	05/04/2018	19:05	29.884145	-97.935554	Hays	City Park
HSM250 Trail	05/04/2018	18:10	29.882213	-97.934867	Hays	Purgatory Creek
HSM260 Trail	05/04/2018	17:09	29.87484	-97.931713	Hays	I-35 Reach

Location / Sample Name	Date Sampled	Time Sampled	Latitude (dd)	Longitude (dd)	County	Location Generic Name
FDHSM260 Trail	05/04/2018	17:09	29.87484	-- 97.931713	Hays	I-35 Reach
HSM270 Trail	05/04/2018	17:32	29.868809	-97.930378	Hays	Capes Dam
TB4	05/04/2018	00:00	NA	NA	Hays	VOC Blank

SAN MARCOS SEDIMENT

Location / Sample Name	Date Sampled	Time Sampled	Latitude (dd)	Longitude (dd)	County	Location Generic Name
HSM 310	6/28/2018	9:58	29.893566	-97.927631	Hays	Sink Creek
HSM 320	6/28/2018	11:11	29.890258	-97.934568	Hays	Spring Lake
HSM 330	6/28/2018	11:54	29.889831	-97.935957	Hays	Sessoms Creek
FDHSM330	6/28/2018	11:54	29.889831	-97.935957	Hays	Sessoms Creek
HSM 340	6/28/2018	13:20	29.883955	-97.935295	Hays	City Park
HSM 350	6/28/2018	13:52	29.880016	-97.932977	Hays	Rio Vista Dam
HSM 360	6/28/2018	14:31	29.87469	-97.931603	Hays	1-35 Reach
HSM 370	6/28/2018	15:19	29.868809	-97.930378	Hays	Capes Dam

SAN MARCOS PDS

Location / Sample Name	Installed	Retrieved	Latitude (dd)	Longitude (dd)	County	Location Generic Name
HSM 410	2/01/18 13:30	2/15/18 10:41	29.893566	-97.927631	Hays	Sink Creek
HSM 420	2/01/18 13:48	2/15/18 10:51	29.890258	-97.934568	Hays	Spring Lake
FDHSM 420	2/01/18 13:48	2/15/18 10:51	29.890258	-97.934568	Hays	Spring Lake
HSM 430	2/01/18 14:06	2/15/18 10:57	29.889831	-97.935957	Hays	Sessoms Creek
HSM 440	2/01/18 14:25	2/15/18 11:07	29.883955	-97.935295	Hays	City Park
HSM 450	2/01/18 14:44	2/15/18 12:01	29.880016	-97.932977	Hays	Rio Vista Dam
HSM 460	2/01/18 15:03	2/15/18 12:16	29.87469	-97.931603	Hays	1-35 Reach
HSM 470	2/01/18 15:35	2/15/18 12:27	29.868809	-97.930378	Hays	Capes Dam
HSM 410	4/02/18 13:15	4/16/18 10:37	29.893566	-97.927631	Hays	Sink Creek
HSM 420	4/02/18 13:28	4/16/18 10:47	29.890258	-97.934568	Hays	Spring Lake
FDHSM420	4/02/18 13:28	4/16/18 10:47	29.890258	-97.934568	Hays	Spring Lake
HSM 430	4/02/18 13:44	4/16/18 10:54	29.889831	-97.935957	Hays	Sessoms Creek
HSM 440	4/02/18 13:55	4/16/18 11:05	29.883955	-97.935295	Hays	City Park
HSM 450	4/02/18 14:10	4/16/18 11:52	29.880016	-97.932977	Hays	Rio Vista Dam
HSM 460	4/02/18 14:22	4/16/18 12:05	29.87469	-97.931603	Hays	1-35 Reach
HSM 470	4/02/18 15:09	4/16/18 12:15	29.868809	-97.930378	Hays	Capes Dam
HSM 410	6/01/18 12:10	6/15/18 9:32	29.893566	-97.927631	Hays	Sink Creek
HSM 420	6/01/18 12:18	6/15/18 9:43	29.890258	-97.934568	Hays	Spring Lake
FDHSM420	6/01/18 12:18	6/15/18 9:43	29.890258	-97.934568	Hays	Spring Lake
HSM 430	6/01/18 12:26	6/15/18 9:51	29.889831	-97.935957	Hays	Sessoms Creek
HSM 440	6/01/18 12:37	6/15/18 10:08	29.883955	-97.935295	Hays	City Park
HSM 450	6/01/18 12:53	6/15/18 11:05	29.880016	-97.932977	Hays	Rio Vista Dam

Location / Sample Name	Installed	Retrieved	Latitude (dd)	Longitude (dd)	County	Location Generic Name
HSM 460	6/01/18 13:20	6/15/18 11:19	29.87469	-97.931603	Hays	1-35 Reach
HSM 470	6/01/18 13:35	6/15/18 11:27	29.868809	-97.930378	Hays	Capes Dam
HSM 410	8/1/18 10:32	8/16/18 10:39	29.893566	-97.927631	Hays	Sink Creek
HSM 420	8/1/18 10:51	8/16/18 10:52	29.890258	-97.934568	Hays	Spring Lake
HSM 430	8/1/18 11:02	8/16/18 11:35	29.889831	-97.935957	Hays	Sessoms Creek
FDHSM 450	8/1/18 11:36	8/16/18 12:59	29.880016	-97.932977	Hays	Rio Vista Dam
HSM 440	8/1/18 11:18	8/16/18 11:17	29.883955	-97.935295	Hays	City Park
HSM 450	8/1/18 11:45	8/16/18 12:59	29.880016	-97.932977	Hays	Rio Vista Dam
HSM 460	8/1/18 11:55	8/16/18 13:16	29.87469	-97.931603	Hays	1-35 Reach
HSM 470	8/1/18 12:15	8/16/18 13:38	29.868809	-97.930378	Hays	Capes Dam
HSM 410	10/1/2018 13:01	10/15/2018 11:36	29.893566	-97.927631	Hays	Sink Creek
HSM 420	10/1/2018 13:12	10/15/2018 11:44	29.890258	-97.934568	Hays	Spring Lake
FDHSM 420	10/1/2018 13:13	10/15/2018 11:44	29.889831	-97.935957	Hays	Sessoms Creek
HSM 430	10/1/2018 13:23	10/15/2018 11:57	29.889831	-97.935957	Hays	Sessoms Creek
HSM 440	10/1/2018 13:39	10/15/2018 13:08	29.883955	-97.935295	Hays	City Park
HSM 450	10/1/2018 13:56	10/15/2018 13:30	29.880016	-97.932977	Hays	Rio Vista Dam
HSM 460	10/1/2018 14:14	10/15/2018 13:35	29.87469	-97.931603	Hays	1-35 Reach
HSM 470	10/1/2018 14:35	10/17/2018 15:30	29.868809	-97.930378	Hays	Capes Dam
HSM410	12/3/2018 10:59	12/17/2018 12:42	29.893566	-97.927631	Hays	Sink Creek
HSM420	12/3/2018 12:34	12/17/2018 12:53	29.890258	-97.934568	Hays	Spring Lake
HSM430	12/3/2018 12:44	12/17/2018 12:58	29.889831	-97.935957	Hays	Sessoms Creek
HSM440	12/3/2018 13:06	12/17/2018 13:19	29.883955	-97.935295	Hays	City Park

Location / Sample Name	Installed	Retrieved	Latitude (dd)	Longitude (dd)	County	Location Generic Name
HSM450	12/3/2018 13:32	12/17/2018 13:31	29.880016	-97.932977	Hays	Rio Vista Dam
FDHSM450	12/3/2018 13:32	12/17/2018 13:31	29.880016	-97.932977	Hays	Rio Vista Dam
HSM460	12/3/2018 13:45	12/17/2018 13:43	29.87469	-97.931603	Hays	I-35 Reach
HSM470	12/3/2018 14:04	12/17/2018 13:54	29.868809	-97.930378	Hays	Capes Dam

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Location / Sample Name	Installed	Retrieved	Latitude (dd)	Longitude (dd)	County	Location Generic Name
HSM 470	**2/01/18 15:35**	**3/2/18**	**29.868809**	**-97.930378**	**Hays**	**Capes Dam**
HSM 470	**4/02/18 15:09**	**5/3/18**	**29.868809**	**-97.930378**	**Hays**	**Capes Dam**
HSM 470	**6/01/18 13:35**	**7/2/18**	**29.868809**	**-97.930378**	**Hays**	**Capes Dam**
HSM 470	**8/1/18 12:15**	**8/31/18**	**29.868809**	**-97.930378**	**Hays**	**Capes Dam**
HSM 470	**10/1/2018 14:35**	**10/31/18**	**29.868809**	**-97.930378**	**Hays**	**Capes Dam**
HSM470	**12/3/2018 14:04**	**12/31/2018**	**29.868809**	**-97.930378**	**Hays**	**Capes Dam**