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.

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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

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 ○ Use TCEQ/TPWD RBA Option 1 Protocol for macroinvertebrate community health without variables. ○ 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. ○ Sampling details: The result is only one sample per reach. ○ 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.

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.

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

EAHCP Staff March 15, 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. 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.

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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.

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.

EAHCP Staff March 15, 2016

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.

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

[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.

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

[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

[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	X	X	
- including Texas wild-rice vulnerable stands	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."

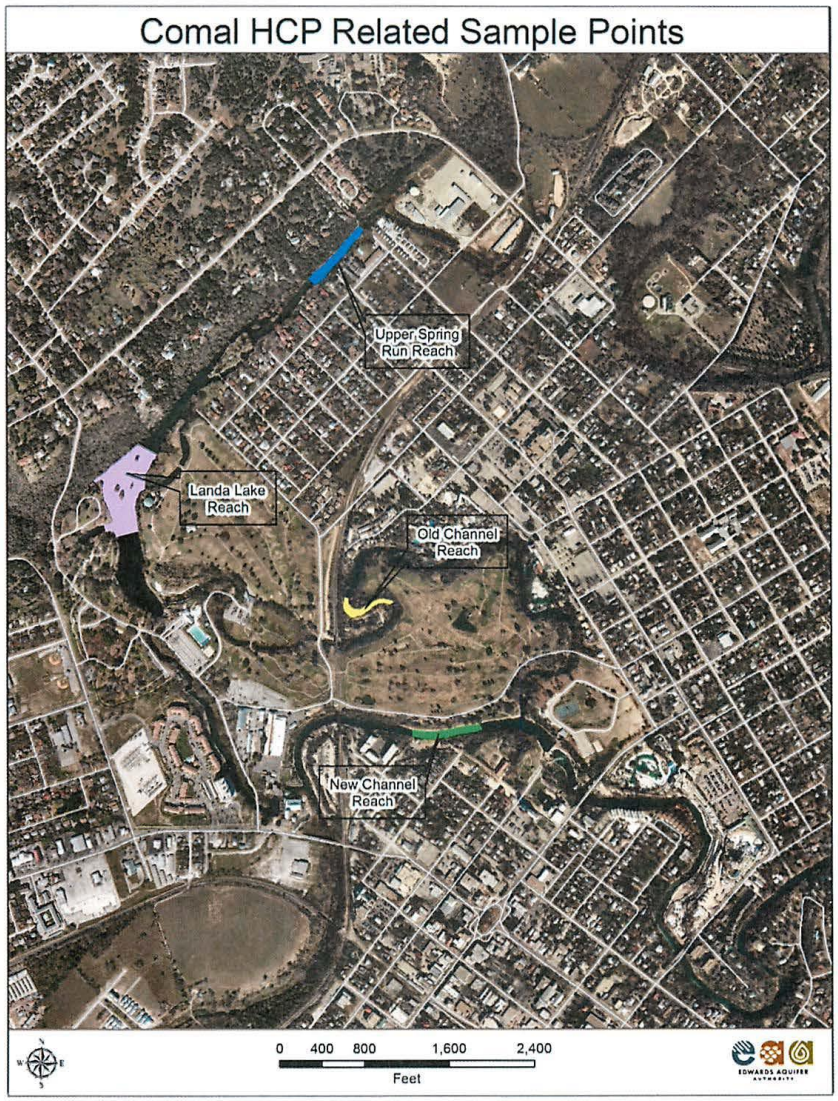

Fig. 2. San Marcos Springs/River ecosystem "reaches."

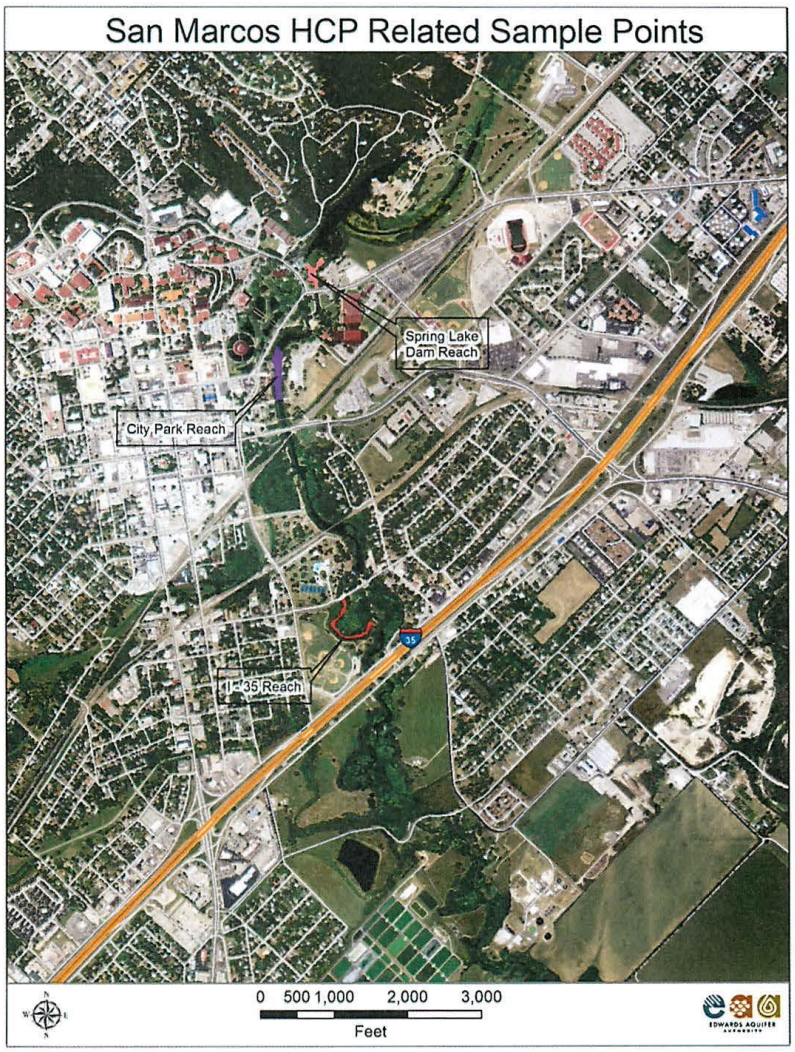

Fig. 3. Sewell Park Texas wild-rice vulnerable stands.

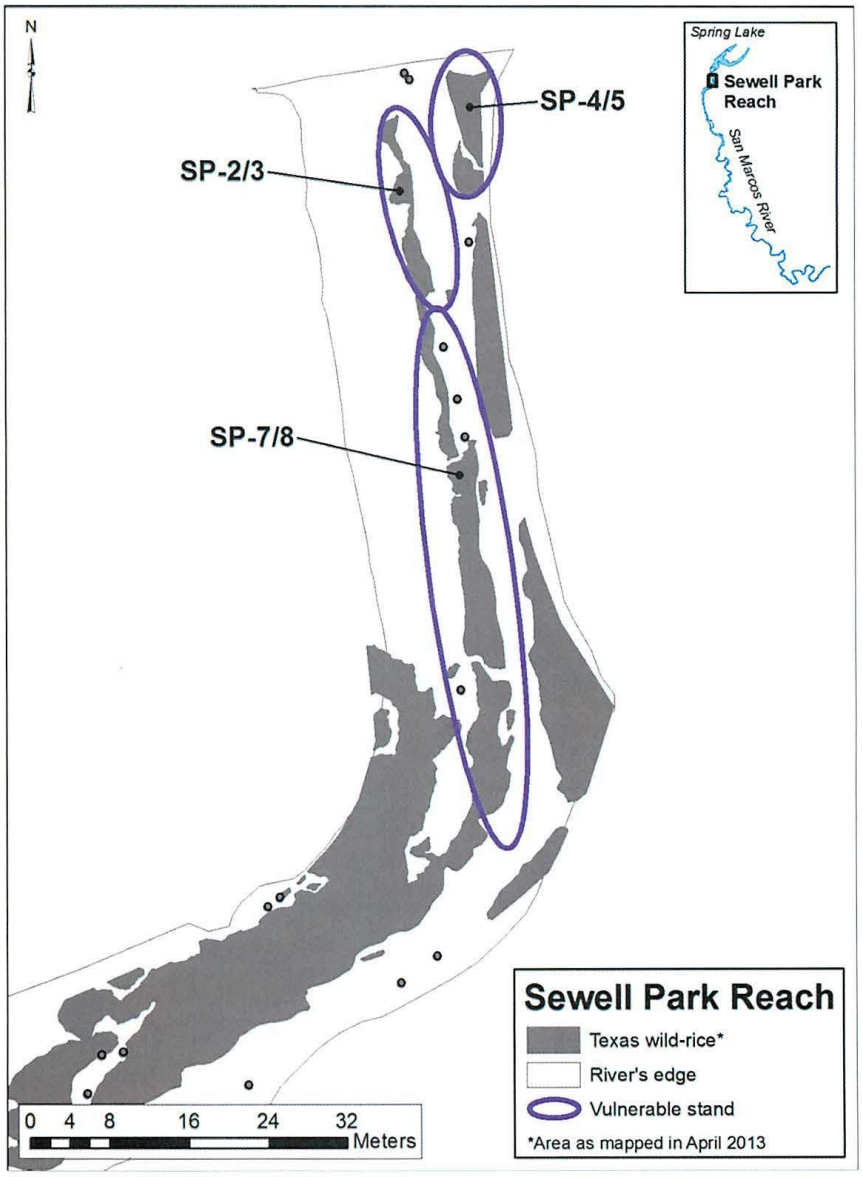

Fig. 4. Upper I-35 Texas wild-rice vulnerable areas.

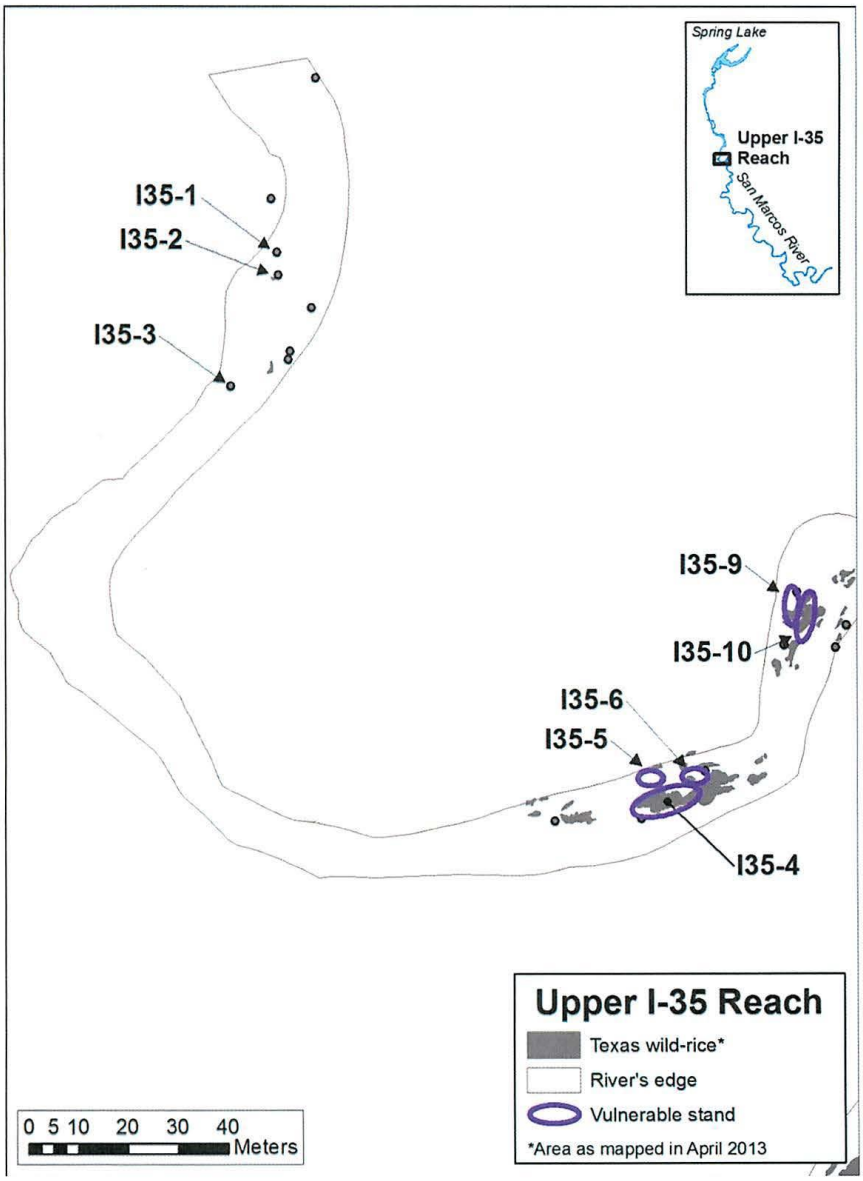

Fig. 5. Lower I-35 Texas wild-rice vulnerable stands.

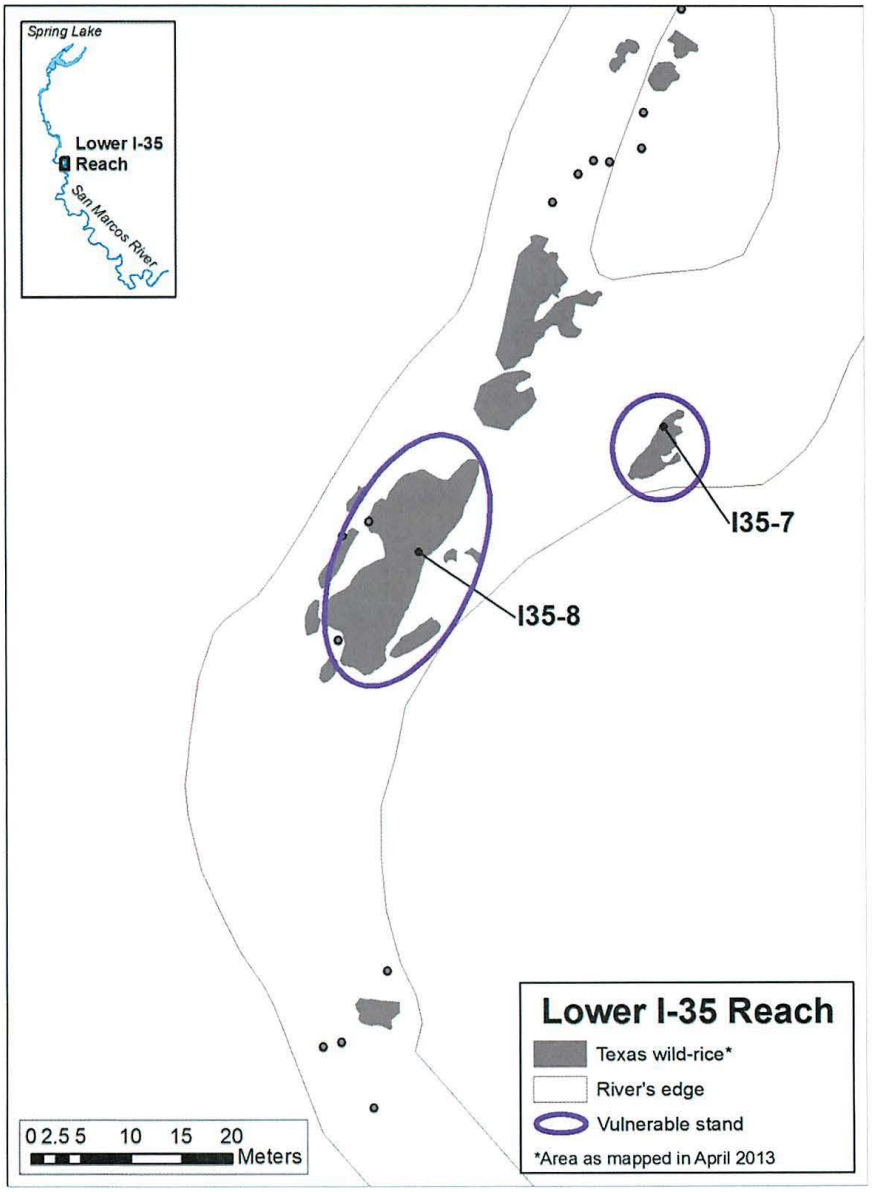

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Fig. 6. Drift net locations in the Comal Springs system.

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

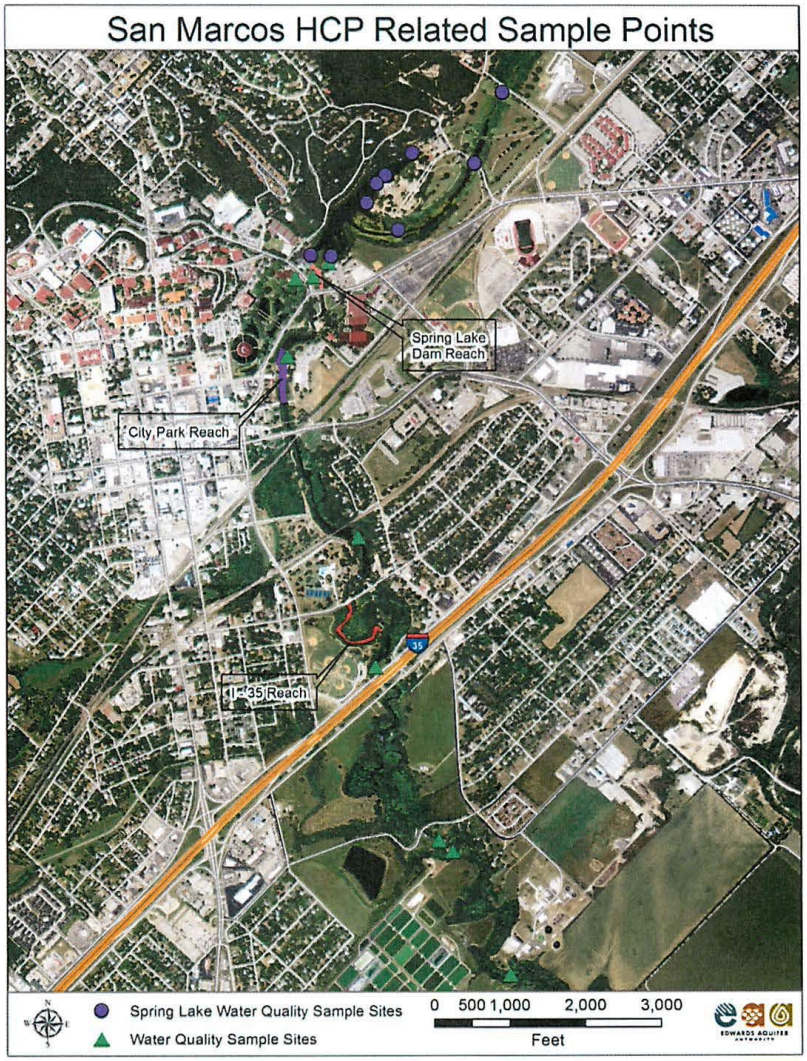
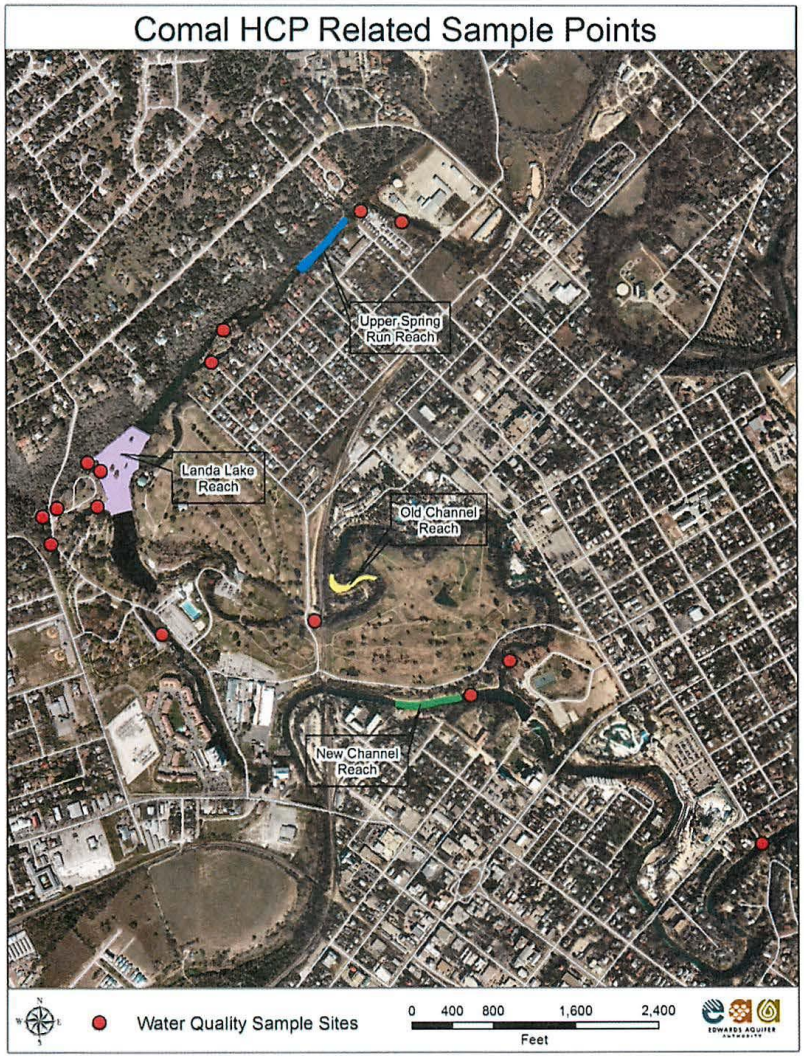


Fig. 8. Comal Springs/River system sample points.



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.