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."

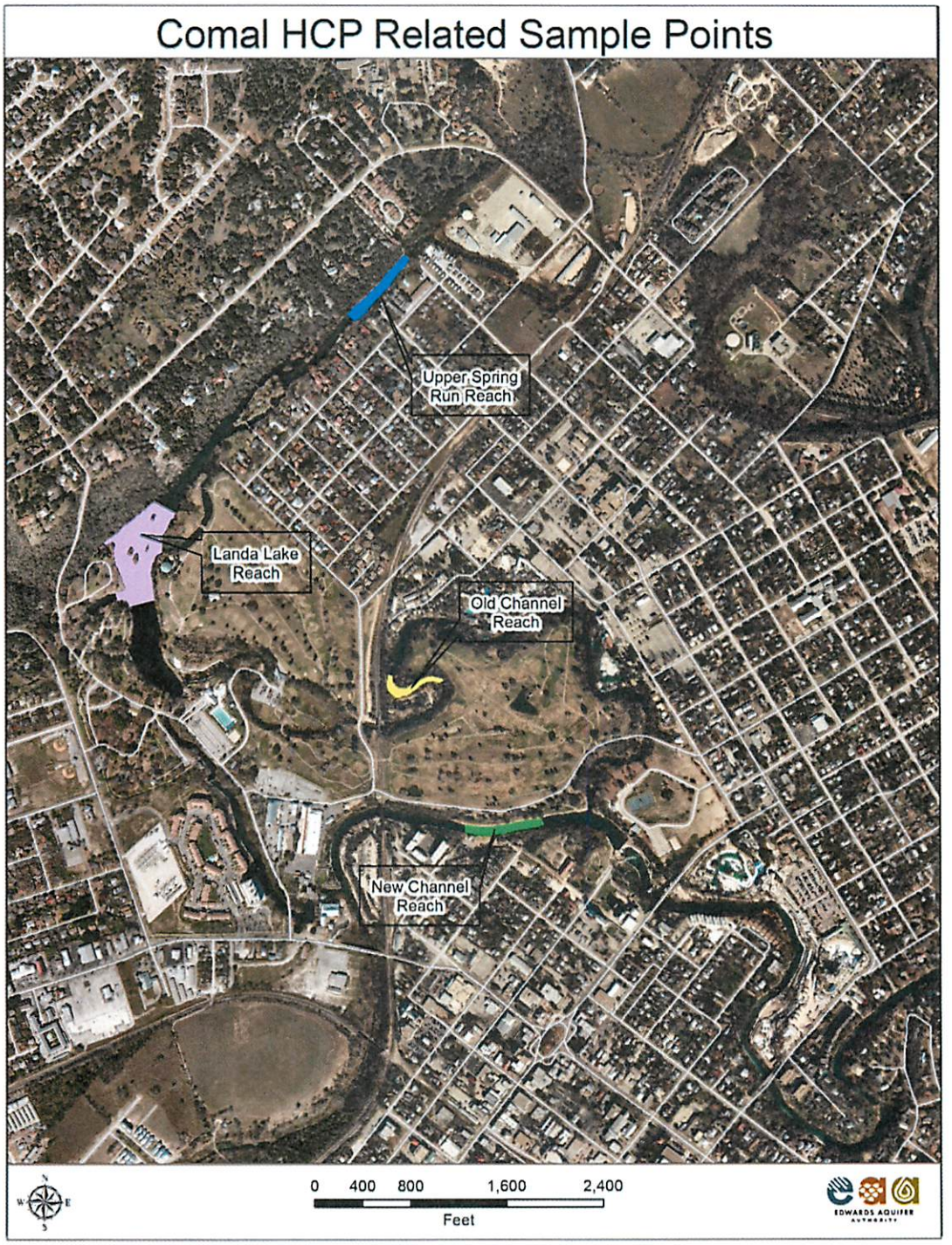


Fig. 2. San Marcos Springs/River ecosystem "reaches."

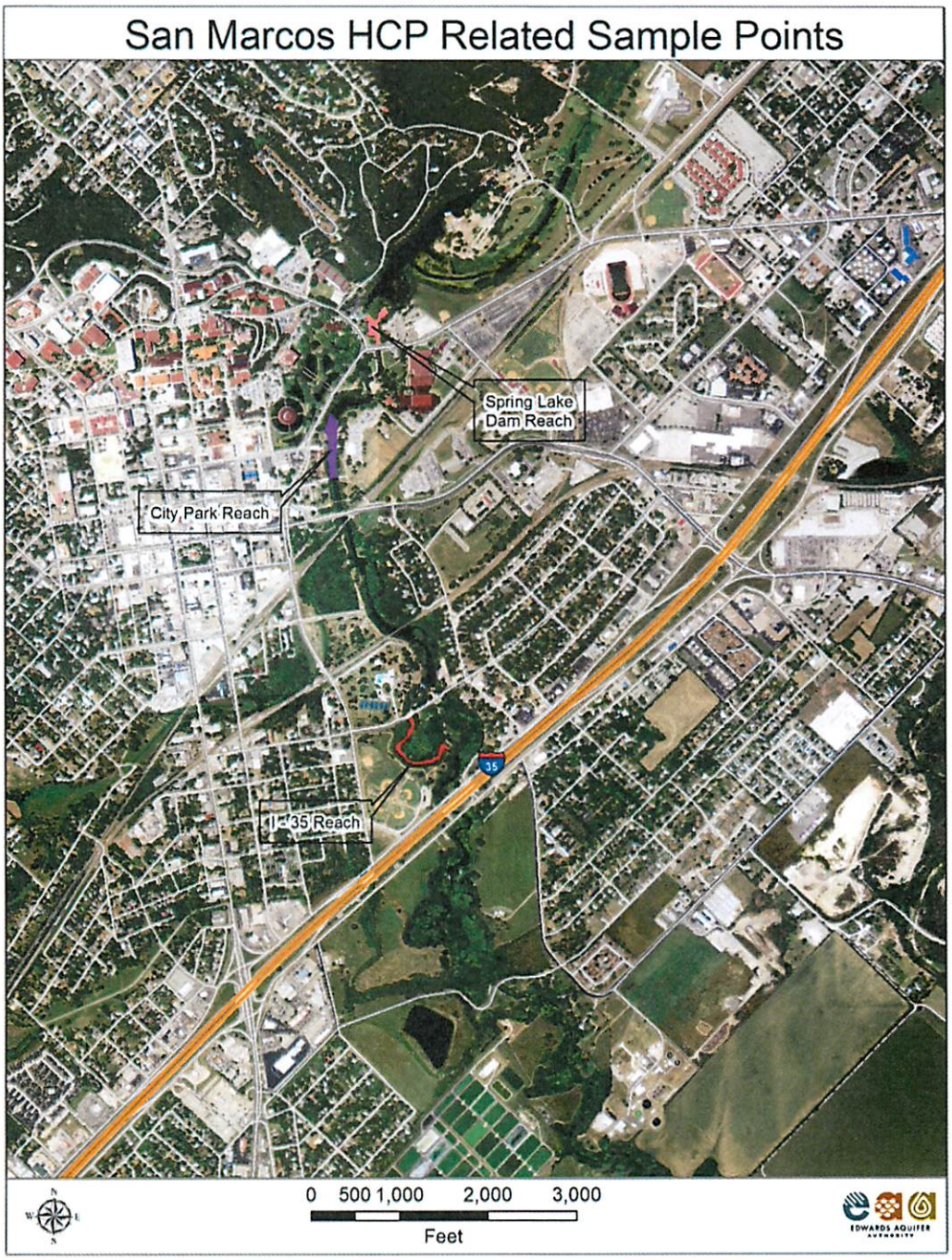


Fig. 3. Sewell Park Texas wild-rice vulnerable stands.

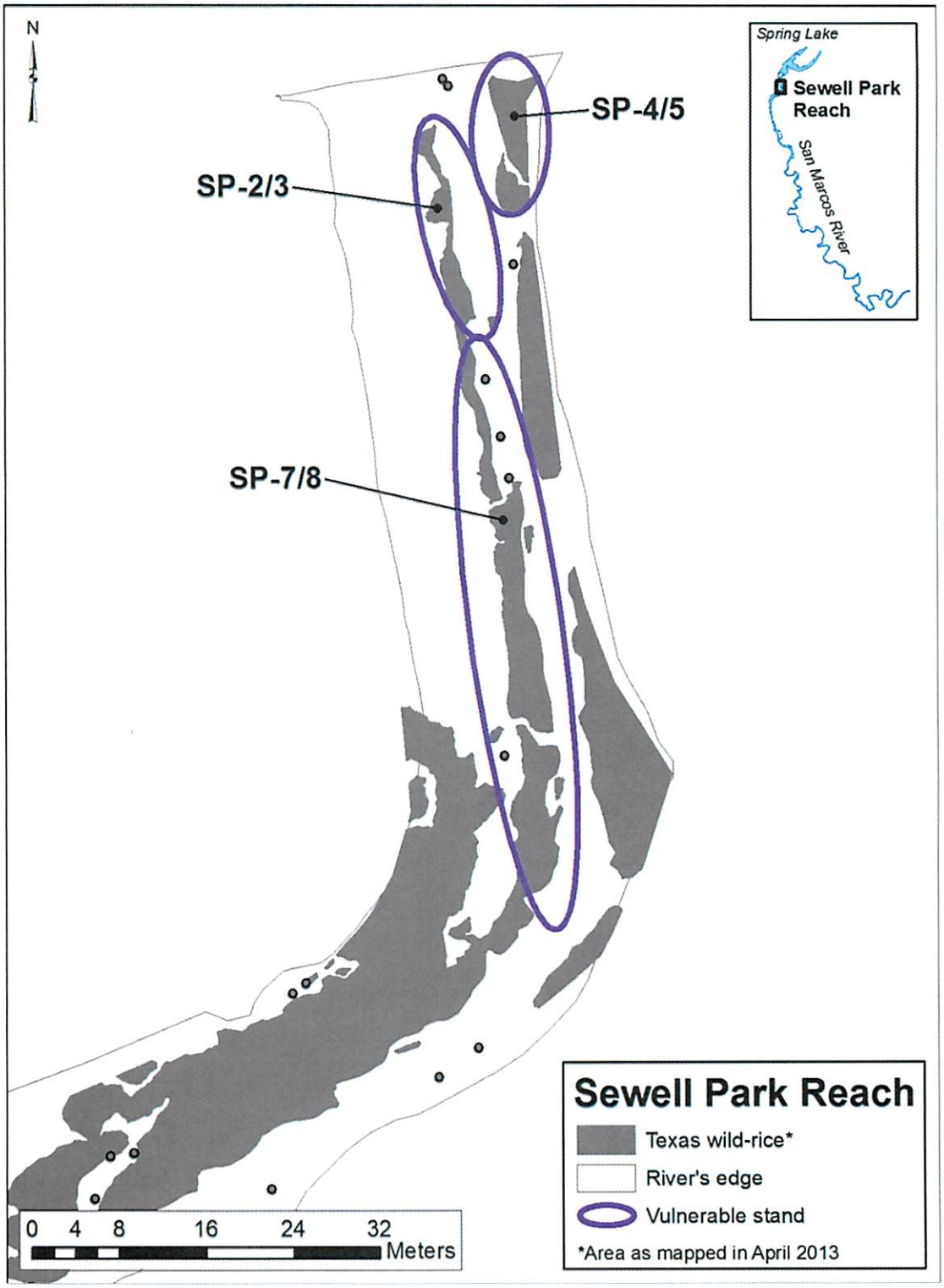


Fig. 4. Upper I-35 Texas wild-rice vulnerable areas.

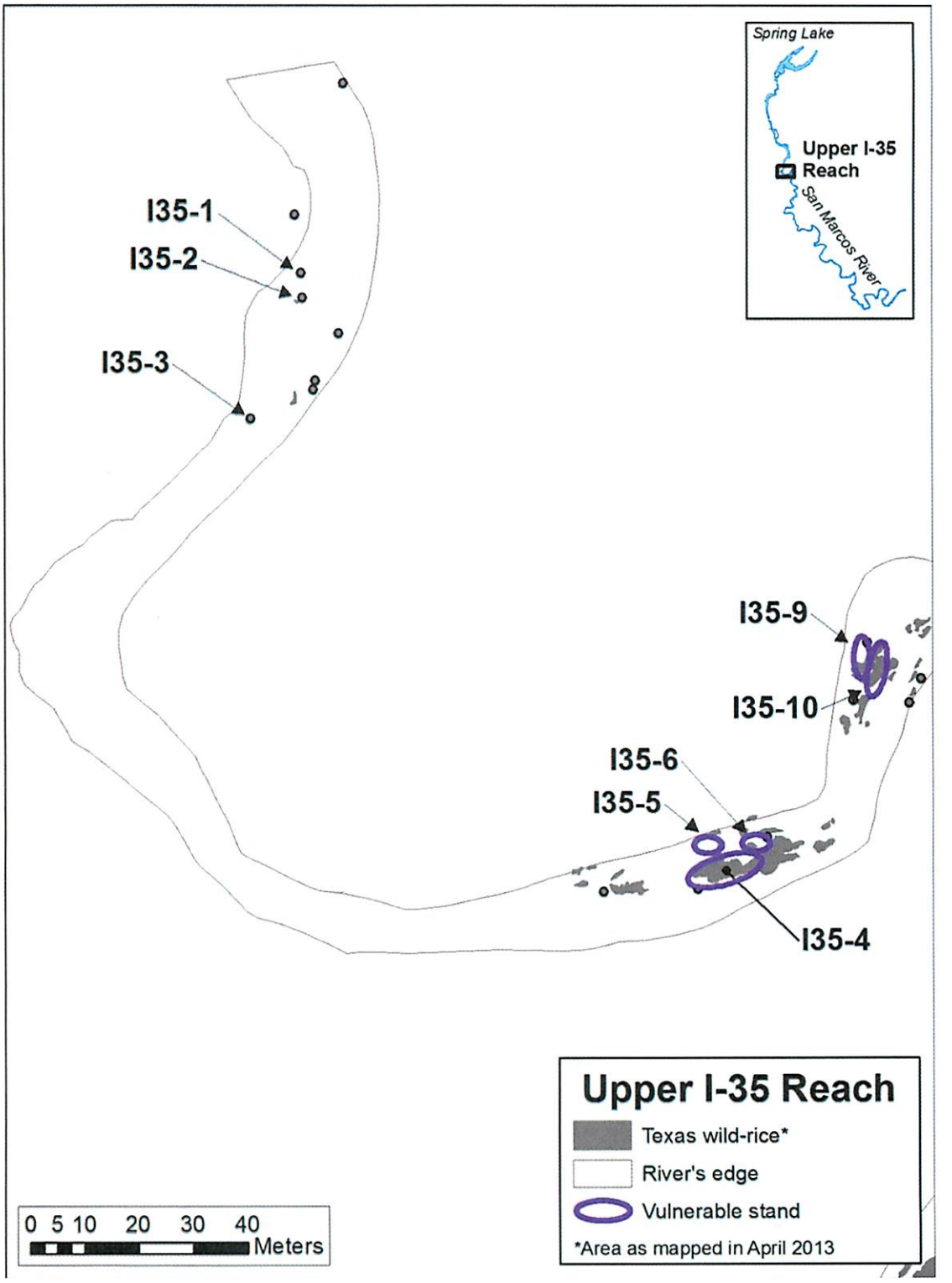


Fig. 5. Lower I-35 Texas wild-rice vulnerable stands.

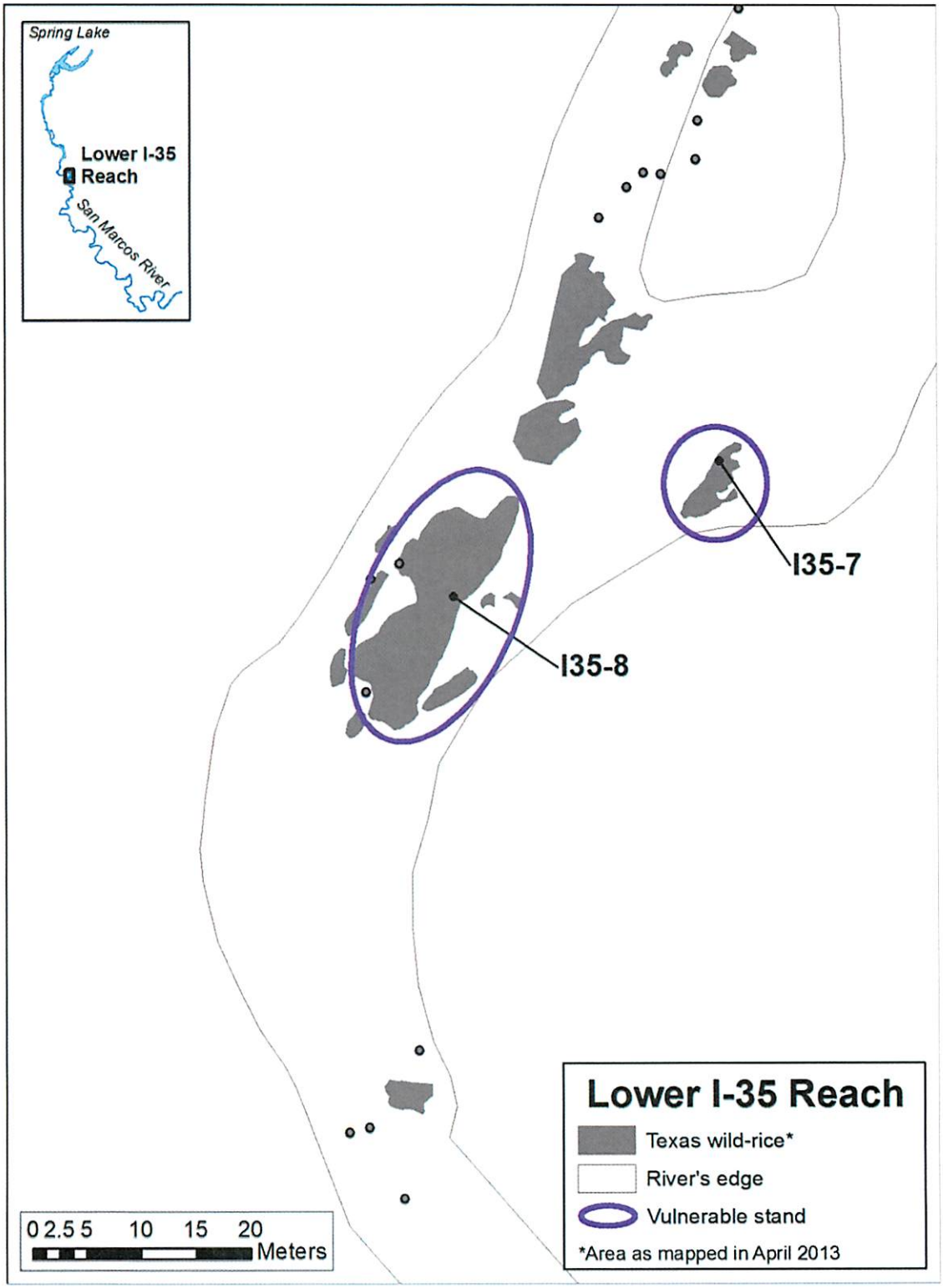


Fig. 6. Drift net locations in the Comal Springs system.

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

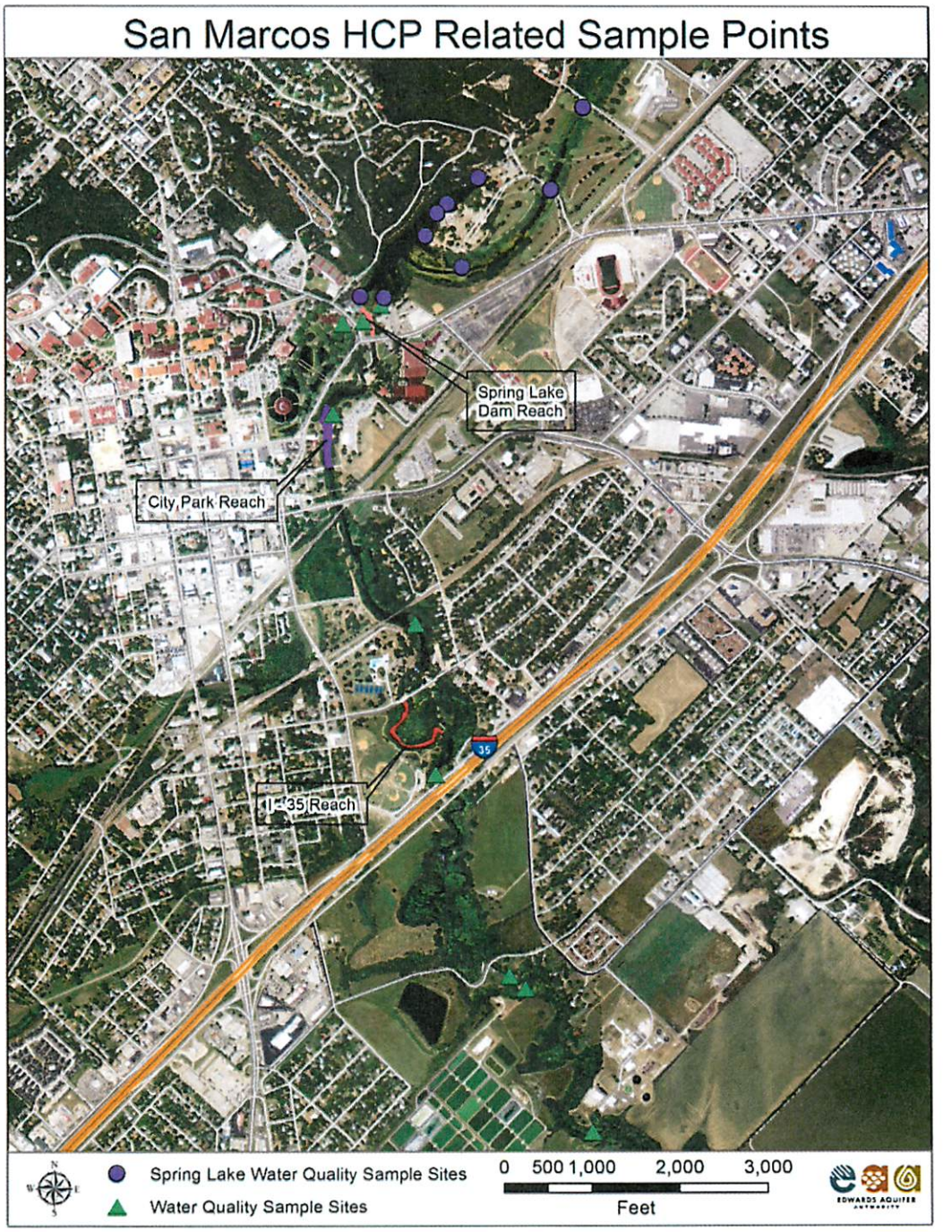
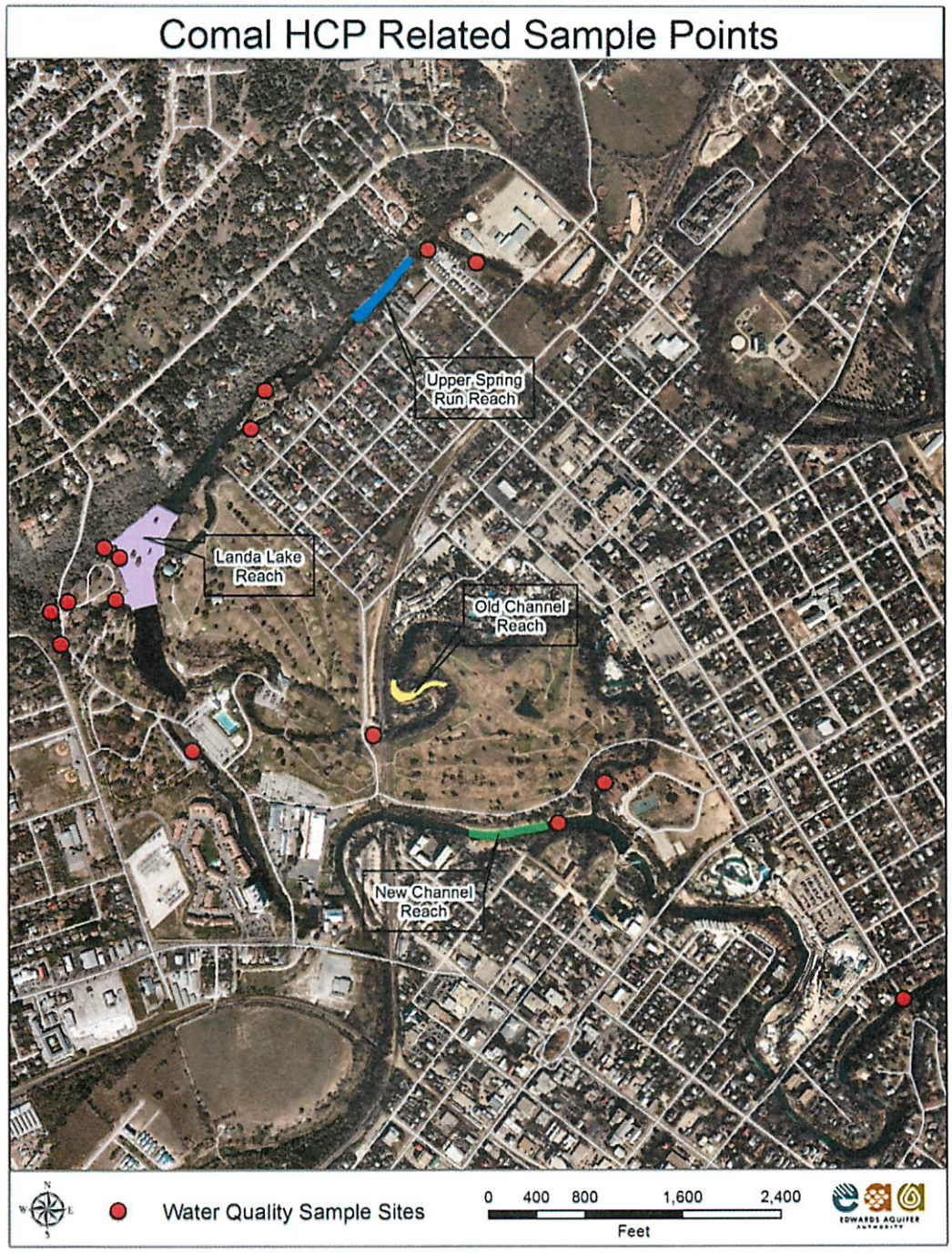


Fig. 8. Comal Springs/River system sample points.



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.